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ECONOMIC FAILURES IN HEATING SERVICE: CASE OF UKRAINE DURING THE 1991–2015 PERIOD

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ЕКОНОМІЧНІ ПРОРАХУНКИ У СИСТЕМІ ТЕПЛОПОСТАЧАННЯ: ДОСВІД УКРАЇНИ ЗА ПЕРІОД З 1991 ДО 2015 РОКУ

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ЭКОНОМИЧЕСКИЕ ПРОСЧЕТЫ В СИСТЕМЕ ТЕПЛОСНАБЖЕНИЯ: ОПЫТ УКРАИНЫ ЗА ПЕРИОД С 1991 ПО 2015 ГОД

It is not sufficient to treat energy systems in a long term perspective as purely technocratic ones. Social actors, socio-political dynamics, co-evolution nature of society and technology should be also taken into account. Applying the framework of a sociotechnical and multi-level theory on transitions it is investigated whether a technological transition in heating service of Ukraine's building sector is observed. It is shown that despite interacting dynamics at the regime and landscape levels heating sector of Ukraine can considered as being in stagnation.

Succesful implementation of innovations requires radically new methodologies compared to currently applied in Ukrainian energy policy. Within the frameworks of ERAIHM project socio-technical approach was adapted for scenario development of heating system for the Ukrainian city of Bila Tserkva.

The article proposes to combine exergy-based and sustainability methodologies as nich-cumulation process for development of new types of heating systems. Extending of the combined exergetic and sustainability approach to meso-level as standards, rules will accelerate transitons in heating service.

***Key words**: energy systems; technological transition; scenario development; exergetic approach.*

Bibl.: 10.

Неправильно розглядати енергетичні системи в довгостроковій перспективі як суто технократичні. Соціальні фактори, соціально-політична динаміка, еволюція природи суспільства і технології повинні бути також прийняті до уваги.

За допомогою застосування структури соціотехнічної і багаторівневої теорії переходу досліджується питання, чи відбувається перехід на нові технології теплопостачання будівельної галузі України. Доведено, що успішне впровадження інновацій вимагає принципово нових методологій у порівнянні з тими, що нині застосовуються в українській енергетичній політиці.

У межах проекту ERAIHM соціально-технічний підхід був адаптований для розробки сценарної системи опалення для українського міста Біла Церков.

Запропоновано об'єднати методології, засновані на ексергії та стійкості для розробки нових типів систем опалення.

***Ключові слова**: енергетична система; технологічний перехід; сценарні системи; ексергетичний підхід.*

Бібл.: 10.

Недостаточно рассматривать энергетические системы в долгосрочной перспективе как чисто технократические. Социальные факторы, социально-политическая динамика, эволюционная природа общества и технологий также должны быть приняты во внимание.

С помощью применения структуры социотехнической и многоуровневой теории переходов исследуется вопрос о том, наблюдается ли переход на новые технологии теплоснабжения строительной отрасли Украины. Показано, что успешное внедрение инноваций требует принципиально новых методологий, по сравнению с применяемыми в настоящее время в энергетической политике Украины.

В рамках проекта ERAIHM был адаптирован социально-технический подход для разработки сценариев системы отопления для украинского города Белая Церковь.

Предложено объединить методологии, основанные на эксергии и устойчивости для разработки новых типов отопительных систем.

***Ключевые слова**: энергетическая система; технологичный переход; сценарные системы; эксергетический подход.*

Библ.: 10.

JEL Classification: Q40

The necessity for restructuring buildings environment into more sustainable forms is obvious and indisputable. The building stock is one of the major actor contributing energy related environmental problems. In many cases existing technological innovations in this sector are implemented very slowely and do not provide transitions toward sustainability. Changes in the existing institutions, professional norms, belief systems and, in some cases, also lifestyles are also required. Adoption of the 'wider system' view to encompass not only technical aspects about building infrastructure but also the societal and institutional elements and understanding how such socio-technical transitions might be brought about is one of a major today's interdisciplinary research challenge (e.g.1).

Today's most influential body of innovation-focused transition research originates in the Netherlands ("Dutch approach"). Approaches that descended from the Dutch school and feature most strongly in the study of "sustainability transitions" are multi-level perspective (MLP), transition management (TM), strategic niche management (SNM), technological innovation systems (TIS)2. The multi-level perspective was originally developed to understand and systematically analyse socio-technical transitions and regime shifts. Understanding the nature of transitions becomes particularly important in light of the major changes that the world faces currently. It can improve our knowledge of how transitions might be managed in a more sustainable manner. In recent years, the multi-level perspective has been used in several empirical studies: transitions from sailing ships to steamships; from horse-andcarriage to automobiles; from propeller-aircraft to turbojets ; analysing the failure of two niches in the Netherlands – heat generation from heat pumps and bio-gas production7; evolution of dynamics in digital technology, analysing system innovation in relation to the uptake and integration of decentralised CHP technology in Germany; transition in Dutch water management etc. Such sudies can be used as a tool to look into how prospective transitions might unfold in future. The framework of MLP has been developed based on findings from evolutionary theory and systems analysis. According to Geels 'the stability of established socio-technical configurations results from the linkages between heterogeneous elements'. For MLP, these are linkages between three conceptual levels: macro, meso and micro.

On the macro level 'landscape events' occur. Landscape is associated with the material context of society. It is made up of various macro factors such as fuel prices, interstate geopolitical relationships and forthcoming events (like treaties and wars), political and governmental coalitions, cultural values and major environmental problems. The socio-technical landscape forms the external context for action of, and interaction between, actors. The meso level is referred to as the 'socio-technical regime'. These regimes encompass social and institutional rules that enable and constrain activities between actors. These rules are related to several institutionalised factors, such as markets, user preferences, (sectoral) policies, industries, science, culture and technology. As a rule of thumb, socio-technical regimes only change incrementally and contain defence mechanisms to fend off attempts to replace them with alternatives, typically radical innovations developed at the micro level in 'socio-technical niches'. The micro level is referred to as the analytical level in which 'socio-technical niches' develop. The niche is one of the central concepts in transition research. Niches form protective spaces in which radical innovation can develop, while being protected from regime defence mechanisms. An important question regarding the role of the niche is upscaling (e.g. addressing the question how to increase the take up and integration of the niche within society). Smith and Raven differentiate three functions for niche protection: shielding, nurturing and empowering. Shielding refers to processes that hold at bay selection procedures from mainstream selection environments. Nurturing refers to processes such as learning, networking and expectation formation. Finally, empowering refers to the process that makes niche innovations competitive within unchained selection environments ('fit-and-conform') and processes that restructure mainstream selection environments in ways favourable to the niche ('stretch-and-transform'). Political, administrative, managerial and academic interest in how to encourage (sustainable) transitional change have led to the development of managerial transitional change frameworks, notably the Strategic Niche Management (SNM) and Transition Management. The interlinked character of the macro, meso and micro levels means that regimes are embedded within landscapes and niches within regimes. Innovations (and hence attempts to bring about transitional change) take off in niches in the context of existing regimes with their specific problems, rules and capabilities. Thus, in a transition process, interactions between dynamics exist between the three levels. Theoretically, the systemic dynamics that result in transitional change follow a typical pattern. Landscape events (like new political situation, environmental problems, increase of fuel prices) create pressure on socio-technical regimes which result in problems that regimes cannot solve from within. Solving these problems via incremental regime optimization will not suffice to solve these problems and creates opportunities for alternative radical innovations with the potential to overthrow the current regime. This provides opportunities for new innovations that is developed in niches and are supported by social networks. After iterative sets of niche experiments (e.g. by organising demonstration projects), innovations mature and have the potential to gain a foothold in the existing socio-technical regime. If successful, it can eventually replace the existing regime and hence the socio-technical system as such. When replacement of an existing regime by a novel regime takes place, one can speak of system innovation. When this concerns a radical innovation, one can speak of transitional change. Breakthroughs of radical innovations consequently depend on interactive systemic processes within and between the macro, meso and micro levels (i.e. between landscape events, the sociotechnical regime and niches). In general, transitions are context dependent. Analysis of important lessons from long-term (1990-2015) performance of the sector providing heating needs for buildings in Ukraine is made in this work using a sociotechnical and multi-level theory on transitions. Among others we will try to answer the following questions: Do we observe a technological transition in Ukraine's heating systems? And is this transition managed for the sake of overcoming today's challenges? During Soviet period Ukrainian heating as one of basic services had been supplied fairly cheaply and abundantly. Although the standards requirenments (SNiPs) to insulation characteristics of envelopes had been changed during that period more than ten times thermal performance of buildings was quite poor. The main reason was very low prices for energy which were set administratively by the state. Investments expenditures for construction materials were of high priority. No heat or hot water metering existed in Ukrainian residential or commercial and public buildings. Consumers did not have the technical capacity to regulate the heat supply individually nor has it been possible usually at the level of an individual building – it was performed only centrally at the heat production plants and at the substations according to outside temperature levels. Heating servise was and still is based mostly on district heating (more than 60 %) and natural gas. Up to 2013 more than 85 % of Ukraine's oil, about 75 % of its gas and all of its nuclear fuel came from Russia or through Russia. Ukraine has some domestic resources of coal, gas and oil but they are not sufficient to meet the country's energy demand. Little attention was paid to energy efficient measures because of low prices on fuel. Although during Soviet period novelties in heating were being developing in the nich-level the mesolevel regime did not provide the opportunity to implement them widely. After fall of the Soviet Union in 1991 Ukraine became independent. Transition from centrally planned economy to market-based one at the end of the 20th century caused considerable pressure on landscape level in Ukrainian society. It stimulated changes at meso-level. But generaly speaking socio-technical modes in the sphere of heating servise remained the same. Reforms in heating sector of residential sector have been too socially explosive to touch. In 1994 Ukraine governed the Law "On Energy Conservation" No 74/94 BP dd. 01.07.1994. This Law stipulates a number of principles in the energy conservation sphere. A lot of them are either declarative or too general, for instance:

− combination of methods of economic stimulation and financial responsibility for the purpose of rational and efficient use of fuel and energy resources;

− popularization of economic, ecologic and social advantages of energy conservation,

− increase of public educational level in this sphere.

After 1994 Ukraine started liberalising its energy sector. But this reform touched only electricity market. The heating sector is being regulated by central state bodies up till now (today National Commission for State Regulation of Energy and Public Utilities provides this function and is subordinated to the President of Ukraine and accountable to the Parliament of Ukraine). Electricity prices are set by the market, but the state regulator can still apply compulsory cost allocation for setting heat tariffs. Electricity prices vary according to market conditions, while heat tariffs reflect the share of costs allocated to it. Such regulation is reasoned by an effort to decrease pressure on households, particularly low-income families which constitute the majority of Ukrainian population. Heating service in households seems to have a higher priority than electricity one especialy in countries with cold climate. Radical policy in heating seems to be too socially explosive to touch. Among possible changes in space heating technologies in Ukraine (main competitors of the district heating) are building or apartment-level natural gas boilers. Consumer dissatisfaction with service quality in district heating and low tariffs for gas favours such changes but not for low-income families (about 70%). On the other hand, installation of such boilers and individual disconnecting from district heating caused new problems. It unbalanced hydraulic modes, overdimensioned capacity and increased maintenance expenditures in existing district heating systems. Moreover this worsened air quality near buildings. As a result the state forbade such installation.

According to the Order of the Ministry of Construction, Architecture and Housing and Communal services of Ukraine new Ukrainian Building Codes were issued in 2006 carrying stronger, about 2 times higher, requirements on energy consumption for spaceheating buildings. The new Codes propose design guidelines for both prescriptive and performance-based compliance paths. According to the prescriptive path further improvements in thermal resistance values for individual building envelope elements have been defined. The performance path requires specific energy consumption levels for space-heating the whole building, allowing for trade-offs in the energy performance of individual envelope elements and giving possibilities to implement a wider range of options for increasing energy efficiency. Methods and paths for achieving requirements of the Codes are chosen during the design process. Achieving requirements of the Codes in compliance with the performance path introduces a wider range of energy efficiency options to implement. This path considers a building envelope and a HVAC system as a whole complex. The results of calculations showed that combination of measures for decreasing energy consumption in space-heating buildings in compliance with the performance path of the Codes can give an optimum solution which has investment feasibility. Some increasing envelope thermal resistance in combination with more efficient ventilation systems, improved control systems, more efficient sources of heating energy, alternative sources of energy, appropriate choice of shape, size and orientation of a building can be proposed to implement in current conditions of Ukraine as energy efficiency solutions which achieve requirements of the new Ukrainian building Codes. Although, the amount of buildings which are operated in compliance with the new Ukrainian Codes is still limited due to lack of economic feasibility.

Currently insulation of individual dwellings in multi-story residential buildings can be observed in Ukraine. Such measures are implemented because of poor thermal comfort inside as a result of low quality service of existing district heating systems. For final customer of heat energy two main pricing models are used in Ukraine: model 1 – price for 1 square meter of heated area, calculated on the basis of "normative tariff" (widely used at present); model 2 – price for 1 Gcal of consumed energy (applied in cases where the heat metering is installed). In model 1 a dwelling doesn't not save any costs after additional insulation of its external constructions. In a case of building-level heat metering (only such installation is permitted in Ukraine) insulation of the individual apartment results in decreasing consumption-based bills for the whole building but not for this apartment (heating bill is divided among apartments based on the living area each apartment occupies). So, the main reason of this retrofitting is improving indoor thermal conditions. Although, it is not financially feasible for residential buildings but mostly for commercial and budgetary ones.

So far, the government has not implemented many of its planned reforms, which thus remain political declarations. Most of the laws are declarative, very general and technocratic. For example, in two versions Energy Strategy of Ukraine for period till 2030 too technocratic approach is used. These Strategies lack well-designed and coordinated with other documents policy framework. New political situation in Ukraine after 2013 formed a new landscape shock. The EU-Ukraine Association Agreement was completely signed on June 2014. But such Russia's actions as annexing Crimea, establishing and supporting a separatist movement in Eastern Ukraine, have fundamentally changed the situation. Gazprom (the largest Russian statecontrolled gas company) increased Ukraine's gas price by 81 per cent from US268.5 per thousand cubic meters in late 2013 to US485 in 2014. Ukraine considered this new tariff - Russia's highest gas price in Europe - as unfair and unsustainable. Since that Ukraine has been trying to cut its dependence on Russian gas, buying and piping it back from European countries that had imported it from Russia at a lower price (Ukraine is one of the most important energy transit countries in the world: about 70% of the gas and 15% of the oil that Europe acquires from Russia travels through Ukraine.). According to the national oil and gas company Naftohaz in 2015 Ukrainian gas consumption fell significantly (from 42.6 bcm in 2014 to 33.8 bcm). Domestic gas production decreased less significantly, to 19.9 from 20.5 bcm. Gas imports fell to 15.3 bcm in 2015, from 19.5 bcm in 2014, and imports from Russia in particular plunged to 6.1 bcm in 2015, from 14.5 bcm a year earlier. For comparison, Ukraine imported 45 bcm of gas from Russia in 2011. At the same time, Ukraine almost doubled gas imports from the EU to 9.2 bcm in 201528. Current Minister of Energy and Coal Industry of Ukraine Volodymyr Demchyshyn announced current heating season without Russian fuel and Ukraine's plans to cut gas imports further to 11–13 bcm in 201629. According to requirements of the International Monetary Fund to resume lending to Ukraine under the Stand-by program increase in tariffs for housing and communal services took place in Ukraine since 2014 . But in dollar equivalent such prices have decreased due to drastic fall of Ukrainian currency. Such situation is not attractive for implementation of energy efficient and innovation technologies. Economic feasibility has turned out to be lower due to the fact that initial investments in such measures are linked to currency market. Such situation made Ukrainian consumers to install where it is possible wood and pellet boilers. But, again, this quite new technology resulted in additional operations and maintanence problems and extra costs.

While sustainability transitions studies are often being criticized for its narrow focus on European and other OECD countries, more and more scholars apply concepts and frameworks like transition management or strategic niche management to countries in Eastern Europe, Asia, Africa or Latin America. Using socio-technical approach to system development, adaptation and implementation of backcasting methodology for strategic decision making in the Ukrainian cities was realized within the frameworks of ERAIHM project (Advancing Research and Cooperation Capacities of Institute of Hydromechanics of the National Academy of Sciences of Ukraine towards European Research Area). Scenario development for heating system in Bila Tserkva has been elaborated. It should be noted that in Ukrainian conditions this is the very first attempt of applying modern techniques for solving of the multi-factor transdosciplinary problems oriented on the middle- and long-term sustainable development of social-economical systems. Today we observe development and implementation of the next generation of principles for provision of thermal comfort in buildings . One of the necessary niche level innovations for implementation of these new principles is exergy-based methodology which includes not only innovations in technical components but also in the societal and institutional elements. Exergy analysis is without a doubt a powerful tool for developing, evaluating and improving thermal systems, particularly when this analysis is applied to the built environment. Today heating needs in building sector are commonly satisfied by burning fossil fuels with exergy efficiency as low as 10 % even when enthalpy efficiency can reach 90% and more. Application of low-exergy approaches to design of new innovative energy use strategies in building sector is one of the crucial challenges for this sphere. Advanced exergetic analysis, exergoeconomics (thermoeconomics), exergoenvironmental analysis – these new exergy approached methods which are mainly developed and applied to chemical industry and power sector can also be promoted for heating/cooling systems of built environment. There are several works which link the exergy concept with insights on sustainable energy supply and sustainable development. But the exergy methodology does not distinguish between renewable and not renewable energy sources. This distinction, crucial for finding options towards a more "sustainable" energy supply, must always be regarded additionally to the exergy analysis. Exergy approach is relatively new in the built environment and it has not been implemented in buldings standards. Extending the exergy-based methodology to mesolevel is one the current important challenge . Including exergy assessment in building energy codes would be a very important step towards a more energy efficient built environment and would help bringing the exergy approach to the public and decision makers. There are some works concerning including exergy in energy legislation39. This research needs additional attention.

Conclusion

1. On the base of socio-technical and multi-level approach the work has made an attempt to identify and analyse change processes which has been taken place in the heating sector of Ukraine during the 1991-2015 period.

2. It is shown that historical change processes within the specified period in Ukraine's heating sector can not be characterized as a transition. There are interacting dynamics at the regime and landscape levels (Ukraine independence in 1991, implementation of market rules, dramatic political changes in 2014-15), but with little influence from niches. Such changes can be regarded as some reproductions but not transitions. Moreover, heating sector in Ukraine can be considered to be in stagnation.

3. Socio-technical regime of this sector remains almost the same as during Soviet period of time (outside market rules, technocratic approach, based mainly on natural gas, strong state regulation of tariffs). The Ukrainian government has not implemented many of its planned reforms, which thus remain political declarations. Action plans in Ukraine show very modest developments for implementations of sustainability transitions in heating systems. Most of the laws are declarative, very general, too technocratic and with poor policy coordination.

4. The main reason is that heating service has a high social importance especially for the major consumer – residential sector. Liberalising, incorporating into market rules, stronger policy seem too socially explosive to touch for the Ukraine's government.

5. Incremental solutions (windows replacement, installation of individual gas boilers, insulation of individual appartments, metering) which happen within the heating sector mostly by chance are reasoned by not only economic feasibility but also the necessity of provision of thermal comfort inside buildings. Quite ofted such un-controlled and not well-established measures worsen technical functionality, economic parameters and even comfortable conditions.

6. However, there are first attempts of applying socio-technical approach to system developments in Ukrainian heating systems (example of ERAIHM project).

7. Exergy-based methodology linked with sustainable indicators will enable to improve nich-novelties in heating service and accelerate breaks through for adjustments in socio-technical regime of heating service.

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