ROLE OF THE NATIONAL ENERGY SYSTEM MODELLING IN THE PROCESS OF THE POLICY DEVELOPMENT

by

Matevz PUSNIK [*]***, Boris SUCIC, Andreja URBANCIC, and Stane MERSE***

Energy Efficiency Centre, Jozef Stefan Institute, Ljubljana, Slovenia

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Strategic planning and decision making, nonetheless making energy policies and strategies, is very extensive process and has to follow multiple and often contradictory objectives. During the preparation of the new Slovenian Energy Programme proposal, complete update of the technology and sector oriented bottom up model of Reference Energy and Environmental System of Slovenia (REES-SLO) has been done. During the redevelopment of the REES-SLO model trade-off between the simulation and optimisation approach has been done, favouring presentation of relations between controls and their effects rather than the elusive optimality of results which can be misleading for small energy systems. Scenario-based planning was integrated into the Modular Energy System Analysis and Planning environment, allowing integration of past, present, and planned (calculated) data in a comprehensive overall system. Within the paper, the main technical, economic, and environmental characteristics of the Slovenian energy system model REES-SLO are described. This paper presents a new approach in modelling relatively small energy systems which goes beyond investment in particular technologies or categories of technology and allows smooth transition to low carbon economy. Presented research work confirms that transition from environment unfriendly fossil fuelled economy to sustainable and climate friendly development requires a new approach, which must be based on excellent knowledge of alternative possibilities of development and especially awareness about new opportunities in exploitation of energy efficiency and renewable energy sources.

Key words: *energy planning, reference energy system, Modular Energy System Analysis and Planning, energy efficiency, final energy consumption modelling, sustainability, energy policy, analytical hierarchy process*

Introduction

Energy use and its impact on the environment is one of the most important challenges facing humanity in the 21st century. With detailed planning for the future, drastic reductions in the energy required can be achieved by implementing the correct combination of technologies and in that manner it is crucial to thoroughly investigate the most important alternatives, before major reforms or commitments are made in relation to the future of the

* Corresponding author; e-mail: matevz.pusnik@ijs.si

national energy system [1]. This problem has triggered global transition from environment unfriendly fossil fuelled economy to sustainable and climate friendly development and requires design and formation of policies and solutions, which will be based on excellent knowledge of other possibilities of development and especially awareness about new opportunities in exploitation of energy efficiency and renewable energy sources. Looking long term, in sustainable development of any country, energy efficiency and renewable energy sources do not have an alternative. Future development of energy systems, with the requirement of fulfilling the internationally set targets is associated with multiple complexities with interactive, dynamic and uncertain characteristics. It is clear that failing to address such complexities may result in missed information and reduced decision robustness. Having in mind its international obligations, every country sets its own goals and objectives for the planning and management of the energy sector. These objectives are often contradictory and have different ranges and effects on many levels. According to [2] organizational behaviour and stakeholder processes continually influence energy strategy choices and decisions. What all energy problems have in common is that there are many alternatives to choose from and that there are important trade-offs among economic, technical, environmental, and social objectives [2, 3].

The main objective of the Slovenian national energy policy is that energy should be used as efficiently as possible, taking into account all resources available. In order to attain these objectives, the efficiency of energy consumption must be enhanced, particularly in public services, housing and transport sector. National energy bill or annual cost of primary energy use in Slovenia clearly indicates possible positive effects and business opportunities. In the year 2008, estimated annual cost without taxes and duties of primary energy consumption in Slovenia amounted to 1.95 billion €2008, or 5.2% of the Slovenian gross domestic product (GDP). By achieving the target of 20% energy consumption reduction by improving energy efficiency at the state level, it is possible to save about 390 millions €2008/year, or 1% of GDP2008. Stated savings represent a conservatively estimated potential for improving energy efficiency in Slovenia up to the year 2020. Nevertheless, development challenges of relatively small energy systems, such as the one in Slovenia have to be addressed in the proper way in order to avoid possible future problems. For example, in the Slovenian case and many other relatively small energy systems, national energy efficiency target should be based on final energy consumption or final energy savings and not on primary energy consumption. By setting energy efficiency target, based on final energy consumption, countries with relatively small energy systems are preserving the right to determine the conditions for exploiting their energy resources, their choice between different energy sources and the general structure of their energy supply.

During the last decade several new concepts of energy planning and energy forecasting have emerged, such as decentralized planning, energy conservation through improved technologies, waste recycling, forecasting models, integrated energy planning and introduction of renewable energy sources as presented in [2, 4-9]. Nowadays, energy systems have become more complex and application of new statistical and information technology is essential. Transition from traditional methods of energy planning and the use of newly developed methods for integrated resource planning have enabled the tools to research and combine a vast array of often contradict sectorial goals into one structured energy system on a national level [10, 11]. Decision-making and implementation of energy strategies and policies require a number of objective analyses and application of various procedures needed for evaluation and assessment of the policy development. Integrated resource planning gives the opportunity for those who decide to resolve complex energy issues in a structured, comprehensive and transparent manner [12-16].

This paper addresses the role of the national energy system modelling in the process of the policy development and presents a new approach in modelling relatively small energy systems which goes beyond investment in particular technologies or categories of technology and allows smooth transition to low carbon economy. Special attention is given to the possibilities for the improvement of the developed model and its role in the policy follow-up process. The main technical, economical and environmental characteristics of the future development of the Slovenian electricity power system, having in mind five different decision alternatives, have been addressed. Also, the principles and use of analytical hierarchy process with regard to an illustrative national energy policy planning example are presented.

Modelling approach – reference energy and environmental system

Throughout the preparation of the new Slovenian Energy Program with the aim to describe technical, economic and environmental characteristics of the Slovenian energy system, new Reference Energy and Environmental System model (REES-SLO) has been developed. The REES-SLO model was used as a decision support tool for national strategic energy planning. Since the modelling results have significant influences on decisions of energy systems planning and emission management, our imperative was to develop an advanced energy systems model which can effectively handle peculiarities of the small energy systems and provide sound decision supports. During the development process we were fully aware that the national energy systems are extremely difficult to model since they are depending on many very complex input parameters. Value added of the new REES-SLO is very strong environment component which was added to the classical Reference Energy System concept and clear focus on interactive and dynamic characteristics of relatively small Slovenian energy systems with the aim to objectively tackle decision problems, such as future energy infrastructure development, power generation expansion and greenhouse gases (GHG) emission reduction.

The REES-SLO is a set of programmes and tools where each subsystem has been described mathematically in correlation with parameters that influence such a subsystem and interconnected to represent the national energy system. A core computation model is a Modular Energy System and Planning (MESAP) tool. The MESAP standard software is a platform for building customer-specific strategic information systems. The core of MESAP is a powerful database that gathers all the information in a central data pool. The simulation model of MESAP environment is called PlaNet and consists of two independent modules: a module which balances flows of energy (end-use and supply) and the module for calculating macroeconomic costs linked to selected commodity flows. MESAP is a linear accounting model with flexible data structure and it can be adapted to the level of aggregation and accommodated to any reasonable level of detail. Scenario-based planning was integrated into the MESAP environment, allowing integration of past, present and planned (calculated) data in a comprehensive overall system. According to [7] MESAP can be used in national or regional energy system modelling and it has no limitations regarding the scenario timeframe or time-step. Combined with its open structure, this makes MESAP a very suitable modelling tool for relatively small energy systems where many peculiarities have to be taken into account. In the Slovenian case, MESAP has previously been used to compare energy efficiency strategies in Slovenia [3] where all above mentioned functionalities have been

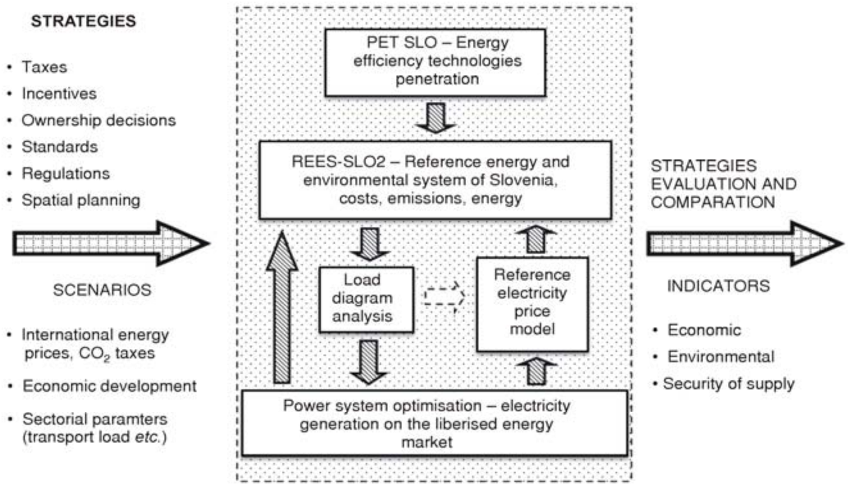

Figure 1. A set of models and information flows in the analysis

proved. During the redevelopment of the REES-SLO model trade-off between the simulation and optimisation approach has been done, again favouring presentation of relations between controls and their effects rather than the elusive optimality of results which can be misleading for small energy systems. Nevertheless, several other tools from the MESAP toolbox, including optimisation modules, can be applied to the developed model.

Within the model the most important driving forces (demand determinants) such as: value added and volume of physical production in economic activities, transport output/volume, building stock structure, space heat demand distribution, number of households, dwelling surface, penetration of new and energy efficient appliances in households and other details like superficies of schools or number of beds in hospitals have been analysed. Special attention was given to the aggregation of data in accordance with the statistical standards for data classification. Economic activities have been disaggregated by branches, manufacturing industry and service sectors are further disaggregated on the sub-branch level. Figure 1 represents a set of models and information flows used in the analysis. The model consists of sub-models for the following sectors: energy use in industry, households, service sector, transport, local energy supply and central energy supply.

MESAP supports a technology-oriented modelling approach where several competitive technologies that supply energy services are represented by parallel processes. The volume of a service supplied by a technology (*e. g.* heat) is defined by market shares that split the service demand between processes (technologies) that can supply selected service. Open structure approach enables the modelling of new, low carbon technologies and different intensity options of the transition to a low carbon society. Also, parallel competitive technologies have been included in the model as shown in fig. 2.

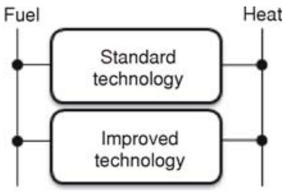

Figure 2. Parallel technologies modelling approach

The segmentation within the model between standard and improved technologies have been made on technical, economic and environmental characteristics of calculated energy flows, costs and emissions for both standard and improved parallel technologies. Parallel modelling of technologies enabled accurate estimation of induced costs, environmental impacts and increased transparency, consistency and precision of the model.

Process flow relations are defined by a set of linear equations (transformation, exogenous, commodity consumption, commodity production, and allocation equations), freely defined for each process. Non-linear problems like losses in the electricity distribution network are linearised, *i. e.* described with a set of linear functions without any trigonometric or nonlinear terms. The reference energy system in the MESAP environment is a bipartite graph, consisting of three basic structures: process, commodities and flows. Figure 3 represents simplified reference energy system, where vertical lines (coal, electricity and CO_2) are commodities and horizontal lines (links) are commodity flows.

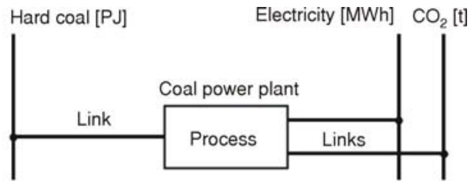

Figure 3. Simplified representation of the reference energy system in the MESAP environment [12]

Within the first step material commodity flows have been specified and corresponding costs have been calculated. Through determined/projected intensity, such as electricity use per person, the need for energy supply in distribution network was calculated and the end-use consumption was modelled. In the case where several processes that produce commodity flows were applied, a market share of individual process was determined. The input commodity flow was determined using the efficiency of each process. The MESAP tool enabled the simulation of quantities and costs of primary and end-use energy flows through efficiencies, market shares and intensities [17]. The process performs the function of converting one or more of the commodities into new commodities through flows (horizontal lines). In REES-SLO the basic modelling principle is the differentiation of fuels and processes by characteristics, regarding efficiencies, costs or environmental parameters. Within the REES-SLO the most important parameters that have significant influence on the future energy consumption were recognised. Those parameters are:

- physical product in industries and other economic activities for each industry sector,
- surface of buildings and employment in the service sector,
- household size and structure of building stock, number of households, and
- transport output/volume, structure of transport.

Also, different external parameters that have significant influence on the REES-SLO model were recognised and applied to scenarios. The most important external parameters that have significant influence on the REES-SLO model are international and regional fuel prices, projected economic growth in the Slovenia and European Union, availability, market penetration and dynamics of market shares for energy efficient technologies. In our case the time horizon was the period from 2010 up to 2030 with 2008 as the base year. Energy consumption and supply data have been obtained from the Statistical Office of the Republic of Slovenia and from [18], while hourly production and load data for the Slovenian power system have been provided by the Slovenian Transmission System Operator (ELES). Within the Power System modelling and analysis (separate module of the REES-SLO) hourly time steps are considered. For the reporting purposes it has been decided that the data should be normalised on the yearly basis for each 5 years interval (2010, 2015, 2020, 2025 and 2030). Load curves for the hourly district heating demand were obtained from local district heating system operators. Heat and process steam demand in industry were treated separately, through energy consumption of industrial sector and have been disaggregated by sub-branches. Entire REES-SLO model was built having in mind the interplay between sectors in smart energy systems of the future. For example, the development of smart grids is assessed directly as the precondition for the wider deployment of distributed electricity generation units (renewable energy sources and high efficiency combined heat and power – CHP production units) and indirectly through the overall increase of energy efficiency (consumer awareness).

Proposed scenarios for future Slovenian energy system development

Utilisation of estimated energy savings for each technology in each sector, intensive deployment of the renewable energy sources and development of the smart grids were identified as pillars of future development of the Slovenian energy system [19]. A benefit of this approach is that it goes beyond investment in particular technologies or categories of technology and allows smooth transition to low carbon economy taking into consideration all peculiarities of relatively small Slovenian energy system. In the case of Slovenia, our analysis for the planning period 2010-2030 indicates that rapid introduction of energy efficiency measures in all sectors, intensive deployment of the renewable energy sources and development of the smart grids are also justified with respect to total costs and it has been included in all analysed scenarios [20, 21]. By this comprehensive development in the field of energy efficiency and renewable energy sources almost zero rate of the electricity consumption growth on the transmission level is expected and that is the reason why the smart grid concept plays a vital role in the Slovenian transition toward low carbon society. According to the model, increase in efficiency of final energy consumption for 22% by 2030 compared to the business as usual scenario is expected. Also, it is expected that more than 5 TWh of electricity would be produced from the small scale renewable energy sources and in the small scale high efficient cogeneration gas fired power plants. In the large hydropower plants, another 5.6 TWh of electricity w0upd be produced [21]. Proposed concept with three pillars of future energy system will improve the fuel efficiency of the entire Slovenian energy system and represents the first step toward low carbon society without jeopardising current economic development and industry in Slovenia. Our aim was to create a solid base for necessary transformation of Slovenia to low carbon society. At this point of development we are fully aware that transition to future low carbon society and respectively carbon free energy system is a very complex process and a broad variety of measures must be combined in order to reach the set target. Nevertheless, small energy systems like Slovenian, in order to improve its strategic and operational security of supply should go beyond all the necessary measures to meet international commitments and should create a supportive environment for the implementation of profitable energy efficient projects, which would provide a greater economic impact and technological advantage of local economy. Based on requirements from [19] during the preparation of the new Slovenian National Energy Programme proposal, analysis of five different national electricity supply scenarios has been made. Scenarios varied due to different power plant portfolios up to 2030.

A Low capacity expansion scenario (LCES) assumes the continuation of ongoing investments and measures for the completion of chain of hydropower plants (HPP) on the lower Sava river, construction of HPP chain on the middle Sava river, substitution of the existing units with new lignite fired unit in thermal power plant Sostanj, extended lifetime of the nuclear power plant (NPP) Krsko and new high efficient natural gas fired CHP production unit in Ljubljana. In the process of National Energy Programme proposal development two gas and two nuclear scenario alternatives have been analysed. The first gas alternative (GAS_1) is an upgrade of the LCES in the direction of greater diversification of sources for the electricity production with the significant increase of the fourth energy source – natural gas. In that manner the construction of two natural gas fired thermal power plants with net installed capacity of 800 MW (total) is proposed by 2030. The second gas alternative (GAS_2) was used to analyse the consequences of reducing the production of electricity from domestic energy source, lignite from the Velenje Coal Mine. In comparison with the LCES, GAS_2 alternative assumes the construction of two natural gas fired power plants with net installed capacity 800 MW by 2030 instead of domestic coal fired unit 6 in the TPP Sostanj. The first nuclear alternative (NUC_1) is extension of LCES and assumes long-term exploitation of nuclear energy in Slovenia. In that manner a construction of the second 1000 MW unit of the NPP Krsko is planned by 2030. The second nuclear alternative (NUC_2) is similar to the GAS_2 alternative and instead of domestic coal fired unit 6 in the TPP Sostanj takes into account a natural gas fired power plant with 400 MW of net installed power and the second 1000 MW unit of the NPP Krsko. Electricity generation per scenario in the year 2030 is presented in fig. 4.

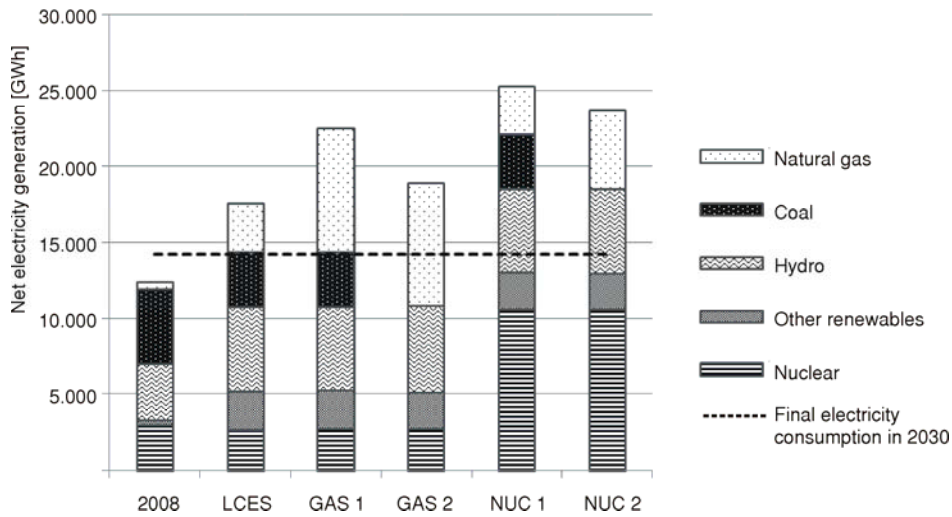

Figure 4. Electricity generation per scenario in year 2030

In all scenarios electricity generation in the year 2030 is higher than domestic demand which clearly indicates problems of small energy system modelling. During the preparation of the new Slovenian National Energy Programme proposal comprehensive analysis of Austrian, Croatian and Italian energy systems has been done and it has been concluded that despite planned huge investment in energy sector [22] Italy will still be a net importer of electricity. However, taking into consideration the size of the Slovenian economy and desired transition to sustainable energy system centralized power generation units are bearing significant risks regarding the number of utilisation hours.

Identification of the best alternative

The decision alternatives were assessed using the reference energy and environment system model for Slovenia which enabled the comparison and assessment of various electricity generation strategies. The optimal strategy for the further development of the Slovenian energy system has been selected based on the results of the comprehensive multi-criteria analysis. Analysis of five different national electricity generation scenarios has been done with analytic hierarchy process (AHP) multi-criteria technique. AHP multi-criteria technique has been selected with regards to published analyses and its wide use in decision support [23-26].

The first step in the optimal scenario selection process is identification of appropriate decision criteria and importance ratios followed by the detection of inconsistent judgments. For analysis of the decision alternatives with analytic hierarchy process following decision criteria were identified as presented in tab. 1.

Table 1. Indicators used as AHP decision criteria for scenario alternatives in 2030

In year 2030	Electricity production cost [€2008/MWh]	Economy [10^6 €2008]	GHG emissions [10^6 t CO_2 ekv.]	Import dependence [%]	Intensity of supply [toe/10^6 €2008]	Nuclear waste [m^3]
LCES	78	674	4,028	45%	113	100
GAS_1	83	1116	5,745	48%	118	100
GAS_2	84	813*	2,584	56%	112	100
NUC_1	72	1172	4,028	31%	134	400
NUC_2	72	10701	1,513	38%	129	400

*Additional costs due to closing Velenje Coal Mine due to the cancelation of the TPP Sostanj Unit 6 project are not included

According to the selected indicator when comparing decision alternatives relative importance ratios were used. At first, an initial matrix called overall preference matrix (OPM) is provided by the pair-wise comparison. The principal diagonal contains entries of 1 and reciprocal values below the principal diagonal according to the methodology. Table 2 presents the OPM with corresponding relative importance ratios. OPM was constructed based on results of comprehensive sets of dialogues with the most important stakeholders from state ministries, energy utilities to non-governmental organisation and individual energy experts. In a forward and back process, inputs were graded regarding the technical, economic and social feasibility having in mind peculiarities of the Slovenian energy system.

As presented in tab. 2, electricity production cost is slightly in favour over economy, environment, and intensity of supply and strongly in favour over import dependence. Economy is strongly in favour over import dependence and slightly more important as

Table 2. OPM matrix with corresponding relative importance ratios

	Electricity production cost	Economy	Environment	Import dependence	Intensity of supply
Electricity production cost	1	2	2	3	2
Economy	1/2	1	2	5	2
Environment	1/2	1/2	1	3	3
Import dependence	1/5	1/3	1/3	1	1/3
Intensity of supply	1/2	1/2	1/3	3	1

environment and intensity of supply. On the other hand environment is slightly less important as economy and electricity production cost and moderate in favour over import dependence and intensity of supply. Furthermore, import dependence is strongly less important as electricity production cost and slightly less important as economy, environment, and intensity of supply indicator. Intensity of supply indicator is slightly less in favour over economy, electricity production cost, and environment and moderate in favour over import dependence. When comparing the decision scenario alternatives, a pair-wise comparison was made in accordance to selected comparison criteria.

A very important step of the AHP is the detection of inconsistent judgments. The main problem of the AHP is hidden in assessment of importance ratios. It is not necessary that the selected importance ratios are consistent due to differences in decision maker's subjective values, preferences, quantitative expression, *etc.* The AHP solves for the set of weights that are, in some sense, the most consistent with these ratios by a mathematical procedure, called eigen-vector analysis [27]. Consistency ratio (CR) for relative importance ratios used in OPM is 0.060 which is satisfying according to the methodology. Maximum eigen-value of OPM is 5.265. Importance ratios used for calculation due to electricity production cost are consistent, whilst CR is 0.071 and maximum eigen-value is 5.319. For the calculation in accordance with economy, calculated maximum eigen-value is 5.125 and CR is 0.028. Relative important ratios used for assessment due to environment are also consistent, calculated CR is 0.056, where maximum eigen-value is 5.245. This is also evident for relative important ratios for import dependence where CR is 0.072 and maximum eigen-value is 5.323 and intensity of supply where CR is 0.044 and maximum eigen-value is 5.198.

The final part of the analysis is the post-multiplication of OPM relative vector value (RVV) by the calculated overall criteria ranking matrix with RVV of each ranking criterion. In tab. 3 overall criteria ranking matrix of the analysed scenario alternatives is presented.

Table 3. Overall criteria ranking matrix of the analysed scenario alternatives using AHP

	Electricity roduction cost	Economy	Environment	Import dependence	Intensity of supply
LCES	0.151	0.401	0.155	0.165	0.322
GAS_1	0.063	0.121	0.072	0.087	0.256
GAS_2	0.043	0.264	0.315	0.064	0.248
NUC_1	0.421	0.097	0.128	0.416	0.067
NUC_2	0.321	0.117	0.331	0.268	0.108

In accordance with the AHP method the best decision alternative is LCES, followed by the NUC_2, NUC_1, GAS_2, and GAS_1. The result of the AHP analysis is the hierarchy of decision scenario alternatives, due to selected criteria as presented in fig. 5. Presented scenarios have been normalised using LCES scenario alternative as a norm LCES = 1. The analysis indicates that in such a context, scenarios with huge capacity extensions are not a suitable way for future development of the Slovenian energy system. LCES alternative is more cost-effective and will fit better into the long-term transition toward low carbon energy system even though it includes new lignite fired unit in the TPP Sostanj. Consequences of reducing the production of electricity from domestic lignite are well addressed in [28, 29].

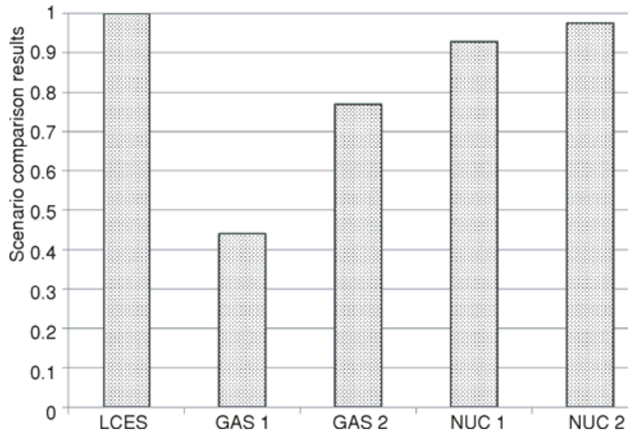

Figure 5. AHP scenario alternatives comparison for 2030

Proposed (LCES) scenario alternative is well balanced regarding the level of electricity production in the country and diversification of energy sources for electricity production with economic and environmental criteria.

Barriers, strengths and weaknesses of the analytic hierarchy process

The AHP is a useful method that helps to structurally organise decision alternatives and gives a good insight into often conflicting decision alternatives and comparison criteria. The strength of the method lies in the elegant way of detecting inconsistent judgments trough the calculation of CR. In general it provides a logical framework to determine the benefits of each decision alternative.

The main issue when using the AHP method is related with not so straight forward expressed weighing process by the pair-wise comparison. Although the scale for the trade-off analysis is proposed, it is often difficult to express the preferences of selected criteria over another. This is especially evident when creating the OPM. The creation of OPM is also amongst the most important steps in the AHP and needs to be carefully thought through and reviewed by the decision makers. As proposed in literature [27] we used comprehensive set of dialogues in the forward and back process during the weighing determination.

Nevertheless, multi-criteria decision method should not replace the decision making process. It should serve as a useful tool for decision process support. Sometimes it is difficult to find accurate and relevant decision criteria, especially when it comes to a small energy system like Slovenian with its own peculiarities and limitations, for example diversification of energy sources and locations. Also, the definitions of selected indicators can be interpreted in a different ways *i. e.* energy security as explained in [30].

Challenges in decision support for energy policy development

Main challenge in decision support for energy policy development is the follow-up programme, which must rely on indicators for monitoring the implementation of national energy strategies and policies. As presented in [31], local component of policy implementation is compulsory to achieve results on a national level. To assess the implementation and evaluate the effects of the Slovenian Energy Programme proposal, key indicators implemented in REES-SLO model are used. In tab. 4, aggregate time series of selected follow up indicators for monitoring the implementation of new Slovenian Energy Programme proposal are presented in accordance with five different analysed scenario alternatives. For the reporting purposes it has been decided that the data should be normalised on the yearly basis for each 5 years interval (2010, 2015, 2020, 2025 and 2030). Proposed indicators could be, where it is appropriate, supplemented with the additional indicators [32].

Also, proposed concept of the annual follow-up report about the implementation of the Slovenian Energy Programme meets all international reporting obligations.

Table 4. Aggregate time series of selected follow up indicators by scenario alternatives

Scenario	Improvement in efficiency of final energy consumption			The share of RES in gross final energy consumption			Reduction of non EU-ETS GHG emissions			Energy intensity of energy supply [toe/10^6 EUR]		
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2010	2020	2030
LCES	-1%	-16%	-22%	18%	26%	31%	-20%	-28%	-30%	200	149	113
GAS_1	-1%	-16%	-22%	18%	26%	31%	-20%	-28%	-30%	200	149	118
GAS_2	-1%	-16%	-22%	18%	26%	31%	-20%	-28%	-30%	200	151	112
NUC_1	-1%	-16%	-22%	18%	26%	31%	-20%	-28%	-30%	200	149	134
NUC_2	-1%	-16%	-22%	18%	26%	31%	-20%	-28%	-30%	200	151	129

Conclusions

This paper presents a new approach in modelling relatively small energy systems which goes beyond investment in particular technologies or categories of technology and allows smooth transition to low carbon economy. Presented research work confirms that transition from environment unfriendly fossil fuelled economy to sustainable and climate friendly development requires new approach, which must be based on excellent knowledge of alternative possibilities of development and especially awareness about new opportunities in exploitation of energy efficiency and renewable energy sources. Successful sustainable and climate friendly development strategy of any state must be adaptive and must rely on the empirical data. Sustainable transformation of each state has to be based on its own strategy, which is developed through process of learning by own experiences and already executed, successful programmes and projects in a broader environment. During the transition to sustainable energy future the role of regulators and officials is vitally important. When it comes to clean technology, the most effective boost that governmental officers can give to a sustainable energy future is to avoid picking winners. Presented approach was applied in real-life decision process for the new Slovenian Energy Programme. The greatest challenge of the new Slovenian Energy Programme proposal has been introduction and evaluation of sustainability in energy sector development in a way to assure implementation and tap its full economic potential. Preformed analysis confirmed that the one of key factors for achieving set targets is energy efficiency. The extent of necessary investments for the implementation of foreseen measures is very extensive, but necessary and justified. During the evaluation of sustainable energy options many barriers have been recognized and in order to remove those barriers many policy interventions have been examined and suggested for the implementation.

Technology-oriented model REES-SLO was used in the energy policy development process as a framework for consistent and equal approach to the identification of instruments, measures and impacts in various energy sectors and subsectors. Also, the role of the developed REES-SLO model in the policy follow-up process is vitally important. With the comprehensive follow-up programme which will enable adaptive approach in policy implementation, chances for the overall success of the proposed energy policy are significantly higher. The results indicated the developed REES-SLO model could effectively address not only challenges associated with the power generation expansion decisions but also uncertainties presented in various formats. Open structure of MESAP proved to be suitable modelling tool for relatively small energy systems where many peculiarities have to be taken into account. The obtained solutions proved its usefulness in supporting decisions of energy systems planning at the state level. Flexibility in operation of new power plants is a very important issue and must be considered in the planning of sustainable energy system in relatively small countries since big centralized power generation units are bearing significant risks regarding their economics.

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