The strategic planning for renewable energy sources deployment in the Czech Republic with the support of balanced scorecard

Ticiano Costa Jordão, Ernesto López-Valeiras Sampedro, Estefanía Rodríguez González, Robert Bata

Abstract—As part of the EU common energy policy adopted in 2007, the Czech Republic has established a commitment to achieve an 8% share of electricity generated from renewable energy sources (RES) in domestic electricity generation by 2010 and achieve a share of 13% of energy made from RES per final consumption before 2020. This contribution suggests a balanced scorecard (BSC) model aimed to set up a group of strategic objectives, initiatives, key performance indicators (KPIs) and targets that can be adopted in the Czech Republic in order to foster a sustainable deployment of renewable energy technologies. The model provides a strategy map showing four perspectives over which the objectives are organized and aligned through a cause-effect relation: Learning and Development, Energy Supply Systems, Energy Services Consumers, and Welfare.

***Keywords*—**balanced scorecard, Czech Republic, renewable energy, sustainable development, environment, climate change.

I. Introduction

ENERGY is essential to all human activities and critical to social and economic development. The United Nations Millennium Development Goals cannot be accomplished without access to affordable energy services.

The concept of sustainable development generally encompasses the social, economic and environmental dimensions which are linked by effective government institutions and policies. Energy planning is an example of the need for the vital role of government institutions in ensuring that energy supply and demand decisions made by all stakeholders – producers, consumers, investors, etc. – are compatible with overall goals for national sustainable development [1].

Despite of the fact that the world energy consumption fell in 2009 by 1.1 % in comparison with the previous year, the first decline registered since 1982, the world energy consumption is again on the rise from 2010 as a signal of the recovery from the global recession. However, this decline was only observed among the OECD member countries and particularly, among the global consumption of oil, natural gas and nuclear power, while the coal consumption has remained almost constant. On the other hand, the hydroelectric output and other renewable forms of energy increased in 2009 even among the OECD member countries. Continuous government support with fiscal incentives in many countries has helped to increase in 2009 global wind and solar generation capacity by 31 % and 47 %, respectively [2].

The significant worldwide growth in renewable energy capacity is recent and has been observed mainly since the end of 2004 when it grew at rates of 10 % to 60 % annually for many technologies. Grid-connected solar photovoltaic (PV) increased the fastest of all renewables technologies, with a 60 % annual average growth rate for the five-year period from 2004 to 2009 [3].

The most important issues that have been contributing to an unprecedented growth in the use of renewable energy sources (RES) for electricity and heating purposes in the past ten years are the global warming and the fossil fuel depletion. The first issue is related with the concerns about the environmental consequences of greenhouse gas emissions. The second issue is related to the currently known reserves and rate of consumption of non-renewable energy sources such as oil and natural gas. The world sources of oil and natural gas are expected to be exhausted by around 2047 and 2068, respectively [4].

The foreseen exhaustion of fossil fuels is visible in the rapid increase in world energy prices observed in the past few years, mainly during the period from 2003 to mid-July 2008, when prices collapsed as a result of concerns about the deepening recession. In 2009, oil prices showed again an upward trend throughout the year, varying from about $ 42 per barrel in January to $74 per barrel in December [5].

Prognostics based on a reference scenario in the United States, in which governments are assumed to make no

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changes in their existing policies and measures that may affect the energy sector, the price of light sweet crude oil (in real 2008 dollars) will rise from $79 per barrel in 2010 to $108 per barrel in 2020 and $133 per barrel in 2035 [5].

The International Energy Agency (IEA) estimates that by 2030 the world primary energy demand will be still mostly supplied by oil, followed by coal taking in acount a similar reference scenario. However, oil is expected to show the lowest average annual growth rate among the primary energy sources, a modest 0.9% rate. On the other hand, although with still a small contribution, RES such as solar and wind power will have the highest average annual growth rate observed during the period 2007-2030, a noteworthy 7.3%. In fact, solar and wind power together tend to contribute with almost the same share of hydro power in the electricity generation by 2030 among OECD countries [6].

Renewable energy feed-in tariffs (FiT) has demonstrated to be the world's most successful policy mechanisms for stimulating the growth of RES. In fact, European Union has taken a leading position on the global transition to a low-carbon economy in various sectors. In Europe, FiT programs have resulted to an unprecedented growth in the solar and wind power industries. The most significant growth has been seen in Germany, Spain and more recently, in Italy. More than a dozen U.S. and Canadian states have also introduced FiT legislation, and other states have initiated or announced plans for FiT regulatory proceedings [7].

Nowadays, the highest installed wind power capacity is in US, Germany and China, in this order. Yet, China has more than doubled its wind power generation capacity between 2008 and 2009 [8]. In the context of solar power sector, the largest concentrating solar thermal power stations are located in Spain and in USA, while the world´s largest photovoltaic are concentrated in Germany and Spain [9]. In fact, Spain became the world´s biggest power generator of solar energy in July 2010 after the installation of a new plant, equaling its solar power production to the output of a nuclear power station [10].

The major progress in research and development of renewable energy technologies accompanied by more effective policy framework have motivated several recent research on strategic territorial analysis and planning of potential RES. Geographic information system (GIS) tools have been widely applied since the last decade in the field of RES, mainly for locating areas with the highest potential for their development; for identifying the areas with restrictions that might affect their exploitation (e.g., environmentally or culturally sensitive lands); and, for estimating the energy output of RES in those areas that are suitable from a technical consideration and available for exploitation. Based on this information gathered, suitable strategies for the deployment of RES can be planned and implemented.

A convenient strategic management tool originally conceived for the private sector [11] that can be well adapted into the planning and development of renewable energy systems is the Balanced Scorecard (BSC).

The paper is structured as follows. The next section gives a brief overview to the current use of renewable energy sources in the Czech Republic. The third section explores the prior studies related to strategic planning of RES in several locations around the world. The fourth section addresses the evolution of BSC from an originally conceived strategic management tool for the private sector into an effective tool for various applications in the public sector. The fifth section explains how a BSC can be implemented for a sustainable deployment of RES in the Czech Republic. A final section presents the theoretical contributions, practical implications, limitations and insights for future research.

II. The Use of Renewable Energy in the Czech Republic

The Czech Republic has one of the lowest energy import dependencies of the European Union, mainly due to its vast reserves of coal, particularly lignite, and of uranium. In fact, coal is the main domestic energy source, representing 46.20% of total primary energy supply (TPES) in 2007. The second highest share in domestic energy production is provided by two nuclear power plants. Currently, there are four nuclear power reactors in Dukovany and two in Temelín, which in 2007 jointly contributed with 14.6% of TPES and almost one third of the total domestic electricity production. On the other hand, Czech Republic is highly dependent on the import of crude oil and natural gas, mainly from Russia. The share of energy import on the total energy consumption was roughly 40 % in 2007 [12].

As part of the EU common energy policy adopted in 2007 to reduce the effects of climate change, the Czech Republic also intends to increase its production and use of renewable energy in electricity, heating, cooling and transport. Such a common energy policy for the EU also contributes to growth, job creation and increase of energy security. The country has established a commitment with the EU to achieve an 8% share of electricity generated from RES in domestic electricity generation by 2010 and achieve a share of 13% of energy made from RES per final consumption before 2020. For the EU-15 Member States these targets are 21% and 20%, respectively. In 2006, the share of renewable consumption to gross final energy consumption in the Czech Republic represented 6.5%, well below the EU average, 9.2%. In 2007, the share of renewable energies in gross electrical consumption was 4.6%, far below the EU average, 15% [4].

A further target set by the Czech Government in allignment with the European Commission proposes a 15%-16% share of renewable energy in total primary energy consumption [13].

Toward the proposed goals, the Czech Government introduced in 2005 by act of law no. 180/2005 a FiT for a range of renewable sources including small hydropower, biomass, biogas, wind and photovoltaic (PV). Unlike the previous unsuccessful FiT implemented in 2002, this one has brought more possibilities to investors by offering the producers the choice to either sell electricity for purchase prices (FiT) or offer it to trader for the "market-price" and simultaneously get extra green bonuses - paid by the operator of Transmission System. The Energy Regulatory Office determines the FiT and the green bonus each year in advance. The prices may not be lower than 95% of the value of the year before. Prices are set on the following assumptions [14]:

- Return on investment of 15 years
- Prices are differentiated according to the renewable energy source
- Prices are differentiated by the year of commissioning

The tariffs were to be guaranteed for between 15–30 years depending on the type of power. The feed-in tariff proposed for solar PV as of January 2010 is one of the highest among the EU Member States. The cost of PV power to the power company is expensive. In 2010 the highest tariff is 12.25 Czech Crowns (€ 0.50) per kWh for small photovoltaic power [15]. For comparison, the average rate that a Czech household paid in November 2009 for power was in the range € 0.087 to € 0.116 per kWh, depending on the annual level of consumption (ERU). In September 2010, however, the electricity rates for households increased to a range between € 0.1189 and € 0.1455 per kWh [4].

Table I presents the FiT currently applied in the Czech Republic according to the RES. Prices are in Euros per kilowatt-hour (€/kWh) and may depend on the amount produced (e.g., biomass).

TABLE I
FEED-IN TARIFFS APPLIED IN THE CZECH REPUBLIC ACCORDING TO THE TYPE OF RES ((€/kWh)

Windpower 'On-shore'	Wind power 'Off-shore'	Solar PV	Biomass	Hydro
0.108	0.108	0.455	0.077-0.103	0.081

Source: [4]

Initiatives in the geospatial field include the use of GIS for mapping the potential of RES and restrictions on their exploitation. Examples with wind power potential are illustrated by wind map of Czech Republic presenting the average wind speed at 100m above ground, a map of areas with sufficient wind resource versus large-scale nature protected areas, and also a map of realizable potential of wind energy presenting the density of wind turbines, i.e., number of wind turbines per square km by district [16]. Other examples illustrate the global irradiation and solar electricity potential for horizontally mounted and optimally-inclined photovoltaic modules in terms of yearly sum of global irradiation, which is described by kWh/m^2 [17].

Energy generation from RES has been increasing by approximately 10% in the Czech Republic every year [18]. Fig. 1 shows the share of electricity production in the Czech Republic by source, while Fig. 2 illustrates the share of individual RES in electricity production. It can be observed that hydro power plants were responsible for more than 60% of the electricity supplied by RES in 2007.

The energy from biomass is expected to play an increasing role in the energy system in the country, mainly from the use of energy crops with crop rotation and good agronomic practice. The role of wind power plants, refuse incineration plants and photovoltaic systems are still rather negligible in comparison with other forms of RES [18].

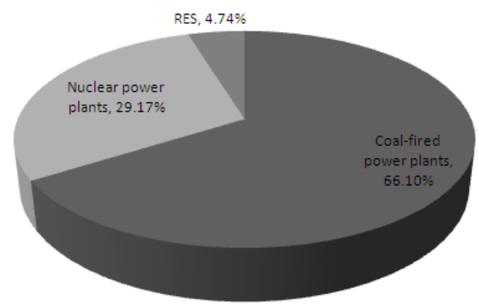

Fig. 1 electricity production in the Czech Republic by source in 2007
Source: [59]

Nevertheless, motivated by the high feed-in tariff and the decreasing cost of PV panels, the solar PV capacity installed in the Czech Republic has grown significantly since 2007 and in 2008 was the fourth highest among EU Member States, just behind Spain, Germany and Italy, in this order [4].

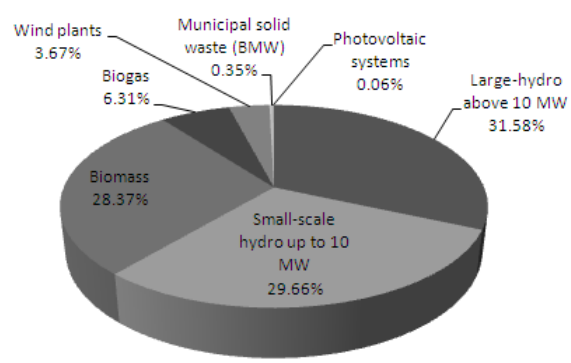

Fig. 2 share of individual RES in electricity production in the Czech Republic in 2007
Source: [59]

The business with solar PV has become extremely profitable since due to the current market conditions investments are repaid within 8-10 years and the feed-in tariff is guaranteed for 20 years [19]. This has led to an unprecedented boom in photovoltaic power, which increased from 70 MW in 2008 to 470 MW in 2009, and is predicted to hit at least 1,000 MW by the end of 2010 [19]. Although not in the same proportion, the wind power installed capacity has also increased significantly in the Czech Republic also motivated by favorable feed-in tariffs. However, energy distributors and operators in the country have warned for the fact that the installed capacity of wind and solar energy projects is nearly four times what can be safely fed into the country's electricity grid. The Association of Czech Regulated Electro-Energy Companies (CSRES) said the installed capacity of all projects approved by the end of January was 8,063 MW [19].

With the purpose to address this threat, the Czech government has given its approval for a renewable energy framework plan which aims to reduce generous subsidies driving the country towards a solar boom. The plan calls for a cap on feed-in tariffs for solar energy, up to approximately 50% of the current level, as well as making the recycling of old solar panels mandatory. A reduction of feed-in tariff (FiT) is expected to be applied for all new solar PV installations from 2011. All existing installations will still receive the same FiT rate they got when they originally installed, as this rate is fixed for 20 years [20]. Nevertheless, the for these PV plants with a guaranteed FiT the Czech Senate has recently approved a law, which will add a 26% tax on solar energy production over the next three years, as well as 32% tax on carbon credits awarded to solar companies in the next two years. Basically, it means a decrease of the purchase prices of solar energy under the FiT that were supposed to be guaranteed to investors for 20 years by the government. The proceeds from the taxes will be used to reduce the increase in household and industrial electricity prices next year [14].

III. LITERATURE REVIEW

There is a large amount of research works related to strategic planning of RES that deserve to be mentioned. Some are particularly focused on one or two RES while other works attempt to be more comprehensive by comparing various alternatives. Here are listed only those research works that somehow have influenced the development of the BSC model proposed in this study.

In 2001, a BSC model was developed to capture and visualize other than financial benefits resulting from the installation of privately owned grid-connected photovoltaic systems in the Perth metropolitan region in the south-west of Western Australia consumer [21]. Some authors have shown the complex relationships of the elements of a national energy system and presented an integrated energy planning approach that can be implemented through computer based modeling tools [22].

Another interesting research consisted in a method for evaluating and ranking energy alternatives based on impact upon the natural environment and cultural heritage as part of the first phase of an Icelandic framework plan for the use of hydropower and geothermal energy [23].

In 2008, other authors remarked the importance of policies and strategies needed to be implemented to create renewable energy market and make the technologies feasible [24]. An appraisal of energy policies and the potential of renewable energy sources in Malaysia were addressed in another study [25]. An analysis on the economic viability of using photovoltaics within future residential buildings in the oil-rich Saudi Arabia was also undertaken [26]. In the same year, the contribution of public funding energy projects for producing electricity from RES in Greece were examined [27].

A fundamental contribution to the definition of strategically planned renewable energy policies can be provided by the spatial evaluation of the renewable energy potential. In this sense, researchers from Argentina adopted GIS tools to identify the potential of RES in Lerma Valley, Salta, Argentina [28]. A strategic analysis methodology for adaptive energy systems engineering with the purpose of optimizing level of service in the context of a community´s social, economic, and environmental position was recently proposed by two researchers from New Zealand and applied to a case study on Rotuma, an isolated Pacific island [29].

Another noteworthy contribution in this field consisted of a renewable energy technology portfolio planning that was proposed with the use of scenario analysis to renewable energy developments in Taiwan [30].

Sustainability of energy systems is addressed by Ghomshei and Villecco [31] in their fuzzy logic model used to scale energy systems based on their valued attributes such as storability, transformability, quality, transportability, availability, environmental value and resource sustainability.

One of the most recent innovations in terms of evaluating the potential of RES in various geospatial areas or regions has been provided by Honeywell International with their patented renewable energy calculator [32]. In 2010, another study showed which activities in the field of RES are economically interesting for investors in the Czech Republic and analyzed the possibility of financial support for their development and the reasons why these funds are utilized [33]. In the same year, some interesting indicators for quantifying the economic, social and environmental benefits of renewable energy sources were proposed by means of GIS tools [34].

IV. THE EVOLUTION OF BALANCED SCORECARD AS AN EFFECTIVE STRATEGIC MANAGEMENT TOOL FOR THE PRIVATE AND PUBLIC SECTOR

The Balanced Scorecard [11] is a strategic management approach that has gained popularity among corporations worldwide in the last two decades by providing a performance measurement framework that adds strategic non-financial performance measures to traditional financial metrics to give managers and executives a more “balanced” view of organizational performance. It was conceived to align business activities to the mission, vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals. BSC evolved from its early use as a simple performance measurement framework to a full strategic planning and management system. It is based on four strategic perspectives which are linked with cause and effect chains. These are: learning and growth, internal business process, customer and financial perspectives. In each perspective of the strategy map there is a group of strategic objectives aligned to the mission and vision of the organization. The financial perspective is placed at the top (effect) while the learning and growth perspective is placed at the bottom (cause). The internal business process is directly linked to the learning and growth and the customer perspective provides the necessary requirements for the achievement of the strategic objectives specified in the financial perspective.

Initially conceived as a modern management control system for the private sector [11], the BSC was adapted to the specificity of the public sector. Some applications included the health care sector [35], [36], education institutions [37], government and non-profit organizations [38], [39], [40], and medium sized public sector enterprises [41].

No matter the case in which BSC is applied, its correct introduction and use starts with the definition of the organization’s “mission”, “vision” and “values” as determined by the managers. These three elements provide the framework within which the strategic objectives are set by the organization. Once they have been established, an examination of the specific characteristics of the business and the surrounding environment can be conducted. The SWOT analysis is helpful for examining the internal Strengths and Weaknesses, as well as the Opportunities and Threats posed by the external environment. This analysis can be based on the development of certain questionnaires and status indicators. The objective is to focus the strategic objectives toward the critical factors in each area of the business. From there on, the business’ critical factors, which will serve as a basis for the strategic plan, can be determined. After that, any future objectives can be based on those critical factors. The last procedure to carry out before the feedback stage consists of an evaluation tool with key performance indicators.

The classic model of BSC introduced by Kaplan and Norton [11] stipulates that the “customer” is best reached through “learning and growth”, and through the management of certain “internal processes”. Used collectively, these three perspectives lead to “financial results”. That is to say that the model sees the financial indicators not as a purpose, but as a consequence of the actions employed by the company.

Nevertheless, a typical problem which can arise in the elaboration of a BSC is that of determining what type of objectives, indicators, and goals should be included. Thus, the ultimate objective placed at the top of the BSC might not necessarily be one of a financial nature. In some companies, environmental and social objectives are already considered of great importance, along with the economic objectives [42], [43], [44].

The transition in the business management strategy is being observed under the newly emerging term sustainability performance management. The management of sustainability performance requires a sound management framework which firstly links environmental and social management with the business and competitive strategy and management and, secondly, that integrates environmental and social information with economic business information and sustainability reporting [45], [46], [47], [48]. For meeting this requirement, an effective tool that can be applied is the Sustainability Balanced Scorecard (SBCS), which is an extension of the conventional Balanced Scorecard [49], [50], [51]. While the conventional model includes four management perspectives, the SBCS also addresses a fifth non-market perspective [52], [53] that includes strategically relevant issues that are not covered in market arrangements with the company. The nonmarket perspective is usually drawn as a frame for the other perspectives because societal issues constitute the framework of market operations with the financial community, customers, suppliers, and employees. These are external or sustainability issues that influence the business and are addressed by stakeholders. Examples of these issues can be illustrated by child work, forced labor and slavery at a supplier, which can have a substantial influence on sales although the company has no market relationship with the workers employed by the supplier [48]. One target in the nonmarket perspective could be to reduce the contribution of the business to climate change. Another concern could be to counteract migration into cities in the region where the company resides. Therefore, the SBSC facilitates the strategically relevant cost-effective application of life-cycle thinking in companies [47].

In the local government and councils the need for integrating environmental, social and economic aspects of the organization´s measurement and management becomes even more evident.

V. THE USE OF BALANCED SCORECARD AS A TOOL FOR RENEWABLE ENERGY PLANNING AND DEVELOPMENT

Within the sphere of applicability of BSC in governmental organizations, the present study adopts a BSC model which can be implemented by ERU for a sustainable deployment of RES in the Czech Republic with its strategic objectives, strategy map, initiatives and key performance indicators (KPI).

Like in a private company, a key driver of effective strategic and operational control is the ability to recognize measure and react to critical success factors (CSF) [49]. Effective performance management depends on the establishment of a balanced set of objectives which are aligned with the strategy of the organization. These objectives, in turn, shall be represented or driven by CSF which will be translated into a group of actions or initiatives

[50]. Critical success factor is the term for an element that is necessary for an organization or project to achieve its mission and vision. It is an activity with regard to its present and future performance that is required for ensuring the success of a company or an organization [54].

Each CSF must have at least one related measurement represented as a Key Performance Indicator (KPI) and one target for the current or forthcoming budget exercise. The identification of CSF for a specific private business will rely on general industry analysis, competitor analysis and macro environment analysis.

In a government energy department, four "decision factors" can be explored and understood as suggested by Chen et al. [30]:

- *Political factors*: government energy and industry policies, related policies for the renewable energy industry, and international environmental issues, including greenhouse gas reduction requirements.
- *Technology factors*: breakthroughs in renewable energy technology and the criteria for technology assessment, including the developing cost of renewable energy.
- *Market factors*: the international oil prices, market demand (local and even external) of the renewable energy related industry, the development of domestic industry, and the requirements of the international market when energy export is foreseen.
- *Natural resource factors*: availability of renewable energy and the supply costs of renewable energy.

In the case a country has the ability to develop a specific renewable energy technology and intends to export it to other locations, it is also important to consider the manufacture capability, the industrial supply chain, the market entry barriers to other countries and the lead time for commercializing. The Czech Republic has manufacturers of wind power turbines and solar PVs.

Nevertheless, the "decision factors" as previously specified should not be confused with CSF. Instead, they will provide the background information upon which the strategic objectives and the CSF will be set.

In order to obtain the values, ideas and expectations of the local community regarding the use of renewable energy, surveys among representatives of various stakeholder groups become necessary. The values identified will show the most important issues for the local population, such as e.g., economic growth, social equity, and quality of life, including environmental quality and balance between work and leisure. Policies can be identified and compared through a benchmarking on the use of renewable energy sources by other regions of similar sizes and characteristics. A set of technology alternatives can be collected from technical experts who will be able to estimate the availability and the supply cost of renewable energy.

Evidences from surveys conducted among citizens in the Czech Republic show the following levels of acceptance for RES: 85% for solar energy, 74% for wind power, 85% for hydroelectric energy, and 67% for biomass energy [55].

Fig. 3 illustrates how the mission of a government energy department can be translated into desired outcomes regarding the increasing use of renewable energy sources.

The present BSC model is based on four perspectives upon which the strategic objectives and their related initiatives (critical success factors), measures (key performance indicators) and targets will be set. These perspectives are: *Learning and Development*, *Energy Supply Systems*, *Energy Services Consumers*, and *Welfare*. As it can be observed, the first three perspectives are not completely different in essence from the original perspectives conceived by Kaplan and Norton. However, the Welfare perspective is placed at the top of the Strategy Map replacing the original *financial* perspective since for a government organization the prosperity of local community is the most important strategic outcome which will be represented by a maximized long-term stakeholder value.

Table II suggests the mission, values and vision that could be pursued by the Czech Energy Regulatory Office (ERU) concerning the planning and development of RES in the country.

Table III presents these perspectives and their related strategic objectives that can be considered in the Czech Republic.

Fig. 4 presents the strategic scoreboard that can be adopted in this case where the objectives, initiatives, measures (KPIs) and targets within each perspective have to be specified. The objectives listed within each perspective shall jointly contribute to the answer of the key-related question as specified. Fig. 5 illustrates the Strategy Map with the strategic objectives defined in each perspective. These objectives are linked in a cause-effect relationship. Each objective can be broken down into a number of CSF (initiatives) which are necessary for achieving that goal. In the scorecard the weighting factor of each strategic objective within each perspective has to be defined by ERU according to the level of importance assigned. The performance level for each strategic objective has to be oriented towards a previously defined target.

The *Welfare perspective* is placed at the top of the Strategy Map since for the Czech Energy Regulatory Office the prosperity of local community is the most important strategic outcome which will be represented by a maximized long-term stakeholder value.

In the *Learning and Development Perspective*, three strategic objectives can be aimed in a sequential order, starting with the enhancement of organizational capital, then improving the information capital and finally, enhancing the human capital.

In the *Energy Supply System Perspective*, four main strategic objectives can be focused. The enhancement of operations management process will partly contribute for the reduction of energy supply cost and for the improvement of energy service level, which are two

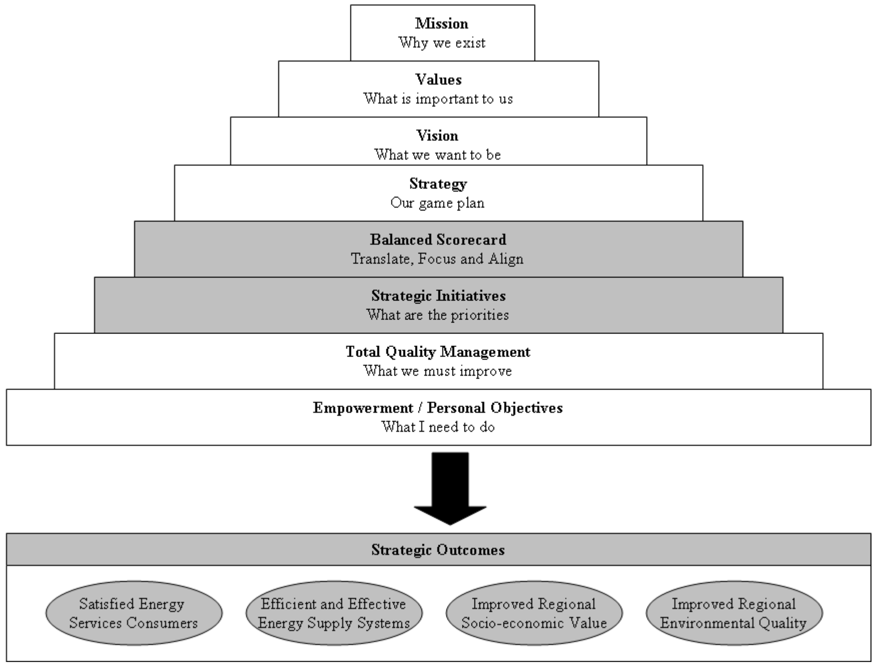

Fig.3 translating mission into desired outcomes for a government energy department
Source: Adapted from Kaplan & Norton, figure 3-2, page 73 [50]

TABLE II
SUGGESTED MISSION, VALUES AND VISION FOR THE CZECH ENERGY REGULATORY OFFICE (ERU)

Mission	To put forth policies that will result in a sustainable energy future for the country and increase the awareness of the benefits of renewable energy and energy efficiency.
Values	*Social value*: healthier home environments that result in healthier people which lead to healthier communities. *Economic value*: lower operating costs, greater home value, longer economic value lifecycle. *Environmental value*: less pollution, energy efficient and better use of natural resources.
Vision	The energy will derive primarily from sustainable, renewable energy resources.

Source: [own]

TABLE III
THE PERSPECTIVES AND RELATED STRATEGIC OBJECTIVES FOR RES DEPLOYMENT IN THE CZECH REPUBLIC

Perspectives	**Strategic Objectives**
Learning and Development	Enhancing the information capital Enhance the organizational capital Enhance the human capital
Energy Supply Systems	Enhance the operations Management Process Enhance the customer management process Enhance the Innovation Processes Enhance the Social and Regulatory Processes
Energy Services Consumers	Reduce energy supply cost Improve the energy service level (reliability and extent of energy supply) Provide additional alternatives of energy sources Increase trustworthiness of energy consumers and community engagement
Welfare	Improve environmental quality Increase the socio-economic value generated

Source: [own]

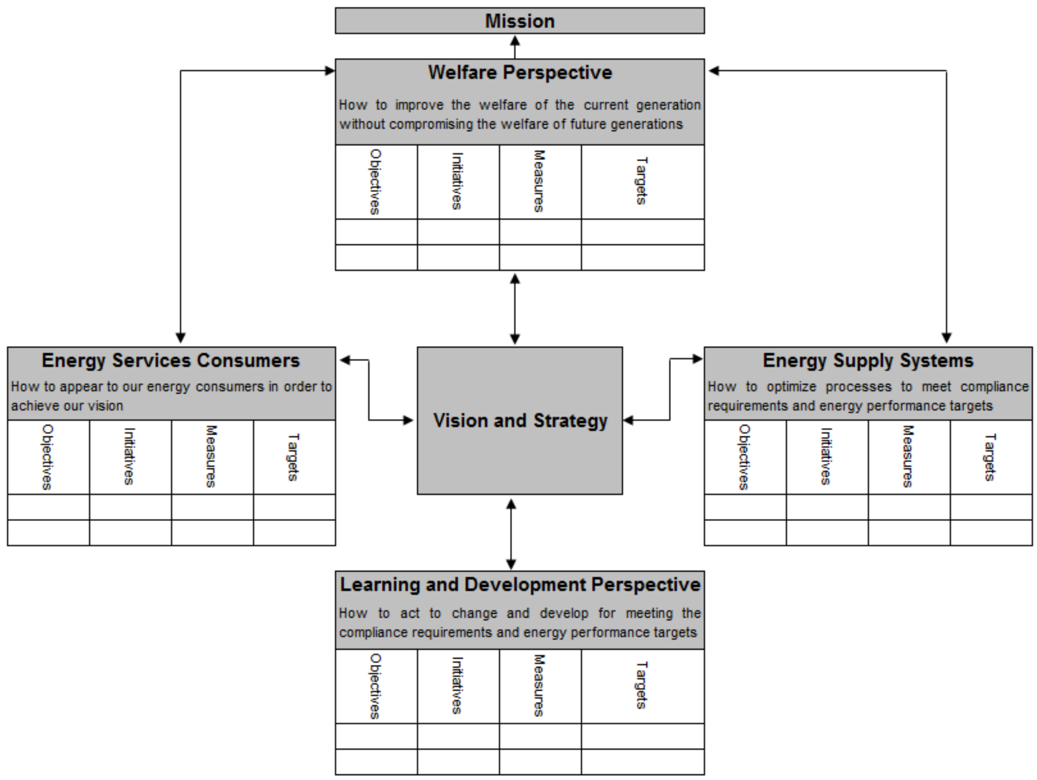

Fig.4 BSC Strategic Scoreboard for a sustainable strategic planning of renewable energy deployment
Source: Adapted from Kaplan & Norton, page 76 [61]

strategic objectives within the overlying perspective *Energy Services Consumers*. The enhancement customer management process will partly contribute to the increase of trustworthiness of energy consumers and in the improvement of energy service level. The improvement in the innovation processes will play an important role in the reduction of energy supply costs by reducing the need for importing components for these technologies or the complete technology itself. It will also provide additional alternatives of RES.

Other important strategic objective within this perspective is the enhancement of social and regulatory processes by providing incentives for the exploitation of all RES identified in the country with moderate to high potential, developing clear procedures and criteria for acceptance of new project based on RES use.

In the *Energy Services Consumers Perspectives*, the reduction in the energy price supplied by RES and the improvement of energy service level together with the provision of additional alternatives of energy sources will contribute for the increase of socio-economic value. On the other hand, the increase of the awareness of citizens and business entrepreneurs about the benefits and level of feasibility of investing on RES through distributed generation (DG), will contribute for the improvement of environmental quality.

The *Welfare Perspective* can be consisted of two main strategic objectives, which in turn can be translated into several detailed initiatives that will take in account the current environmental and socio-economic conditions. Among the initiatives oriented towards the improvement of environmental quality by using RES, the most remarkable ones are those related to minimization or avoidance of air pollution and greenhouse gas emissions.

Other important initiatives in the environmental sphere include the minimization or avoidance of noise, water resource use, aesthetic impact on landscape and impacts on terrestrial and aquatic biota.

The increase of socio-economic value generated can mainly be addressed by incoming foreign and local investment, generation of local employment, increase of real state value, and reduction of impacts to human health, all related to the introduction of RES technologies in the country. Finally, the decrease of energy import dependency also contributes for the increase of socio-economic value.

Table IV in the Appendix presents examples of objectives, initiatives and measures (KPIs) that can be proposed by ERU for a successful deployment of RES in the Czech Republic based on the proposed BSC perspectives. Each strategic objective will have a different weight factor in relation to each other according to the level of importance assigned by ERU after consultation with representatives of various stakeholder groups. This consultation should result in a stakeholder analysis matrix, which will specify for each stakeholder group their respective priority issues, their capacity and motivation to bring about change, and the possible actions to address their interests.

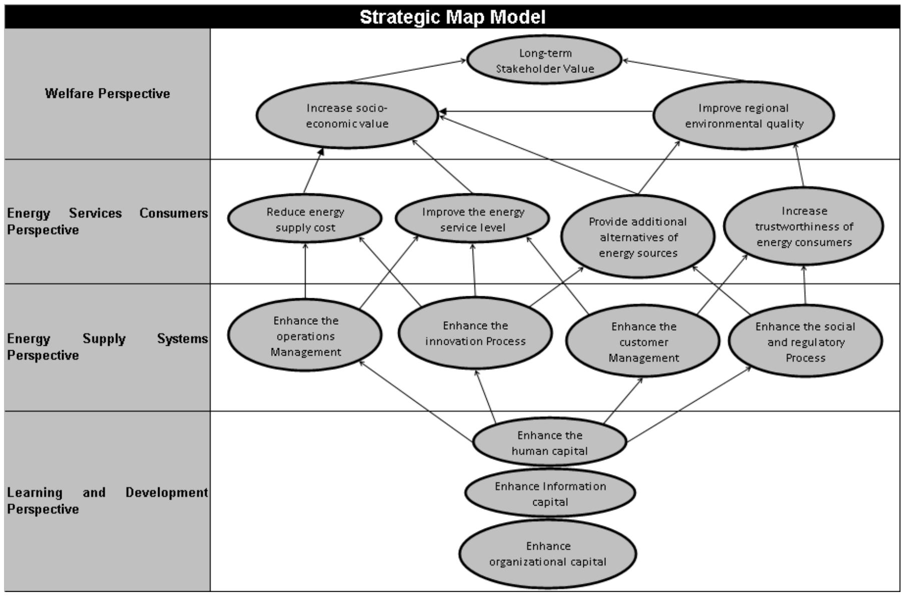

Fig. 5 BSC strategy map for a sustainable strategic planning of renewable energy use
Source: Adapted from Kaplan & Norton, figure 1-3, page 11 [51]

VI. CONCLUSION

As previously shown the BSC can also be used for a sustainable strategic planning of renewable energy use in the territory. The initiative of developing a balanced scorecard metrics for renewable energy sources might not be completely innovative [56]. However, the perspectives and strategic objectives presented in this BSC model are completely new and provide a holistic view of the complexities involving the use of renewable energy in a region due to the several inputs necessary for its development and the high diversity of socio-economic and environmental aspects to be considered in its outcomes. For large countries like the United States specific BSC framework can be developed for each State or region since there are might be considerable variety of socio-economic and environmental conditions to consider. In the case of the Czech Republic, the strategic objectives have to be aligned with the proposed commitments to the EU in terms of share of electricity generation and energy generation from RES. However, it is important to consider the level of incentives provided for the investors (e.g., feed-in tariffs) and estimate it carefully in order to avoid a major increase of energy prices for households and for the industrial users. Therefore, the BSC model does not aim to maximize the use of RES but mainly to work towards its optimization. The accomplishment of this task depend on the collaboration of various stakeholders, such as technology experts, business executives, government officials, major educators, prominent artists and community leaders.

Due to the current economic recession in which the country is currently found, the following objectives may gain a higher relative weight by ERU in comparison with the others: the reduction of energy prices, the improvement of energy service level, the increase in the security of energy supply, and the generation of local employment provided by RES investments. These weight factors assigned to strategic objectives may change in the future as the country will overcome the recession and the environmental objectives may receive a higher relative weight.

APPENDIX

TABLE IV
EXAMPLES OF OBJECTIVES, INITIATIVES AND MEASURES (KPIS) THAT CAN BE PROPOSED FOR A SUCCESSFUL DEPLOYMENT OF RES IN THE CZECH REPUBLIC

Perspectives	Objectives	Initiatives	Measures (KPIs)
Learning and Development	Enhance the information capital	Assessment of the current energy supply system and the end-user energy service needs. Obtain the values, ideas and expectations of the community regarding the use of RES. Generate a set of technology alternatives and assess their risk indicators. Develop future scenarios including the situation of importance of global warming, breakthrough in RE technology, and government commitment on RE policy Identify the potential for renewable energy use in the region with GIS maps.	Reserves-to-production ratio Resources-to-production ratio Proven recoverable RE reserves Total renewable energy production Total estimated RE resources
	Enhance the organizational capital	Set up expert committee on integrated energy policy with a special focus on the use of renewable energy sources. Set up a stakeholder's committee that will be responsible for identifying the range of social and cultural values and perceptions of the community regarding the use of RES.	
	Enhance the human capital	Enhance capabilities and skills of local personnel regarding the use of RES and installation of the technologies and equipments.	
Energy Supply Systems	Enhance the operations management process	Development of a well formed supply chain of components for the use of RES technologies. Increase the efficiency of energy conversion and distribution. Reduce the number of accidents per energy produced by RE source.	Operational efficiency expressed as $\mu_{oe} = (100)\ E / E_{100\%}$ where μ_{eo} = operational efficiency (%) E = energy output from the power plant in the period (kWh) $E_{100\%}$ = potential energy output from the power plant operated at 100% in the period (kWh)
	Enhance the customer management process	Support the local community in the choice and acquisition of the most appropriate RES technologies.	
	Enhance the Innovation Processes	Increasing investment on R&D for local manufacturing of technologies and equipments for RES use.	
	Enhance the social and regulatory processes	Provision of incentives for all RES identified in the region with moderate to high potential. Development of clear procedures and criteria for acceptance of new project based on RES use. Removal of barriers for acquisition of equipments for RES use. Incentives for local manufacturing of RES technologies.	
Energy Services Consumers	Reduce energy supply cost	Reduce the usually high upfront cost of finance the RES equipments through a subsidy and an attractive feed-in tariff. Reduce the RE supply tariffs.	Feed-in-tariff in $/kWh for the adoption of renewable energy sources by customers (e.g., solar PV) and the duration of guaranteed purchase prices of RE. Share of household income spent on fuel and electricity End-use energy prices by source and by sector Cost ratio to traditional energy in 2020 Percentage cost reduction from 2010 to 2020 SAIFI (average annual number of outages per consumer) and SAIDI (average annual outage duration per consumer)
	Improve the energy service level (reliability and extent of energy supply)	Enhance reliability and reduce interruptions in the energy supply.	
	Provide additional alternatives of energy sources	Provide incentives and financial mechanisms for investment in new alternatives of renewable energy sources.	
	Increase trustworthiness of energy consumers and community engagement	Increase the awareness of citizens and business entrepreneurs about the benefits and level of feasibility of investing on renewable energy sources through distributed generation (DG).	

Source: [own]

TABLE IV (CONT.)
EXAMPLES OF OBJECTIVES, INITIATIVES AND MEASURES (KPIS) THAT CAN BE PROPOSED FOR A SUCCESSFUL DEPLOYMENT OF RES IN THE CZECH REPUBLIC

Perspectives	Objectives	Initiatives	Measures (KPIs)
Welfare	Improve regional environmental quality	Reduce air pollution Reduce greenhouse gas emissions Reduce noise Reduce water pollution and impacts on aquatic biota Reduce soil pollution Reduce impacts on terrestrial biota Reduce solid waste generation and improve waste management Reduce aesthetic impact on landscape Reduce water resource use	Ambient concentrations of air pollutants in urban areas Air pollutant emissions from energy systems Greenhouse gas emissions and projections in tonnes of carbon dioxide equivalent (CO_2eq.), greenhouse gas intensity as the ratio between energy related greenhouse gas emissions (carbon dioxide, methane and nitrous oxide) and gross inland energy consumption Noise level of wind farms measured in dB (A).
	Increase the socio-economic value generated	Increase incoming foreign and local investment Generate local employment Increase real state value Increase total revenues of RE suppliers and share of RE use Enhance the economic value distributed* Reduce impacts to human health Decrease energy import dependency and increase security of energy supply Reduce the cost of RE generated	Number of firms manufacturing RES components Share of local employment provided by renewable energy industry measured in terms of electricity generating capacity installed Number of local jobs provided by RES industry per kWh of electricity generated. Increase in residential housing prices (in %) due to reduction of particular kind of air pollution (in %) Amount of RES (in kWh) locally generated and locally sold and exported Number of RES users Total payment to RES investors Taxes paid by RES suppliers Total payments of salaries and benefits to employees involved in RES Average level of operational costs of RES suppliers Net energy import in oil equivalents

Source: [own]

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