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Innovative method of regional sustainable energy strategies

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This article aims to increase knowledge and find the best practices on how sustainable energy management (SEM) can be boosted and implemented at a regional level. It presents the main results from the RESGen (RES Generation – From Research Infrastructure to Sustainable Energy and Reduction of CO_2 Emissions) project (subsidized by the EU in 2009-2012) and the procedure developed within the project, which aims to support regionally comprehensive implementation of SEM involving all the main stakeholders. Physical prerequisites to support the transition of the energy sector towards SEM exist. The renewable energy sources (RES) potential is vast, the economics, especially regional impacts, are feasible, general perceptions are positive, technologies are evolving and the majority of stakeholders support this agenda. There are however barriers slowing the process. The RESGen procedure provides a structured and strategic approach for the shift towards SEM.

Keywords: sustainable energy management, renewable energy sources, regional implementation process

1. Introduction

This article aims to increase knowledge and find the best practices on how sustainable energy management (SEM) can be boosted and implemented at a regional level. The main approach for this has been through developing comprehensive regional strategies, which integrate all the main stakeholders (authorities, industry, R&D bodies) into regionally rooted programmes. This paper presents the main results from the RESGen (RES Generation – From Research Infrastructure to Sustainable Energy and Reduction of CO_2 Emissions; EU Regions of Knowledge; 2010-2012) project within which a documented 'RESGen procedure' was prepared and used.

SEM descends from the idea of sustainable development, which has several different interpretations, including more than three hundred definitions within environmental management (WCED 1987, Johnston et al. 2007, Chichilnisky 2011). SEM interlinks with all the other aspects of sustainability, which depend on the

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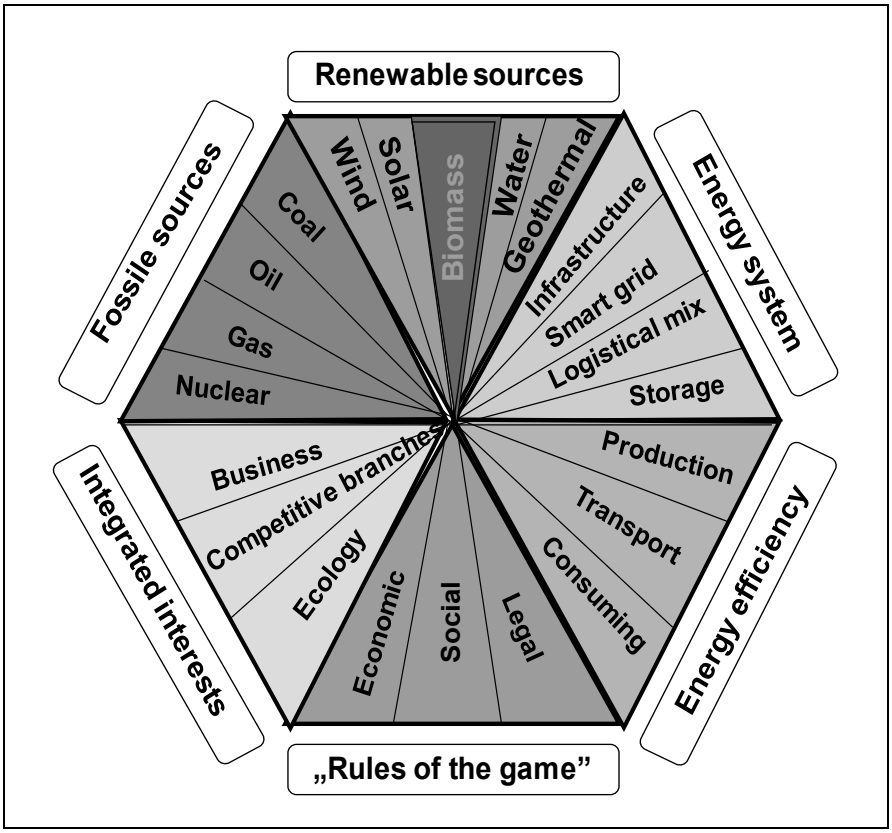
secure operation of energy supplies. Comprehensive understanding is necessary in developing SEM (Figure 1). The complex model of SEM is elaborated, defined and tested by us based on an evaluation of wide range of literature (Dinya 2009). We use abbreviations (buzzwords) above or below because of sparing with the space.

There are a number of technologies for rational use of energy (RUE) and RES, the integration of which is the key to creating complete alternative solutions with different degrees of regional energy self-sufficiency. SEM is necessary to avoid adverse impacts and careless use of RES in the name of SEM (Peura 2013). In developing the RESGen procedure this approach has been applied regionally.

Figure 1. The concept of sustainable energy management



Source: Dinya (2009)

The main objectives and research problems in this paper were:

- To construct a documented procedure for assisting implementation of SEM regionally.
- To test and analyse the procedure in the Northern Hungarian region, questioning:

1. Can the procedure help create commitment and trust among stakeholders?
2. Is the procedure helpful in implementation of SEM?
3. Is the procedure suitable for a more widespread use?

The need for SEM is based on the following reasoning:

- Deterioration of the environment is a threat to the whole of humankind and caused by discharge and overconsumption of natural resources. Humankind's ecological footprint reached an overshoot of 44 % in 2006, resulting in an ever-growing sustainability gap and causing reductions in natural buffers for self-purification abilities (Weijermars 2011). The cost for remedies has been estimated to exceed 14 trillion Euros and a 7% loss in global GDP in 2050 (EC 2008). It has been widely accepted that the problems are real and caused by human activity.
- Energy production has been one of the core issues concerning humankind's environmental impacts, whilst also having significant economical and societal impacts. That's why "*climate policy is principally…energy policy*" (Huberty–Zysman 2010, p. 1027). All thinkable fossil energy sources are becoming scarce and more expensive (Smalley 2005, Jefferson 2008, Hall–Day 2009), and the transition to SEM will be among the most important components in comprehensive global change (Peura 2013).

There is a vast literature about humankind's environmental impacts, population dynamics, limits of existence and natural resources (Peura 2013). Summarising, the world will face comprehensive changes and the transition towards SEM can be an integral part of them. "*... sustainability in a fundamental sense is connected to the survival of our species*" (Chichilnisky 2011, p. 126). It is important to develop SE in line with 'normal' business criteria. SEM is however not normal business and cannot be understood merely as economic transactions and 'business as usual' based on the following reasoning:

The construction of energy infrastructure has been subsidised by public funding. It has become more of a commercial activity following the privatisation of power plants and networks (originally publicly subsidised). However privatisation has not led to free markets based on equal competition, which would be a precondition for classical economic decisions "*...without a 'constraint' for sustainability*" (Chichilnisky 2011, p. 127). The development of energy infrastructure is still led by political decisions and the general rules define what can be profitable in the energy sector. Today most regulations still support the prevailing actors, and there are a number of structural barriers for any newcomers trying to introduce SEM to the market. For instance, in 2011 subsidies to fossil fuels were $523 bn globally, but only $83 bn to RES (IEA 2012).

Energy safety and self-sufficiency have national strategic implications, and there are important regional impacts. The money presently flowing to oil producing

countries, for instance, would have significant benefits if it stayed 'at home'. Therefore decisions to support the development of SEM are essentially strategic ones, and they are directed towards creating a stable business environment.

It is essential however that any new power plant is feasible. All operations take place in real time markets and concurrence cannot be avoided. "*... unsustainable practices have become a problem (...) because we are using world resources to the limit*", but the constraints involved by sustainability criteria "*... do not exist in neoclassical decision criteria*" (Chichilnisky 2011, p. 128). Therefore, "*we need new economic foundations that update classical economic thinking*" (Chichilnisky 2011, p. 128).

Today there are a number of positive drivers for SEM. However, the diffusion of SEM has been slow and there are many barriers. To make the dynamics understandable, the main drivers and barriers have been briefly reviewed in Chapter 2.

2. Drivers of and Barriers to Sustainable Energy

Over the last two decades there has also been increasing awareness and aspirations to see more widespread use of RES. The main reasons for this have included the following:

- *The RES potential.*
  Empirical material from Europe and globally demonstrates that there is realistic and easily mobilized potential for RES to enable energy self-sufficiency. Even 100% RES systems have been planned in practice (Peura–Hyttinen 2011).
- *The economy of RES technologies.*
  The business case for RES solutions is often already feasible and investments in RES technologies have performed well (Masini–Menichetti 2012). The benefits beyond business profitability can be significant. This regional added value (Hoffmann 2009; monetary aspects, reduced costs, increased purchasing power, new employment, tax income, social, ecological and ethical aspects, improved vitality) would be remarkable. RES also generates more jobs than conventional energy.
- *General perception and policies.*
  Development of a positive perception has prepared the ground for social acceptance of SEM, which has been high since early 1980s (Wüstenhagen et al. 2007). Policies and other support frameworks were established in 118 countries by early 2011 (REN21 2011). RES has moved to the top of the international political agenda, the institutionalization of SEM is occurring globally, and SEM has become the key concept in reforming the energy sector.
- *Technical evolution.*

Technical evolution is in early development phase, but new solutions are being developed on constantly. The strong spatial diffusion of RES technologies worldwide, despite their low market share, indicates a high overall potential for further diffusion to cover 60% of produced energy in 2050 (Lund P. D. 2010).

Despite strong signs of progress, the expansion of SEM has been far less than, for instance, the increase of world coal production (Jefferson 2008). There are a number of reasons for this:

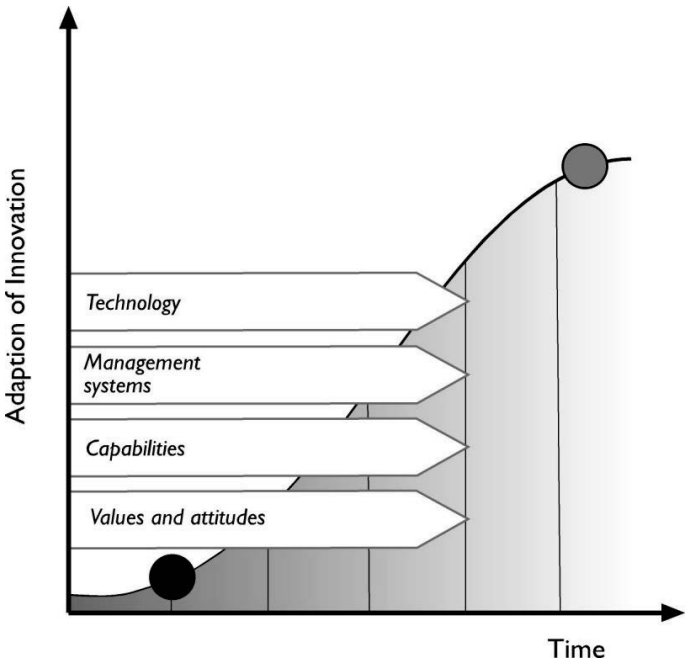
- *Institutional opposition.*
  The prevailing large actors tend to prevent any development that does not support their own business (Lund H. 2010). This also means that RES based solutions are fighting against existing energy structures.
- *Diffusion of RES based technologies.*
  SE and RES based systems require often a total change from fossil fuels to new raw materials. The shift towards these structures, different from the prevailing system, will be a long-term process. Technology and innovative institutional frames (Leszczynska 2011, Wolsink 2012) are necessary. As is the case of any innovation, institutional lock-ins preventing acceptance by key actors must be 'unlocked':
  1. Key social actors must accept the innovation.
  2. The process must be 'structured' so that laws, regulations and other institutions support them, or do not oppose them.
  3. Innovations must evolve technically.

  RES solutions are in early phase of diffusion, but concurrence takes place in real time markets, where the opponents are at the opposite end of diffusion. Thus, they are competing against technologies with many years of technical evolution, where investments have been repaid, supportive social structures are in place and the benefits of mass production and established value chains exist. As illustrated in Figure 2, RES technologies can be located to the left and lower down the diffusion curve, whilst the prevailing technologies are to the right and higher up the curve.
- *The process.*
  Change towards SEM will be a long evolutionary process, which needs to involve the majority of people. There will be a huge number of decision-makers, from individual citizens, families, farmers and businesses, to the public sector. Its success depends primarily on how the crucial stakeholders approve it (Wüstenhagen et al. 2007).

The conclusion drawn is that physical prerequisites for SEM exist. A shift towards SEM and away from fossil fuels will presumably be on the global agenda in

the near future. The majority of stakeholders wish to see this agenda move forwards, but there are barriers slowing the process. Also the role of economics is problematic: Market penetration and competition against powerful prevailing structures is difficult, but along with the diffusion, the prerequisites and feasibility of SEM are expected to improve. Conscious strategies and programmes can boost this development, which has been the focus in constructing the RESGen procedure.

Figure 2. Diffusion of innovation and capabilities



Note: RES technology: bottom left, conventional technology: top right
Source: Rogers (1995)

3. Methology

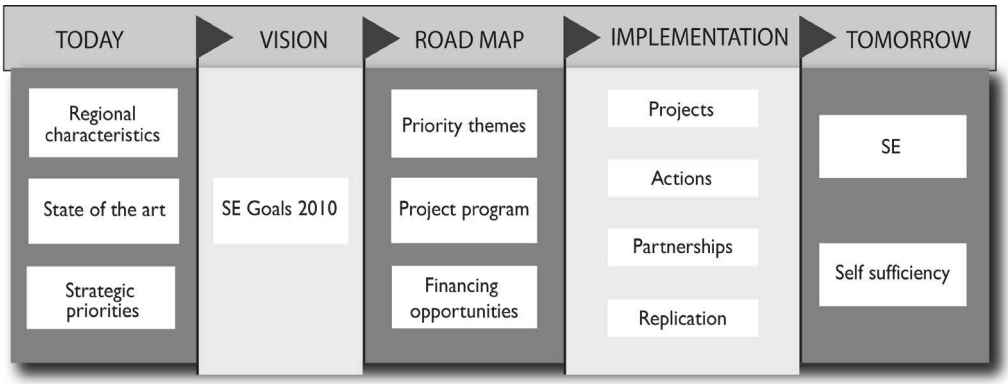
The underlying idea was to boost SEM by developing a replicable common approach and methodology, the RESGen procedure. In the project it resulted in a regional roadmap for implementing SEM. The Roadmap was clearly defined by practical project programmes based on regional strategy, for which stakeholder commitment is crucial. Figure 3 illustrates an overview of the procedure and its phases:

- Development of regional strategy based on the regional characteristics (regional SEM, capacities and capabilities) and priorities.
- Development Vision and Roadmap 2020.

Regional characteristics formed the starting point, i.e., the current energy mix and future perspectives of SEM. The analysis aimed to identify alignment and complementarity between the regional SEM R+D supply, demand and policies. Collecting of information was based on two different focus-groups or panels (16 – 16 selected members from the experienced stake-holders of the region) as follows:

- SEM – state of play;
- current energy overview;
- situation and perspectives: workshops, interviews, analyses;
- SEM policies;
- directories of SEM R+D demand and supply, basic regional information (2008);
- companies' R+D: employees, turnover, expenditures, international presence, main fields of activities, funding sources.

Figure 3. Overview of the RESGen procedure



Source: Dinya et al. (2014)

The data was further elaborated in a regional SWOT analysis for defining the regional priorities. Information attained through questionnaires and workshops were organized into a matrix (Figure 4), which enabled the definition of strategic steps:

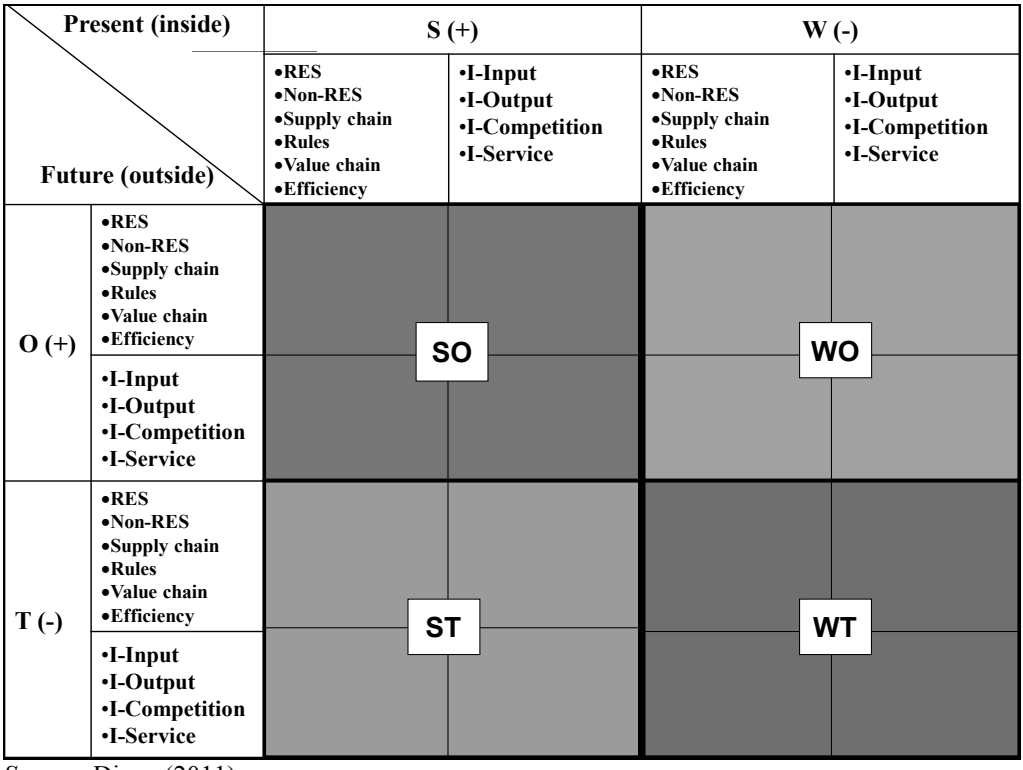
- 'SO': exploiting opportunities, based on strengths;
- 'WO': eliminating weaknesses, exploiting opportunities;
- 'ST': avoiding threats, based on strengths;
- 'WT': avoiding threats, eliminating weaknesses.

The matrix was used as follows: each S,W,O and T was collectively defined and given numbers (S1, S2....T1, T2 etc.), which were placed into the matrix. Every cell was a combination of S-O, S-T, W-O or W-T. The SWOT panel participants gave scores to each cell according to how important they considered each combination (S1-O1, S1-O2...W1-T1, W1-T2 etc.) on a scale of 0-5 (0 = no relevance, 1 = very

little relevance…5 = very important). The collective opinion was the sum of all scores and those combinations that received the biggest scores were considered the most important ones.

Then, the region has defined its Vision 2020 and Roadmap. Regional panels outlined the most likely future scenarios for the Vision, defined the priority themes and project ideas; these were further developed by emails and discussions. A series of regional workshops were organized to guide the region. The Delphi method (Linstone–Turoff, 2002) was used to attain a collectively defined Roadmap. In the final workshop the results were discussed and the participants could comment on the earlier results.

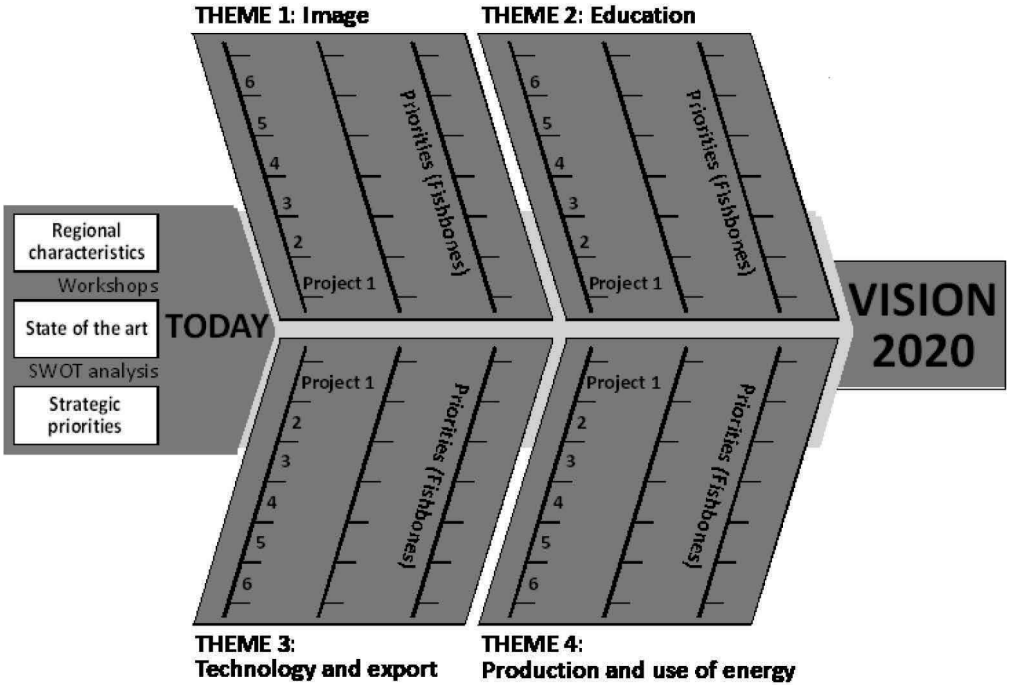
Figure 4. The SWOT matrix



Source: Dinya (2011)

Each participant received an email including the proposed themes and project ideas for scoring, instructions and Excel-templates to be filled in. The overall scores were considered as the regional collective opinion. This organization resulted in the "fishbone" structure, which was the Roadmap for each region. In the fishbone (Figure 5) the themes are the four blocks, the priority areas the fish bones and the separate projects the actions.

Figure 5. The regional roadmap as the fishbone structure, presents the final priority themes and projects



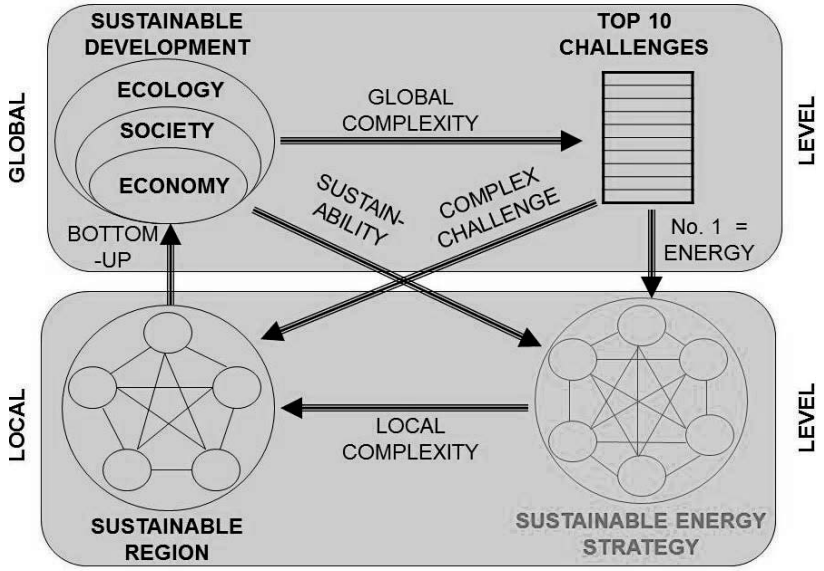
Source: Dinya et al. (2014)

4. Applying the RESGen Procedure – experience of the Northern Hungarian region

The starting point was the complex system of global sustainability challenges, which was applied at the regional level (Figure 6). Selected actors (forming a Regional Strategic Committee; RSC) tested this model in Northern Hungary. The RSC had an open geographical, sector-wide and functional representation of the regional stakeholders.

The RSC elaborated the regional SWOT matrix and provided the regional energy (Figure 7) and RES-innovation profiles (Figure 8). Based on these the present situation and the future potential of the energy sector and RES related innovation capacity in Northern Hungary were defined (Figures 9 and 10). The work resulted in the following vision: "*The Northern Hungarian region will work towards energy independence by achieving the highest possible RES-ratio and effectiveness of energy production and consumption by 2020.*"

Figure 6. The SEM regional model applied in Northern Hungary

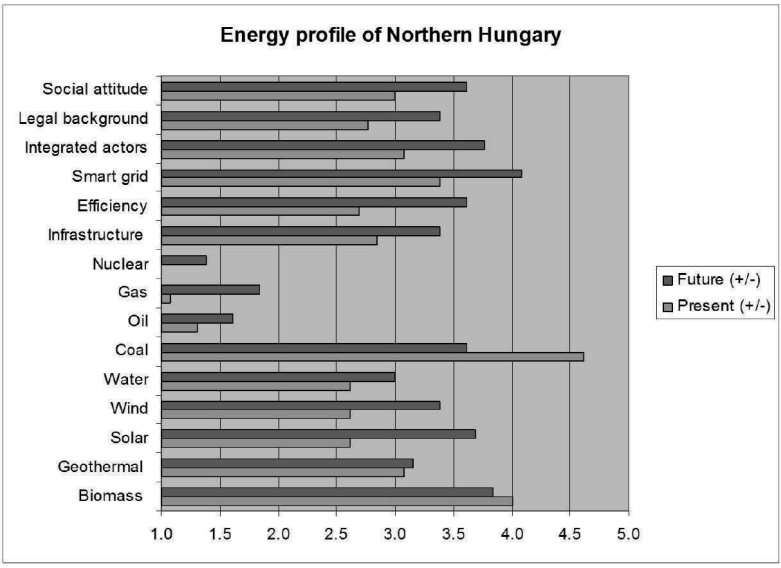


Source: Dinya (2011)

The RSC outlined the regional RES-strategy with the most important actions as follows:

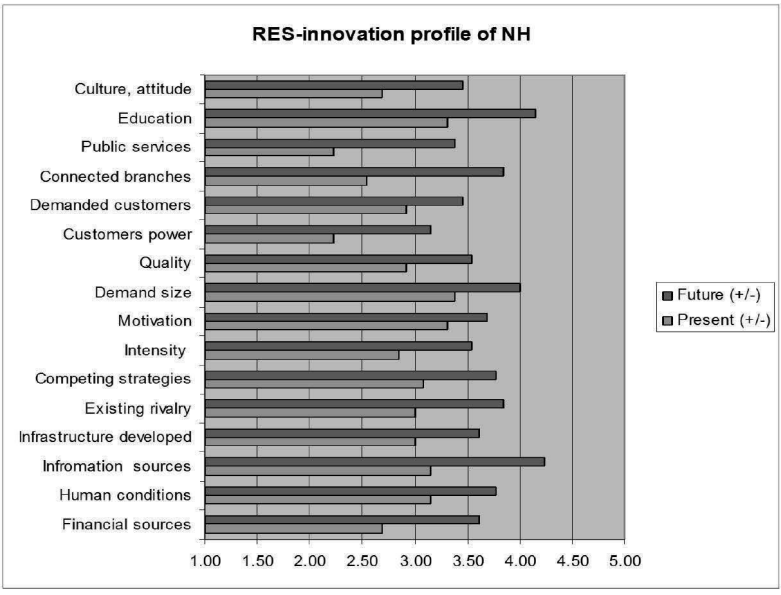
1. Developing integrated local systems based on the bioenergy potential and pilot systems.
2. Introducing zero-emission technologies into the exploitation of coal reserves and subsidizing the co-firing of biomass with coal.
3. Serving the increasing innovation and education needs through the regional bioenergy knowledge centre and involving solar energy.
4. Intensive dissemination of successful RES-projects to drive innovation and RES-investment and to exchange the culture and attitude of energy consuming and to establish the social basics of SEM.
5. Providing knowledge services for RES-projects outside the region based on developing regional RES-innovation capacity especially in bioenergy and distributed energy systems.
6. Establishing RUE programs using the knowledge services of regional innovation centres.
7. Implementing consultation programs to involve the public sector (local governments, hospitals, schools, etc.) in SEM.
8. Elaborating innovative solutions for the private, public and NGO-sectors to help them in starting successful RES-projects.

Figure 7. The regional energy profile of Northern Hungary



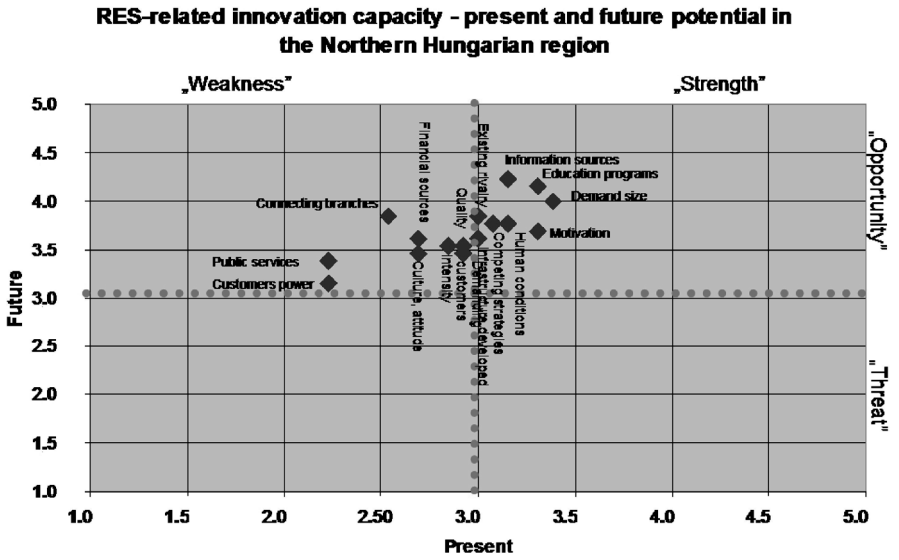
Source: Dinya (2012)

Figure 8. The regional RES-innovation profile of Northern Hungary



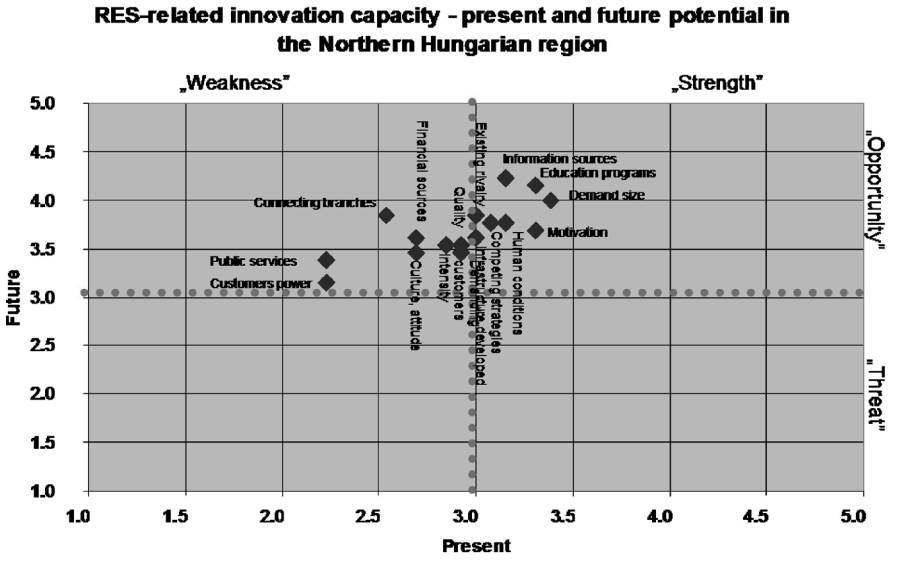
Source: Dinya (2012)

Figure 9. The present and future potential of the energy sector in Northern Hungary



Source: Dinya (2012)

Figure 10. The present and future potential of innovation capacity in Northern Hungary



Source: Dinya (2012)

5. Summary

Results from the regional strategy and the main features are included in the following:

- The region followed the RESGen procedure and defined its own priorities based on regional characteristics, which caused differences in details of the procedure.
- Stakeholder involvement was high, and all main actors were represented in the roadmap. This created excellent commitment and base for implementing the roadmap.
- In Northern Hungary the roadmap focus was establishment of regional systems and creating regional energy self-sufficiency.
- Embedding the sustainable energy strategy and the innovation strategy into the regional development strategy (that is a combination of them) is a very useful approach to solve the complex problem.

The innovation of the RESGen procedure was two-fold. It integrated new approaches and methods with well-known tools (SWOT) into an easily applicable system, and it was applied in a novel branch for a bottom-up strategy and implementation of SEM. Systematic management is essential, as the anticipated SE reform is a social process involving all stakeholders. The procedure provided regional stakeholders with a 'platform' for structured discussion and commitment. This contributed to the fact that the project was nominated among success stories in EU projects in 2012. It also contributed to the '3S' (Smart Specialization Strategies; Foray et al. 2009, EC 2010) definition to include SE.

The main conclusions are the following:

- The procedure worked well, with some requirements to improve user-friendliness. The application has demonstrated the flexibility of the method.
- Public awareness, attitudes and trust, stakeholder commitment and functioning of the decision-making system are vital for successful implementation of SEM.
- Regional stakeholders were motivated to develop their own strategy, aiming at SEM.
- The procedure can reveal facts that are not known or expected. It may also reveal institutional opposition and negative attitudes against SEM, thus making the barriers and bottlenecks visible. These and the new strategic tool enable realistic development.
- There is a call for 'rules of the game', in order to reduce uncertainty of the business environment for SEM. Conscious development through comprehensive regional strategies and structured programmes will be important. The RESGen procedure is an attempt towards SE development integrating local and regional implementation, national and international policies, smart specialisation and general progress.

The RESGen procedure provided a systematic tool enabling unified development for all regions. The experiences suggest that the procedure could be fit for a more widespread use. The existence of this kind of tools encourages regional programmes and thus promotes the implementation of SE.

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