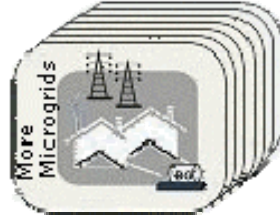




A European Project Supported by the European Commission within  
the Sixth Framework Programme for RTD



# **Advanced Architectures and Control Concepts for More Microgrids**

**Contract No: SES6-019864**

## **WORK PACKAGE G**

**DG3. Report on the technical, social, economic, and  
environmental benefits provided by Microgrids on  
power system operation**

**Annex 7 – SOCIAL BENEFITS OF MICROGRIDS**

**November 30<sup>th</sup> 2009**

**Final Version  
PUBLIC**

**Contribution from:**

*UKIM*

*ICEIM-MANU*

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## **Executive Summary**

In the first part of the document, the general social issues which are part of the Lisbon Strategy are addressed. In the second part, the ways by which the Microgrids concept can influence these issues are identified. These findings, which are correlated to the experiences of the actual test locations (collected by making use of an appropriately developed questionnaire), are described in the third part of the document. At the end, the ways to improve the overall awareness of the social benefits related to Microgrids are analyzed by means of problem and objective tree method.

## 1 Social benefits of Microgrids

Energy is a crucial social variable, but it has sporadically been of interest to sociologists. Recent world events and trends have revived both interest and concern of the impacts of energy on society and life quality. These events also created a different, more productive atmosphere for discussions on energy issues from many aspects, especially in terms of using new technologies and concepts to surpass the current problems. On the other hand, the energy end-users have been exposed to a lot of information on energy, its availability, price changes, emissions concerns, etc, which has enabled them to draw their own conclusions and to join the discussions stating their own needs and views. In this context, when discussing energy related issues, it is important to provide an overview of benefits that are not only technical and specific for power systems, but wider range of benefits, which are related to improvement of socio-economic conditions and living environment. Therefore, the investigation on social aspects of energy related issues is nowadays undertaken along with the investigation on economic and environmental issues. Additional reason for this is that the social benefits are usually tightly related to the economic and environmental benefits and sometimes it is hard to make real distinction between them.

The social benefits assessment of a certain concept can be conducted by identifying socio-economic issues that can be impacted and the positive/negative effects the concept inflicts on those issues.

## 2 Major social issues to be addressed

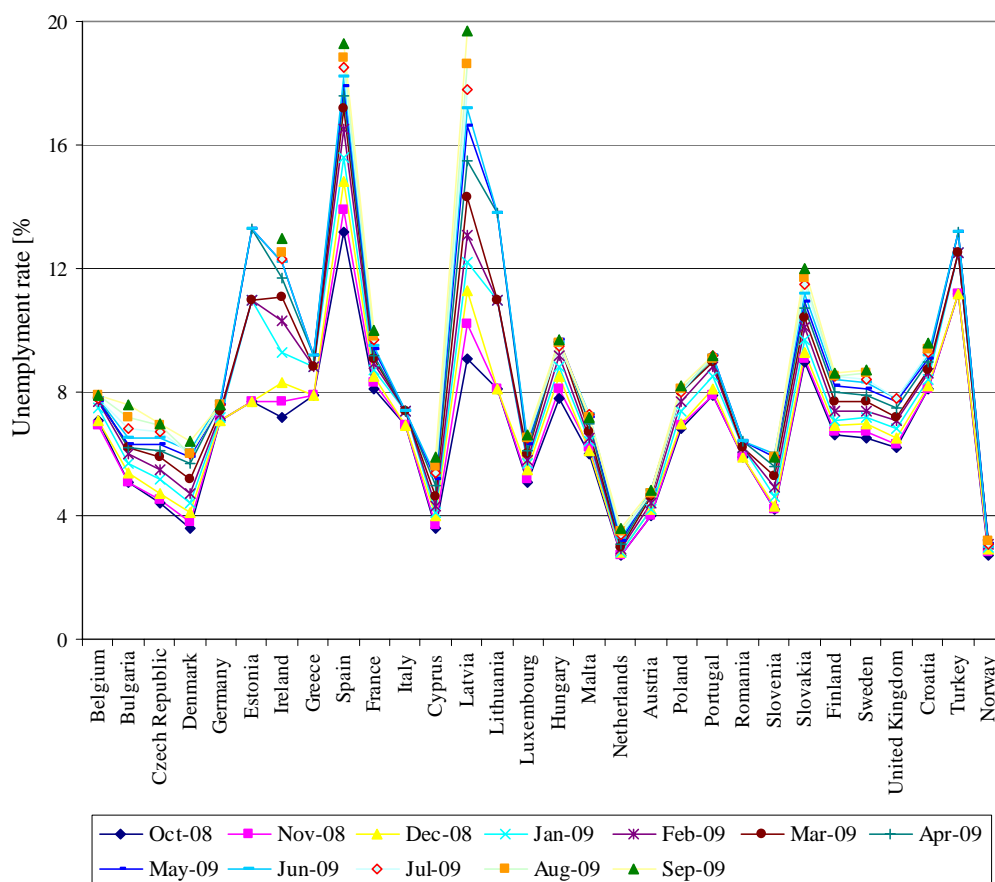
European Union launched the Lisbon Strategy in 2000 as a way to address the main challenges of our time: the globalisation, the climate changes as well as the aging population. In 2005 the Strategy was re-launched with the initiative *Working together for growth and jobs*, with key areas for reforms which include [1]:

- investing in people,
- more research, development and innovation,
- more dynamic business environment and
- greener economy.

Just when the growth and jobs strategy was starting to deliver with steadily declining unemployment rates throughout the EU, the economic and financial crisis reversed the situation, highlighting the need to pursue and accelerate structural reforms. The crisis has affected other segments of the national economies as well, but still both to individuals and society, the decrease of the unemployment rate is a priority, just as before the crisis.

As presented in Figure 1, the unemployment rate has increased in most of the European countries in the past year. The unemployment rate statistics along with other labour market statistics make a key contribution to the indicator sets, i.e. the Structural Indicators within the Lisbon strategy and the European Employment Strategy. [2] Therefore, concepts and measures that would provide possibilities for

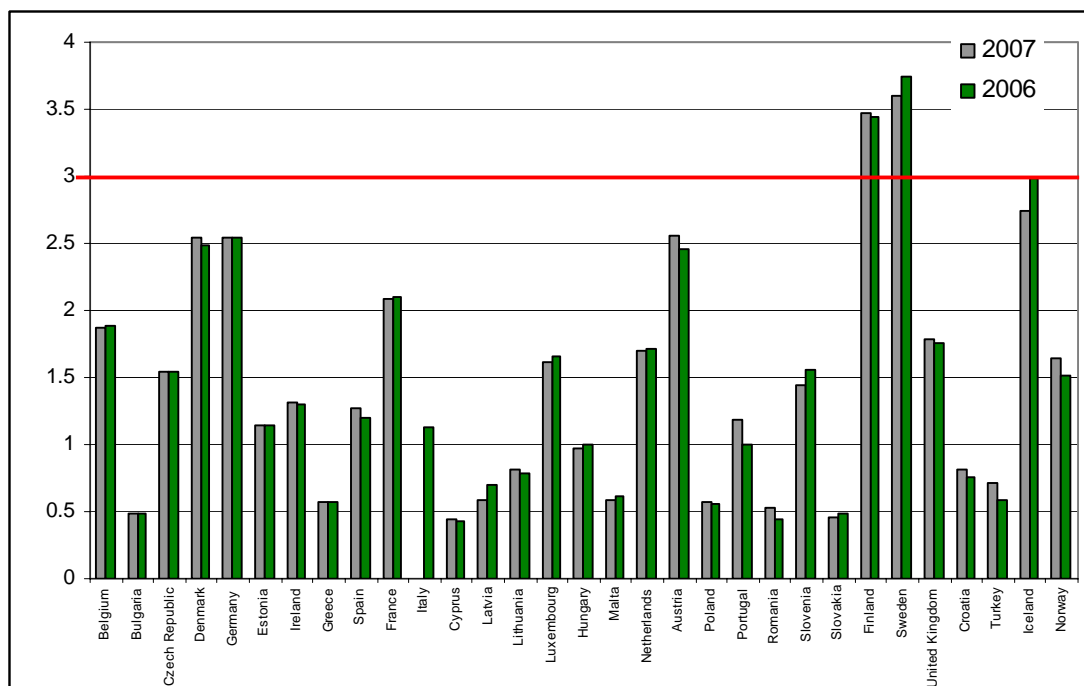
new jobs on the labour market will be a contribution for improvement of the current conditions and are in line with the objectives of the Strategy.



**Figure 1 Unemployment rate in Europe, source-Eurostat**

One of the main commitments of the EU is reducing the differences in prosperity and living standards across Member States and regions, and therefore promoting economic and social cohesion. EU has promoted different measures, as social programmes and funds (for example the European Social Fund) to ensure the realization of this commitment. However, a lot more needs to be done, especially for the remote areas and regions in different European countries.

Investing in people and in research & development (R&D) are crucial objectives of the Strategy, and thus, of the European Union. The goal is to help the transformation of EU into "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion". Considering that the science, technology and innovation are often considered as main drivers for economic development, another aim was added to the Lisbon Strategy in 2002, namely to spend at least 3% of GDP on research by 2010 of which two thirds should be financed by the business sector. Figure 2 presents the gross domestic expenditure of the European countries in research and development in 2006 and 2007 in correlation to the Strategy goal [3].



**Figure 2 Investment in R&D by country, source Eurostat**

At the Spring European Councils of 2006 and 2007, one of the four priority areas agreed upon by the Member States was more investment in knowledge and innovation. In 2007 the European Commission launched the Green Paper 'The European Research Area: New Perspectives', a "broad institutional and public debate on what should be done to create a unified and attractive European Research Area" [4].

The Strategy commitment to create financing framework for R&D provides better working environment for researchers in terms of possibilities to widen the research topics and to increase the human research potential working on these topics. What is even more important is the creation of a firmer link between business and research sectors, which at the end would influence the industry and economy development and enable faster application of the new ideas and concepts.

Another important commitment, which is related to the greener economy reforms in the Lisbon Strategy, is reducing the greenhouse gas emissions and preventing global warming. EU has been the leader and promoter of climate change actions and renewable energy packages. The efforts led to international negotiations concerning climate change issues which are expected to move step further on the UN climate change conference in Copenhagen this year. If seen through the prism of socio-economic conditions, the climate change issues have a strong influence on global economy and life quality and need to be considered carefully by developed as well as developing countries.

The above mentioned issues are not only of concern to the EU member states, but rather are global issues that need to be addressed.

### **3 Expected social benefits of the Microgrids concept**

The above mentioned issues are closely related to the energy challenges our society is facing today. One of the most important commitments of the EU is providing secure, competitive and sustainable energy as a driving force for the development of low-energy economy. In order to achieve this goal and to enable the end users access to secure energy supply, EU has to overcome a set of issues regarding climate changes, imports dependence and energy resources strain.

The impacts of the Microgrids concept from technical point of view (mainly development of control concepts and alternative network designs, increase of reliability, reduction of network losses, as well se wider Microgrids benefits in terms of impact on the overall network reinforcement and replacement strategy of the aging infrastructure) are all discussed in details in the deliverables in the framework of the MoreMicrogrids project. On the other hand, the concept would provide some common benefits with overall benefits expected of the increased distributed energy sources (DER) and renewable energy sources (RES). In this context, it is important to mention that the IRED<sup>1</sup> cluster has done research on the socio-economic aspects of the increase of DER share within several FP5 projects [5]. These findings were a good base for further research, especially as they sketched some economic and regulatory requirements which need to be fulfilled in order to increase the DER share in an economically efficient manner. The research is important from the aspect of the Microgrids concept, as DER/ RES technologies are part of the concept. Our findings show that the Microgrids concept offers some additional social benefits, which will only add up to the overall values brought by the concept.

#### ***Job opportunities in research, industry and SMEs***

The Microgrids are rather new concept and although they are being in the scope of the academic research groups for some years now, further investigation on technical, economical and environmental aspects is needed. This creates a certain area for developing research projects and collaborative projects between industry and various research groups. These actions could require additional human capacity, both in the research institutions and in the industry. As a result, new positions could be opened for young researchers or doctoral and postdoctoral students, as well as for engineers in the research departments in the industry, especially in the companies producing electricity equipment. These assumptions could be backed up by the fact that the EU countries have committed to continuously finance R&D, so it should be easier to provide additional funding for new positions. As the concept is investigated in several different parts of the world, especially in USA, Canada and Japan, possibilities for joint research projects exist, thus facilitating the projects funding and exchange of knowledge and experience. Keeping in mind the increasing unemployment rate is a global problem, all possibilities for creating new jobs should be used.

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<sup>1</sup> *Integration of Renewable Energy Sources and Distributed Generation into the European Electricity Grid (IRED)* is a large European Cluster of RTD projects funded by the European Commission which represents over 100 stakeholders in the electricity networks sector.

The link with the industry is important from another aspect as well. The research on new concepts, such as Microgrids, provides conditions for development of new devices and products based on for example, new standards and protocols. After being tested, these devices have the potential for further commercial production, having the utilities as potential buyers.

The additional benefit of the collaborative research projects which include both partners from the industry and research centers and/or universities is the opportunity for the companies to work on development of new products and test them while having an overview of the ongoing theoretical results, simulations as well as on the potential problems and further needs. This type of collaboration increases the R&D capacity of the company as well. The possibilities for commercial production of new devices could sometimes be accompanied by new job openings.

It is interesting to investigate the possibilities for the small and medium enterprises (SMEs), seen from the aspect of implementing the Microgrids concept. For example, the establishment of the pilot Microgrid location Agria involved collaboration between a SME, responsible for biogas production on the location, the owner of the location, i.e. pig breeding company and two research institutions. This type of collaboration could be easily transferred to other similar projects, if common interests for the partners exist. The farms in the region have to manage their waste and the SMEs can provide solutions for waste water management. The possibility to use the biogas for electricity/heat production for the local users is additional benefit for the partners. Further on, depending on the size of the production unit, the produced electricity could be sent to the grid, while the owner will receive payment under special RES tariff. Of course, other opportunities exist. These enterprises could provide different services in the process of Microgrid implementation, as equipment, products, consulting etc. The social benefits in this context are related to the new business opportunities for the SMEs and providing possibilities for new jobs on the labor market.

### ***Remote areas electrification***

Some experiences in [6] showed that community based Microgrids established in rural undeveloped regions with no access to electricity were a good solution to the electrification problem. Except solving the electrification problem, the access to electricity in these types of regions enables and improves the delivery of social and business services from a wide range of rural infrastructure (schools, markets, water pumps) while improving the productivity of agricultural activities. The increased productivity and growth in revenues, contribute to achieving higher social and economic benefits for the rural communities. The experience from [6] highlighted the potential for an alternative way to accelerate rural electrification. The authors propose use of group-based micro-grids that are initiated and managed as common property resources. These micro-grids can be based on the use of a mix of energy sources (e.g. diesel, micro-hydro, solar, wind, biomass) to serve small and geographically dispersed villages. According to the authors of the paper, further research is needed to explore the likely incentives and constraints of initiating and managing electric micro-grids collectively. Of particular interest would be an empirical inquiry into the ways in

which heterogeneity of economic interest (differences in electricity end-uses) is likely to shape the incentives for collective action, patterns of electricity consumption, equity in access to electricity, and mechanisms for conflicts resolution. The study also raises some policy implications concerning subsidies and support measures which could be available in undeveloped region and these issues are discussed in details in [6].

### ***Social cohesion and regional development***

Maintaining constant and even regional development is one of the pre-conditions for sustainable development. The better security and quality of electricity supply envisaged with the implementation of the Microgrids concept would allow better life quality in the developed regions and would provide a positive impulse for the undeveloped regions. The increased security of supply and reliability which the Microgrids concept enables are important both to the utilities and the end users. The utilities have already shown interest for further testing of the Microgrids concept, which is a stable base for further research and implementation. On the other hand, when introduced to the Microgrids concept, the end users have shown general acceptance and interest. Crucial for their support is providing information on the overall benefits of the concept and not imposing too many requirements. It would be good to investigate the acceptance of a pilot facility when it is a part of a community project. The assumptions so far are that these types of projects would increase social tolerance and cohesion.

## **4 Experience from the test locations - Questionnaire Summary**

In order to have a better overview of the social benefits of the Microgrids, a questionnaire has been created for the pilot Microgrids responsables/owners, intended to outline the key findings regarding social benefits from the specific test locations.

The questionnaire was organized in two sections. The first section referred to utility related issues and the utility-customer relations, while the second section covered the customers' related issues. The questions included environmental and financial issues, further research, field tests and institutional barriers, but all seen through the prism of increasing the overall social benefits of the Microgrids concept. The questionnaire is presented in the annex of this document.

The questionnaire was distributed to all partners responsible for the pilot locations. The response was 50% (4 out of 8).

### **4.1 Utility related issues**

#### ***Further research on Microgrids***

All partners who have answered the questionnaire are interested in further research in Microgrids and will provide conditions for specialization of their employees in this field. Also, they all agree that the decision to continue with the research in this area will be made easier if there is available funding. This is well in line with the general commitment of the EU member states to provide R&D funding in the amount of 3%

of their national budgets. As energy is one of the research priorities, the possibilities to provide funding for continuing with research are higher, especially within joint collaborative projects. This will also result in opening more new research positions. All of this is very important for the companies that have introduced the Microgrid concept for the first time or have low experience in this area, where an additional personnel is required to work on this concept.

### ***Further testing***

All four companies are keen to continue with the experiments on the existing Microgrids and will accept to test the Microgrid concept on other locations as well. They will also accept to test new devices that will facilitate the Microgrids operation. One of the partners (Labein) has frequently used their laboratory for testing commercial and pre-commercial equipment. The results from the Microgrids' tests can be used to improve the infrastructure and the operation of the distribution grid.

### ***Environmental issues***

All companies are ready to take actions which affect the environmental problems in the area/region. Some of them have separate units that are dealing with the environmental issues. One of the companies (EDP) has established guidelines that guarantee the minimization of the environmental impact of the power stations.

Most of the companies will be more enthusiastic for further research in Microgrids if the environmental benefits of Microgrids are described in a qualitative manner (for example in terms of emission reductions).

### ***Utility - Customer relations***

The awareness for the Microgrids at the selected pilot locations was low and most of the companies have organized public events, such as conferences and workshops, to promote this concept. The concept was also promoted through publication of books and papers in journals.

Most of the companies will consider the public opinion in the decision making whether to continue with the research on Microgrids and practical test on the pilot locations, but the technical/financial factors will play a key role to the final decision.

The companies didn't have any problems in getting consent from the customers for the test locations. But, in most of the cases the customers were well informed about the process, prior the tests.

### ***Institutional barriers***

The companies didn't encounter any institutional barriers during the pilot Microgrid testing process.

## **4.2 Customers' related issues**

### ***Customers' awareness***

In general, the customers at the pilot test locations are willing to adopt the energy saving and emission reduction measures. However, they are not very enthusiastic to engage or invest in new technologies for distributed generation, without any previous

experience. In all four cases the customers were not familiar with the Microgrid concept, but with several information campaigns their response was positive. But, it is quite unlikely that the customers will change their everyday habits and shift their daily energy use according to the Microgrid operation, even if they are familiar with the benefits of the Microgrid. On the other hand, in Portugal, compensation is given to the customers in order to stimulate the changing of their everyday habits and the majority is willing to adhere to the grid conditions.

### ***Financial issues***

Most of the countries have established feed-in tariffs for the electricity produced from different RES (PV, wind, small hydro, CHP using biomass as a fuel, fuel cells, biogas from biomass etc.). It is compulsory to purchase the electricity from the producers qualified for feed-in tariffs. However, in some countries, the higher rates of deployment of several technologies (such as PV) have caused reduction of the feed-in tariffs and changes in the limits of the installed capacity. Other support measures are tax incentives at fiscal level, namely related to VAT, individual and corporate income taxes. Investment subsidies are also introduced in some countries in a form of a repayment of a certain percentage of the investment costs for some of the technologies.

The customers/communities on the pilot Microgrids locations are aware of the support schemes established in their countries, but on the country level the awareness is still low. The high investment costs and the payback period are the major obstacles for the customers to invest in the technologies for distributed generation.

### ***Further testing***

In general, the customers are receptive to take part in future demonstrations of microgrids. Still, prior to any tests they should be well informed about the consequences from these activities, such as local adaptations to the microgrid operation and disturbances in the energy supply that may occur during the tests.

## **5 Conclusion: How to increase the overall awareness of Microgrids social benefits**

The experiences from the test locations provided some general conclusions which were presented in the previous section. Apart from these conclusions, it could be noticed that although the social benefits of the Microgrids concept exist, it is not always easy to recognize them and value them appropriately. In order to provide a better overview of these benefits and to pinpoint the general problems which contribute to the insufficient awareness of the social benefits of Microgrids, the problem tree analysis is implemented.

### ***The problem tree & objective tree method***

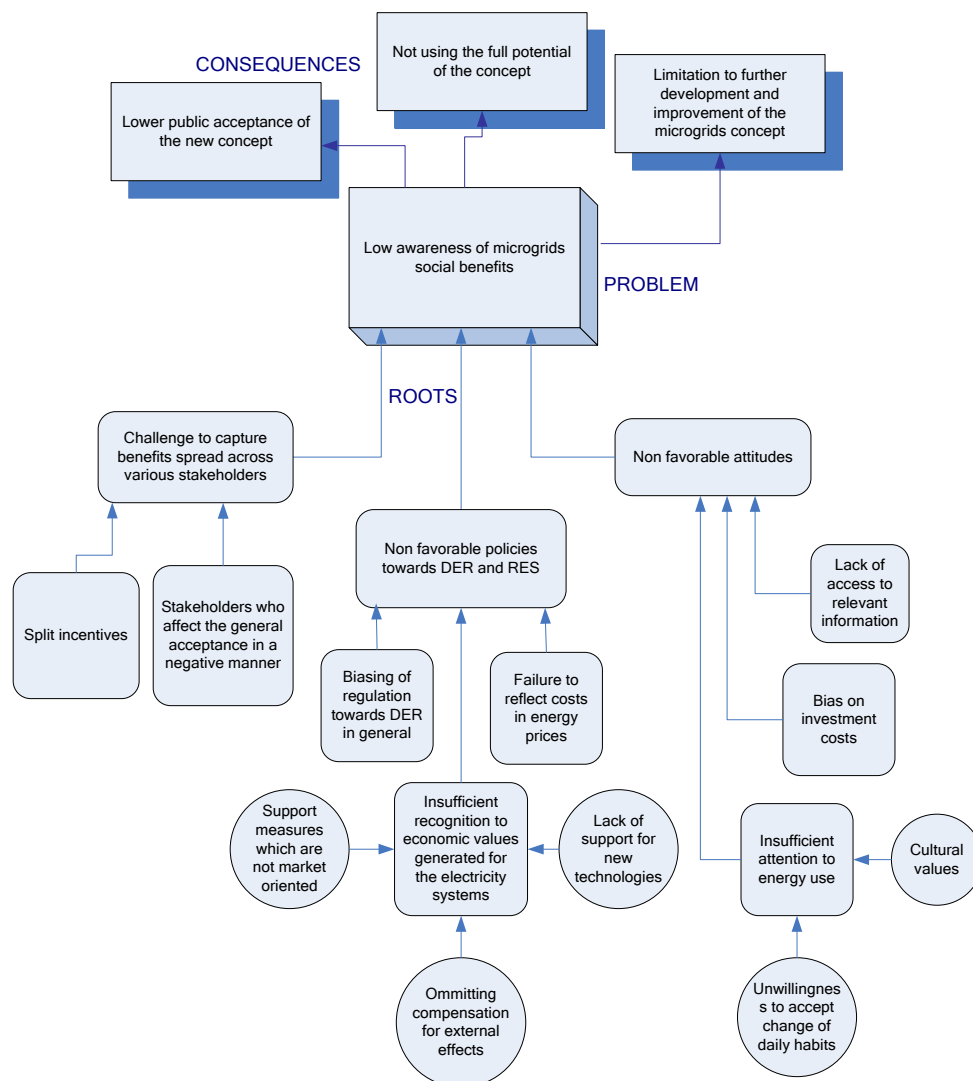
The Problem Tree method is used to uncover the causes of the particular problem. A step further is the formulation of the Objectives Tree. By this method, any broad goal (for example, achieving a certain share of RES into the total energy consumption in

agricultural sector, rising public awareness of the expected Microgrid benefits) can be broken, graphically, into increasing levels of detailed actions that must, or could be done to achieve the stated goals, and the relationships between them.

As it was previously mentioned, in order to fully access the Microgrids benefits, it is important to consider the social benefits of the concept. However, they might be omitted in the assessment of the overall concept benefits. The reason most likely is the low awareness of this type of benefits which might result in:

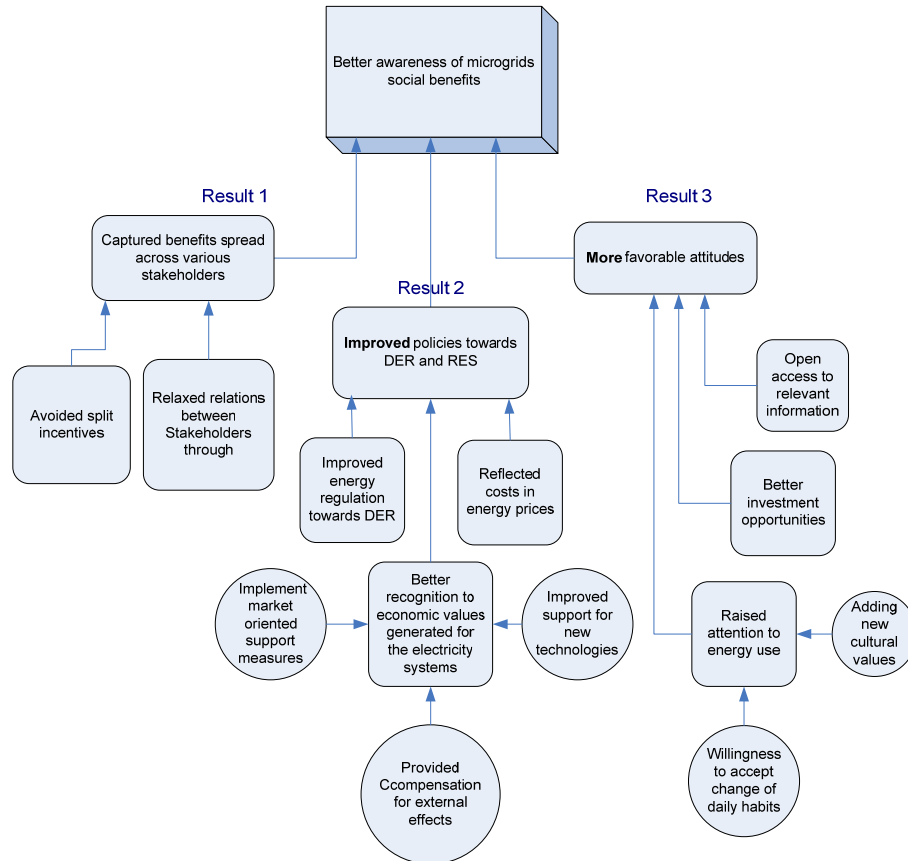
- not using the full potential of the concept,
- lower public acceptance,
- limitation to further development and improvement of the Microgrids concept.

So, the problem tree presented in Figure 3 aims to uncover the causes to the low awareness of the Microgrids social benefits.



**Figure 3 Problem tree**

The improvement of the RES/DER policies in general would cause an increase of their share in the energy systems. The activities which lead to improved RES policies are already discussed as lessons learned within the IRED Cluster [6]. It is worth mentioning that harmonization between national and EU policies would ease the fulfillment of these activities.



**Figure 4 Objective tree**

Open access to relevant information is very important for gaining more favourable attitudes. The experiences from the test sites also pointed out the importance of providing appropriate information of the concept and its benefits. Other experiences provide similar conclusions. According to [7], although the individuals can never have perfect information relevant to a decision they're making, the development of efficient markets of services and goods in general, requires the individuals to be aware of the available options, the rough costs and benefits of the different options, how to deploy these options and the costs to invest in these options. Of course, these simplified general rules do not always coincide with the real situation, especially in the case of new concepts and technologies in grids. The individuals would be interested in things like who pays for the investments for the new concepts, how will the investments reflect to the individual's budgets, will the new concept work well enough like the existing, would it require change of habits, who is responsible for solving defects and problems, etc. So, it is important that the individuals are acquainted to the concept, its performance and expected benefits in order to be able to accept it, but the information should be served in an appropriate manner, avoiding confusion and unclear issues.

The cultural values of the people are shaped by the society and culture. As mentioned in [7] they should not be considered as a barrier, but sometimes, if the inherited values do not evolve, they might become obstacles. The authors give a rather obvious example saying that the inherited attitude towards the desirability of centralised energy supply, which evolved when this was a dominant technology, may become a barrier in these times, when we strive for distributed energy and intelligent grids. In general, people do not accept the new technologies and concepts right away. In fact, this is related to their decisions on investments, as they are keener to make the investment decision based on past experiences, or in other words, repeat what has once been a successful decision.

The previous discussion points to another interesting observation, namely, the roots of the problem are usually related, but so are the activities which lead to fulfilment of the main objective.

## Appendix

### Questionnaire

#### Utility related issues

##### Further research on Microgrids

1. Is your company interested in further research in the field of Microgrids?  
Yes  No
2. Would research on Microgrids require additional personnel to work on this concept?  
Yes  No
3. Is the company interested in providing conditions (for example funding) for specialization of its employees in this field?  
Yes  No
4. If funding is available, would it ease the decision to continue the research in this area and provide more research positions for this particular area?  
Yes  No

##### Further testing

5. Is the company interested in further experiments on the existing pilot Microgrid locations?  
Yes  No
6. Would the company consider testing on other locations as well?  
Yes  No
7. Would the company also accept testing of new devices developed to facilitate the Microgrid operation?  
Yes  No

**NOTE** Please fill in comments/your views/additional information regarding questions 1 to 7

##### Environmental issues

8. Has the company taken any actions in the recent years to impact the environmental problems in the area/region?  
If yes, please list the actions
9. If no, would the company be interested in taking this type of actions?  
Yes  No
10. If the environmental benefits of Microgrids are described in a qualitative manner, for example, in terms of emissions reductions, would the company be more interested in further research on Microgrids?  
Yes  No

Utility – Customer relation

11. Has the company taken actions to promote the Microgrids concept to the customers?  
Yes  No   
If it has, what types of actions were taken?
12. If the community is well acquainted with the Microgrid concept, would the public opinion play a role in making decision weather to continue with the Microgrid concept research and practical testing on pilot locations?  
It would play a significant role   
It will be considered but other factors (technical/finacial) will be basis for decision   
It will not be considered
13. Has the company encountered problems in getting consent from the customers for the pilot test sites? Were the customers well informed prior the test process? Please describe your experience

Institutional barriers

14. Has the company encountered certain institutional barriers during the pilot Microgrids testing process?  
Yes  No   
If it has, what type of barriers were they? Please describe shortly

**NOTE** Please fill in comments/your views/additional information regarding questions 8 to 14

Customers' related issues

Customers' awareness

1. Are the customers willing to adopt energy saving and emission reduction measures in general?  
Yes  No
2. If the customers/local communities have no experience or relevant information for the new technologies for distributed generation, are they willing to engage and invest in such technologies?  
Yes  No
3. Were the customers (at the selected location) familiar with the Microgrid concept?  
Yes  No
4. If the customers are more familiar with the benefits of the migrorgid, are they ready to shift their daily energy use according to the grid operating conditions even if it means changing their everyday habits? Please describe your experience

### Financial issues

5. Are there any existing support schemes (such as investment subsidies, energy tax relives, obligatory purchase and support feed-in tariffs for energy from RES) for distributed generation?  
Please explain shortly
6. What is the awareness of the customers/communities for such subsidy schemes? Please explain shortly
7. What are the most frequent issues/obstacles customers/local communities consider when making the decision to invest in DER technologies? (for example payback period, high investments, etc.)  
Please describe shortly

### Further testing

8. Will the customer agree to become a part of a test – Microgrid in future and to support the utility in performing Microgrid's operation tests?

Yes  No

If not, what are the main reasons?

## References

- [1] European Commission, Lisbon Strategy for growth and Jobs, available on-line <http://ec.europa.eu/growthandjobs/objectives/>
- [2] Eurostat, Labour market, available online <http://epp.eurostat.ec.europa.eu>
- [3] Eurostat, Science, technology and innovation, Domestic expenditure in R&D, available online <http://epp.eurostat.ec.europa.eu>
- [4] Eurostat, Science, technology and innovation, available on-line <http://epp.eurostat.ec.europa.eu>
- [5] EU Cluster IRED, European Commission “Towards Smart Power Networks – Lessons learned from European FP5 projects”
- [6] Kirubi C. et al “*Community-Based Electric Micro-Grids Can Contribute to Rural Development: Evidence from Kenya*”, World Development 2009, Elsevier
- [7] C. Dunstan, J. Daly, “*Institutional Barriers to Intelligent Grid*”, iGrid project, Working paper v.4.1, 2009