# Transnational Recommendation Report

*Fostering Innovative Labour Market-Oriented Educational and Research Approaches in the Field of Renewable Energy at Latin American and European Institutes of Higher Education.*

JELARE

Joint European-Latin American Universities Renewable Energy Project

ALFA

EUROPEAID CO-OPERATION OFFICE

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# Contents

## Dear Reader,

In the context of climate change associated with the consumption of fossil fuels and environmental problems associated with nuclear energy, renewable energy has recently become a field of great relevance. Whether the production of biogas from waste, large wind parks or the use of solar home systems for providing energy to rural households, the uses of renewable energy are manifold in terms of scale, application and natural energy sources.

Not only in less developed countries, such as those of Latin America, but also in highly industrialized countries, the use of locally available renewable energy resources is a means of improving quality of life and fostering economic development. However, when implementing technologies, policies or political imperatives, it is of central importance to take sufficient account of environmental and social consequences. For example, the cultivation of crops for biofuel production and the ecological and social impact of large dams for hydroelectric power plants give rise to much discussed and controversial issues. Many countries face the challenges of a lack of institutional policies and frameworks, limited access to technology, restricted access to financing, unsuitability of local infrastructures and, last but not least, a lack of training. Due to the innovative nature of this field, universities, as providers of research and education, can play a crucial role in overcoming these problems.

In the context of the Joint European-Latin American Universities Renewable Energy Project (JELARE), implemented from November 2008 to November 2011 under the ALFA III Programme of the European Commission, various initiatives have been undertaken to develop the renewable-energy sector in the participant countries in both Europe (Germany, Latvia) and Latin America (Bolivia, Brazil, Chile, Guatemala). Over the last three years, JELARE has placed special emphasis on the need to address the problems posed by the lack of expertise and training in this important field. The JELARE project's activities have ranged from capacity-building, networking and developing university strategies for the inclusion of renewable energy topics to the practical implementation of transnational pilot modules for renewable-energy education, research and technology transfer. All these activities have been closely monitored and evaluated. The lessons learned during implementation of the project have been compiled in this recommendation report, which is especially addressed to other higher-education institutions that also plan to foster education, research and technology transfer in the renewable energy sector.

Thanks are due to the JELARE project partners, who have developed practical tips for other higher-education institutions on the basis of their JELARE experiences.These are presented in this report together with examples of good practices from the JELARE project. We would also like to thank the ALFA III Programme of the European Commission for supporting the JELARE project.

It is hoped that this publication, which will be widely disseminated in print and online, will provide a long-lasting contribution to the further development of renewable energy activities at higher-education institutions in Latin America and Europe.

Enjoy the report!

Professor Walter Leal
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Julia Gottwald
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# 1. Introduction

Apart from environmental benefits, renewable energies offer great potential for local socio-economic development in Latin America. As renewable energies can be produced locally, they provide a wide range of local job opportunities (from high-skilled to low-skilled labour, from high-tech to agriculture), foster local investments and reduce the need for importing fossil fuels. However, the sector of renewable energies cannot develop adequately due to a lack of expertise. Local enterprises and other public and private institutions involved in the renewable energy sector are in great need of technical and methodological support in order to implement technologies, strategies or political frameworks.

Due to the innovative nature of this field, HEIs are very important actors in this sector, especially in terms of research and educating future employees. Despite the value of the topic of renewable energies, it is not yet prominently featured in the curricula of Latin American universities (or EU universities).

On the basis of the above needs, the JELARE (Joint European-Latin American Universities Renewable Energy Project "Fostering innovative labour market-oriented educational & research approaches in the field of renewable energies at Latin American and European institutes of higher education") project was undertaken in the period November 2008 to November 2011. The project was funded by ALFA III, an EU programme for co-operation between the European Union and Latin America, in the framework of higher education and training.The purpose of the project was not only to improve the academic quality of European and Latin American higher-education institutions, but also to strengthen their role in contributing to local economic development and social cohesion.

The project was a cooperation scheme involving universities from Germany, Latvia, Bolivia, Brazil, Chile and Guatemala with the aim of fostering innovative labour market-oriented educational and research approaches in the field of renewable energy at Latin American and European higher-education institutes (HEIs).

**Four specific objectives were set for the project:**

- to develop and implement labour market-oriented research and educational approaches in the field of renewable energy;
- to increase the capacity of university staff to modernise their educational and research programmes and activities;
- to strengthen the link between universities and the labour market, business and the public sector in the field of renewable energy;
- to establish a long-term partnership and network between European and Latin American universities.

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# Introducing the JELARE partners

Hochschule für Angewandte Wissenschaften Hamburg
*Hamburg University of Applied Sciences*

**1. Hamburg University of Applied Sciences (HAW)** has been extensively involved in technical research and the implementation of state-of-the-art renewable energy technologies and actively involved in many local, national and international networks and partnership projects in the field of renewable energies and higher education (e.g. RENET, JELARE, DIREKT, REGSA). HAW is a leading institution in terms of education and awareness-raising on renewable energy and has established a competence centre for renewable energies and energy efficiency (CC4E) as well as a Technology Transfer Office for Renewable Energy for Developing Countries (TTO-REDC).

**2. Bolivian Catholic University (UCB)** is involved in renewable energy education and research and technology transfer through its work in several international projects (e.g. JELARE, REGSA, CELA) as well as in national projects and networks (e.g. National Network of Research and Innovation in Renewable Energies). UCB is the most renowned private university of Bolivia and it is consolidating its leading role in the energy field through the implementation of a Renewable Energy Technology Demonstration Centre and the introduction of a blended learning master's programme in "Planning and Management of the Energy Mix".

UNIVERSIDAD Galileo Guatemala, C. A

**3. Galileo University** is a higher education institution which was authorized by the Private Higher Education Council (Consejo de Enseñanza Privada Superior) in October 2000, making it the first university in Guatemala with a technological approach. Currently, almost 28,000 students are enrolled at Universidad Galileo, which consists of five faculties, four schools, two programmes and two institutes, including the Institute of Research and Development, which is a University Institute attached to Universidad Galileo with emphasis on renewable energy. The Institute is becoming an international point of reference in strategic research areas and provides a high-quality service to national and international companies.

**4. Rezekne Higher Education Institution (RA)** established an Applied Ecology and Nature Resources research laboratory in 1996. At the same time, RA began to implement an Environmental Engineering study programme. Over 15 years, four national projects relating to renewable energy problems and two international partnership projects have been completed. RA integrates research and higher education in renewable energy on the basis of Latgale Sustainable Research Institute, laboratories, the Environmental Technology Transfer Centre and bachelor's, master's and doctoral study programmes in environmental engineering sciences with a major in renewable energy. RA is the only leading research and educational institution in the field of renewable energy and environmental engineering in Latvia's eastern Latgale region.


**5. University of Chile** was founded in 1842. Historically, it represented one of the clearest movements towards national self-determination, establishing knowledge and public education as the chief focal points in the newly developing country. The engineering departments belong to the School of Physical Science and Mathematics (FCFM – its acronym in Spanish), which emerged together with the University of Chile. The Universidad de Chile is a leading institution and promotes excellence in higher education, research and the expansion of knowledge in different speciality areas in Chile.

**6. University of the South of Santa Catarina (UNISUL)** occupies the position of one of the most dynamic and innovative Brazilian universities. The traditional goals of a university – development, policies and objectives – are rigorously combined with the most up-to-date business approaches, dealing with global strategies, planning and strategic action.

With four campuses situated in the capital and in the south of the State of Santa Catarina, UNISUL is a philanthropic non-profit institution offering more than 40 undergraduate programmes in almost 60 disciplines, as well as 42 Honours programmes and 7 master's degrees. It has 38,000 students, 1,743 professors and 644 employees. UNISUL also offers the widest choice of distance-learning courses in Brazil, providing a model for Latin America in this area. Unisul has over 60 international cooperation agreements with universities from 16 different countries throughout the world.

**To meet these objectives, the activities of the three-year JELARE project included:**

- conducting a renewable energy labour market survey in Germany, Latvia, Bolivia, Brazil, Chile and Guatemala;
- developing teaching and research concepts for renewable energies;
- developing and implementing teaching and research pilot modules for renewable energies;
- conducting a university staff capacity-building programme;
- setting up an international JELARE network, with local subgroups in the partner countries, organizing networking events and an international conference.

One of the final outputs of the JELARE partnership is a recommendation report for improving the quality of education and research activities of higher education institutions and for strengthening their role in regional socio-economic development. These recommendations are based on the experiences gained by the JELARE partners during the three-year project. The report is also addressed to other European and Latin American universities that also plan to increase the attention given to renewable energy in their research and teaching activities.

This report is structured in three thematic sections: education, research and technology transfer. Each section contains a short introduction of the relevance of the subject and gives practical tips on how higher education institutions can foster the inclusion of renewable energy at their own institution. The tips are supplemented by practical experiences that have been made by the JELARE partners during the project implementation. It is hoped that these recommendations will inspire many other universities in Latin America and Europe to place more emphasis on the important topic of renewable energy in their academic activities.

# 2. Recommendations in the Field of Education

## 2.1 Education: overview

For the development of the renewable energy sector, as with any new sector, the local availability of well-educated human resources is of central importance. The labour market survey conducted as part of the JELARE project has clearly indicated that public and private-sector employers, both in Latin America and Europe, have difficulties in recruiting appropriate staff for their renewable energy activities, and this is a barrier to the development of the sector.

According to labour market studies carried out in the context of JELARE, there exists a strong need for additional qualification programmes in the field of renewable energies. The survey also identified the fact that there is not only a need for better inclusion of renewable energy topics in the curricula of bachelor's or master's degree courses but also for short-term training opportunities for existing employees, such as tailor-made in-house training, specialisation courses or postgraduate diplomas. In a young and dynamic sector such as renewable energy, lifelong-learning concepts are crucial to keeping abreast of the latest technological developments. Moreover, in countries where vocational training is less developed, the role of universities also extends to non-academic education, such as the training of technicians.

The experiences of the JELARE project also show that it is important not only to focus on the technological elements of renewable energy. Building up the capacity of decision-makers responsible for establishing appropriate legal and economic frameworks for renewable energy or assessing the environmental impact of renewable energy projects is also essential. Thus, the inclusion of renewable energy topics is also important for students of law, economics and environmental disciplines. The development of interdisciplinary courses is thus a matter of great relevance.

Perhaps one main lesson learned from JELARE is that higher-education institutions have an opportunity to engage in a broad range of teaching options in order to support the development of the renewable energy sector, and that they ought to take advantage of the many benefits to which this may lead.

# 2.2 Education: recommendations

### Tip 1: Introduce "Renewable Energy" (RE) courses gradually into existing study programmes before implementing a fully specialized programme

Bolivia and several other less developed Latin American countries are not yet able to rely on a legal and regulatory framework, large-scale investments and technological know-how sufficient to develop an extensive renewable energy market. Moreover, several Latin American countries are endowed with huge fossil energy reserves which reduce the possibility of developing a national market for renewable energies. It is therefore still important for engineers specialized in energy technologies to have a broader focus which includes non-renewable energies or other fields of specialization in order to avoid difficulties in the labour market. Furthermore, in many Latin American countries there is still a lack of university professors with qualifications in the area of renewable energies which makes it a more viable option to increase capacities gradually.

### Tip 2: Integrate RE topics into the existing curricula of relevant degrees on a short-term basis by offering elective courses on RE (CH)

New trends in education and curriculum design show the importance of providing complementary training in specific areas related to new challenges on human development such as renewable energy. It is therefore important to respond in a short-term manner to the needs of the local labour market. Many degree courses contain a certain percentage of elect ive modules, whereby the students can elect-to study subjects of their own interest. This is the case for "minor" programmes allowing students to receive training in complementary topics, such as: astrology, environment, mining, geophysics, renewable energy, etc. In the specific case, a minor in renewable energy provides knowledge of the basics and practical issues so that engineers are able to participate in projects and conceptual discussions about developments in renewable energy. Conceptual issues are linked to identifying renewable energy sources, estimating their potential and characterizing the associated technologies. Practical work is designed to increase understanding of how to generate electricity from them, identify the more appropriate generation technology and provide a feasible set of solutions to a specific energy supply problem.

### Tip 3: Introduce RE topics not only in engineering subjects but also in other relevant disciplines such as agriculture and economics

Introducing renewable energy classes in a BSc curriculum in the subjects of engineering, environmental science, economics and business administration is very important because

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## Good Practice:

### Introducing "Renewable Energy" minors in engineering degrees at the Universidad de Chile

**Objective(s):**

- To increase the focus on renewable energy topics in current engineering degrees at the Universidad de Chile.
- To offer a more competitive professional profile for the engineers trained by the Universidad de Chile.
- To promote students' interest in trending topics such as renewable energies.

**Activities and results:**
Four courses were introduced in the degree course in engineering as minors. If students select all the elective courses on RE, they can receive the credit points of each course and will be awarded a minor in renewable energy. The minor is made up of the following courses:

- Introduction and application of solar energy,
- Renewable energy from biomass,
- Electric power generation with renewable resources,
- Introduction to the fields of meteorology and oceanography,
- Principles of geothermal energy.

**Partners involved:**
Universidad de Chile, Faculty of Physical and Mathematical Sciences, Chile

**Lessons learnt:**
These minor courses have been implemented since 2009. Students' participation has demonstrated the great interest in RE, especially among electrical engineers. 605 students enrolled in RE courses, with an average of 55 students/semester.

**Potential for replication/extension:**
Courses with adequate coordination are also useful for other minors (i.e. environment). Course content may, in the long run, form the basis for setting up a dedicated RE/environment master's programme

**Country of implementation:** Chile

of the high interest and demand in the past years. Owing to the changing conditions in the environment and the limitation of non-renewable sources, universities and businesses across the planet are investing in future clean energy projects. Along with the economic factors, this is a must for the ability of engineers and environmentalists to develop new technologies.

A serious obstacle to the introduction of renewable energy is not only the lack of respective specialists in the field but also a general lack of understanding on how to solve the problem among other specialists who do not deal directly with energy but are able, within their area of competence, to make decisions either facilitating the development of renewable energy or the opposite – impeding it.

As graduates of any study programme may hold various responsible positions in their further activities within which they will need to evaluate the opportunities and prospects for using renewable energy, they should acquire basic knowledge in that field.

This means that a study course in renewable energy has to be included in technical study programmes relating to environmental engineering and engineering. As a first step, it could be an elective course, but in the longer term a compulsory one.

In other specialities in which graduates' prospects of holding positions related to the use of renewable energy is smaller but still possible (primarily in the study programmes for economics and agricultural technologies), it should be included as an elective course to be transferred into the elective course category.

## Good Practice:

### Development of a "Biomass" course

**Objective(s):**
To enrich the knowledge of students following "Environmental Engineer" and "Master of Environment Protection" study programmes at Rēzeknes Augstskola in an important field of renewable energy in Latvia – the use of biomass as an energy source.

**Activities and results:**
Developing a "Biomass" study course and preparing the necessary lecture materials. The course includes the following chapters: 1. Introduction to biomass energy; 2. Biomass species and resources; 3. Biomass properties; 4. Production of resources; 5. Processing of biomass; 6. Energy production processes. The course is included in the elective courses offered in the "Environmental Engineer" study programme. The various components of the study course were also offered in the following courses at master's level: "Physical and Chemical Processes in Environment", "Ecotechnologies and Industrial Ecology", "Agricultural Ecology".

**Partners involved:**
Rēzeknes Augstkola, Faculty of Engineering, Latvia; Latvia University of Agriculture, Latvia; Riga Technical University, Latvia

**Lessons learnt:**
The course "Biomass as a Renewable Energy Resource" was included in the "Environmental Engineering" study programme. Some sample lectures were given to all 4th-year students and simultaneously to the staff of the Department of Natural and Engineering Sciences.
As a result, more experience has been acquired, and the whole course structure has been optimized and transposed into the Moodle e-learning environment.

**Potential for replication/extension:**
The course may also be used for students studying construction, economics and business studies. An adapted version of the course may also be used for students of the Faculty of Pedagogy at Rēzeknes Augstskola.

**Country of implementation:** Latvia

## Tip 4: Create multidisciplinary courses on renewable energy and related topics at post-graduate level

The idea of establishing a multidisciplinary course at postgraduate level came up as a result of the survey conducted within the JELARE project. It became evident that there was a need to place the subject of renewable energy in a wider context, beyond the identification, creation and distribution of new energy sources. The survey showed that companies required a bigger and better definition of public policies regarding development, especially concerning the energy matrix planning. This instrument allows for the establishment of goals relating to the introduction of these energies within pre-defined periods of time.

Within the JELARE project, the partners from Bolivia, Brazil, Guatemala and Latvia developed a 100 % virtual interdisciplinary postgraduate programme in "Sustainability, Environment and Renewable Energies" which is designed especially for professionals from different areas who would like to gain a specialization in environmental and energy topics.

## Tip 5: Create exchange study programmes with multinational diplomas

The use of renewable energy has a global role. For this reason, broad and extensive interstate cooperation is needed to solve the problem of training of specialists, research and the technical performance of companies with regard to engineering. This would facilitate effective information exchange, which would in turn make it possible to identify the fastest and easiest way of solving common problems, train specialists able to work in the companies of any state and increase awareness of specific conditions in each state in the field of power generation.

## Good Practice:

### E-learning pilot module – international postgraduate degree in "Renewable Energy"

**Objective(s):**
The general objective of the e-learning pilot module entitled "Postgraduate Degree in Sustainability, Environment and Renewable Energy" is to increase the capabilities of partner universities in the area of virtual education and to have a postgraduate multidisciplinary study programme concerning the environment and renewable energies implemented within these universities and other entities and by individuals which might become partners.

**Activities and results:**
- Curricula design of the courses,
- Development of 4 courses: Wind Energy, Hydro Energy, Solar Energy, Research Methodology.

**Partners involved:**
Universidad Católica Boliviana, Bolivia; Fundação Universidade do Sul de Santa Catarina, Brazil; Galileo Universidad, Guatemala; Rēzeknes Augstkola, Latvia

**Lessons learnt:**
The importance of the transfer of knowledge between different universities and countries.

**Potential for replication/extension:**
- Can be replicated with regard to other degrees and topics
- Course content may, in the long run, form the basis for setting up a dedicated RE Master Programme

**Country of implementation:**
Brazil, Bolivia, Guatemala and Latvia


It is crucial to create new study programmes for graduates to acquire multinational diplomas. The implementation specialist of the JELARE project, which involved cooperation between universities in six countries, is a vivid example of how to continue this cooperation, which will produce abundant results in the development of renewable energy in all project member states.

## Tip 6: Establish 100% virtual study programmes in RE to reach a wider audience

In Bolivia and other Latin American countries, which do not yet have a developed renewable energy market, the introduction of specialized bachelor's or master's degrees in renewable energies is often hindered by the fact that there is not sufficient demand for such professionals. In this context, it can be a good option to implement e-learning programmes which allow more potential students to be targeted, including students from other countries and full-time working professionals with no option of participating in programmes requiring compulsory presence. Implementation of these e-learning courses may follow the example of an interdisciplinary postgraduate programme

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in "Sustainability, Environment and Renewable Energies", which is designed especially for professionals from different areas who are not able to attend classes in a strict way and for whom 100% virtual modules offer the only possibility of gaining a specialization in environmental and energy topics.

## Tip 7: Create a blended learning study programme in "Renewable Energy"

The creation of a blended learning study programme in "Renewable Energy" has been considered useful as it allows professionals with little time to partcipate in classes by means of the e-learning component of the programme and, at the same time, offers the necessary practical lessons in the field of renewable energies in the sessions requiring attendance.

## Tip 8: Integrate practical projects and their outcomes into university education

Integrating practical projects, such as the development of a demonstration stand for the solar home system at the HAW Hamburg, into undergraduate or postgraduate courses gives students a good opportunity to apply the theory they have learned during classes in practice and to gain their first practical research experience. It is a project which enables not only students to improve and deepen their technological knowledge, but also to strengthen their soft skills such as teamwork or learning how to take responsibility and meet deadlines. The practical outcomes of such projects can also be used by academic staff as an illustration tool for teaching and lab exercises.

## Tip 9: Create itinerant conferences in the field of renewable energy at regional level

One of the best ways to disseminate knowledge and encourage development of renewable energy in developing countries is through seminars and workshops, sharing successful experiences, new technological developments and expertise. Thus, learning from the role of technological antenna developed for an institution or group of institutions, it is possible to organize a series of itinerant conferences in several countries in Latin America. This activity gives countries access to new developments, expertise and the experiences acquired in the country hosting the conference. It is even possible to organize fairs and technology demonstrations developed by the host country or university visitors. The organization of these conferences should be led by a university that is able to gather experts in renewable energies at regional level and in developed countries looking for successful experiences in the countries of the region. This group should coordinate with several universities and technological centres in the host country in order to achieve greater impact in countries where they are developed.

## Tip 10: Reach a consensus about a strategy for the introduction of renewable energies in education and research programmes at the university

Successful initiatives in the field of education and research on renewable energy can only be implemented in the university if a long-term strategy is devised and if this strategy is built on a consensus between university authorities, lecturers and researchers from different departments and institutes.

## Tip 11: Collaborate with other universities to develop curricula

The use of expertise and technological knowledge from partner universities will foster the design of curricula. The purpose is to learn from each other and to use existing know-how to improve existing or new curricula. Not only can partners from Europe with a greater experience in renewable energy education support and consult partners in developing countries, but HEIs in Latin American can also cooperate with and help each other. For example, in the JELARE project the very experienced partners in terms of e-learning in Guatemala and Brazil provided valuable support to less experienced partners in Latvia and Bolivia.

## Tip 12: Define curriculum design according to required ability and knowledge competences for programmes relating to degree certificates issued at universities.

When designing curricula, account should be taken of the competences needed in university programmes in order to modernize them. Curriculum design must be based on competences in order to validate degree certificates, which

is possible thanks to the results obtained in the Tunning Project for Latin America, financed by the European Union. This also allows courses to be assessed according to innovations and for it to be determined whether the knowledge taught corresponds to the competence identified, considering the level of knowledge achieved and the specific labour markets. At the same time, it is an innovative action enabling an academic degree to be obtained that allows our professionals to work in other countries in Latin America.

## Tip 13: Cooperate with other research and education institutions in order to promote intensive capacity-building

In the framework of JELARE capacity-building activities, experience shows that intense and repeated seminars in specific topics have the longest-lasting impact in the university as they allow the participating staff to gain a deeper understanding of the topic or tool being dealt with. This provides the basis for applying the knowledge afterwards in a competent and sustainable manner. In this context, it can be useful to establish cooperation agreements

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## Good Practice:

### Development of pilot modules – the Solar Home System

**Objective(s):**
To develop a lab-scale renewable generation unit (PV solar home system) for application in rural electrification in respect of local needs. To educate students, engineers and technicians with the help of a demonstration stand and learning materials in order to raise awareness of systems and life cycles.

**Activities and results:**
- Design and modelling of the Solar Home System,
- Development of the Solar Home System as a simulation tool for households with no access to the public power grid.

**Partners involved:** Hamburg University of Applied Sciences, Germany

**Lessons learnt:**
Students learn more quickly by doing practical work. Students are very interested in converting ideas into real models. Students not only gained knowledge about technology but also developed soft skills such as teamwork, taking responsibility and meeting deadlines.

**Potential for replication/extension:**
- Can be replicated with regard to other topics such as wind power,
- Course content may, in the long run, form the basis for setting up such projects for students.

**Country of implementation:** Germany

with other organizations which are specialized in certain areas and topics of interest to the university.

## Tip 14: Develop and invest in new pedagogical resources and materials and the study environment (classrooms, libraries and labs)

Investments in more than adequate infrastructures are needed in order to help and embrace the development of and studies concerning renewable energies. Private and government funding are needed for the expansion and infrastructure of laboratories and research centres.

Investment in research infrastructure should be provided alongside investment in pedagogical infrastructure for universities and technological institutions. For students to develop and expand their knowledge of renewable energies, they will require the latest information and book materials to study from.

A continuous training of teachers and researchers also has to be funded in order to ensure that students receive up-to-date knowledge and data.

## Tip 15: Disseminate the results of research and project activities to own university staff and students

Given the permanent development of the field of energy resources, it is necessary to adapt both research and education to market needs. For this, the results of own research and project activities can be very useful. It is therefore important that academic staff working on relevant research or educational projects also disseminate outputs to students and other staff in their university and inform them of seminars, workshops, textbooks or other teaching material.

## Tip 16: Implement permanent capacity-building courses for professors and researchers in renewable energies and the environment

Investment in research infrastructure should be provided alongside investment in pedagogical infrastructure for universities and technological institutions. For students to develop and expand their knowledge of renewable energies, not only are the latest information and book materials required, but also a very well-trained academic cadre. The curriculum for courses of study must be constantly updated based on the curricula of the top universities in the subject, and constant further education on the part of teachers is expected. Moreover, regular capacity-building seminars for academic staff on technical as well as educational topics are of major importance.

## Tip 17: Establish cooperation agreements with NGOs and market actors in order to implement innovative educational approaches

The experience of the JELARE project has shown that it is a very fruitful approach to involve different stakeholders from the market and the public sector in the design and implementation of new educational concepts in the field of renewable energies. Firstly, these actors can contribute their knowledge and practical experience to establish educational and research programmes which really suit the needs of the students and the market. Secondly, such contacts are very important for the constant updating of knowledge and proximity between academia and industry.

## Tip 18: Rethink academic practices and search for greater synergies between HEIs and the RE market

Universities need to develop new courses and capabilities in RE. The profile required by companies and market organizations forces HEIs to rethink their practices and search for greater synergies. When developing the curriculum for renewable energy, the university must think about what greater good these courses will serve. Most of the time, they are designed for industry. The university must therefore take this into account when designing its curriculum. To achieve this goal, all activities (e.g. seminars, fairs, etc.) should be used that allow exchange between the two sectors.

## Tip 19: Work out a set of study aids and handbooks to train engineers and technicians in the field of renewable energy

Despite a broad range of literature on renewable energy, there is a lack of special literature on each kind of renewable energy resource providing comments and deeper theoretical and practical engineering knowledge about the exploitation of renewable energy resources, while in some countries, such as the Republic of Latvia in Latvian, such literature is practically unavailable in the local language. In order to ensure a qualitative study process, study aids are needed which enhance theoretical knowledge about renewable energy and understanding of technological processes and develop practical skills for direct engineering activities in this field, competence and the ability to justify and make decisions. Study aids, handbooks, collections of tasks and laboratory work on renewable energy must therefore be developed.

## Tip 20: Prepare practical study courses based on life-long learning for the in-service training of engineering and technical personnel of companies to solve technical tasks relating to renewable energy

Training specialists starting from the 1st year is a long-term process – in Latvia it takes 4–5 years. It should be taken into consideration that a university graduate will be able to demonstrate really practical returns and complete professionalism in just 2–3 years of employment in a company when he acquires practical skills.

This means that, alongside the training of specialists according to a study programme, in-service training of engineering and technical personnel in companies is needed to solve technical tasks relating to renewable energy

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## Good Practice:

### Renewable energy profile module in the "Environmental Engineer" professional bachelor's study programme

**Objective(s):**
The module was designed in order to train specialists in the field of renewable resource extraction and processing and energy production.

**Activities and results:**
An "Environmental Energy" study module has been developed in the framework of the "Environmental Engineering" study programme. It contains four compulsory study courses and a study paper in the 7th semester. Moreover, students choose 2 out of five selective study courses. In semester 8, students have a period of pre-diploma in-company practice relating to renewable energy, and must also prepare and present a diploma project. Graduates receive a qualification as an engineer with a specialization in "Renewable Energy". The study module is included in the study programme submitted to the Ministry of Education and Science for accreditation.

**Partners involved:**
Rēzeknes Augstkola, Faculty of Engineering, Latvia; Riga Technical University, Latvia; Latvia University of Agriculture, Latvia; biomass fuel production companies in Latvia

**Lessons learnt:**
All staff of the Faculty of Engineering at Rēzeknes Augstskola were involved in the development of the study module. It was important to devise an optimal structure for this module, because it substitutes the 7th semester courses of existing study programmes, requiring restructuring of the entire study programme.

**Potential for replication/extension:**
The content of the module may be used in study programmes at other Latvian universities. The module structure might also be useful to universities outside Latvia.

**Country of implementation:** Latvia

use or to re-qualify them so that the development of renewable energy can be speeded up.

A survey of company managers carried out in Latvia in the context of the JELARE project showed that a majority of them want and would support the in-service training of their engineering and technical personnel on short-term and regular courses, as well as on distance-learning courses.

In this case, a significant role should be attributed to the application of information technologies and e-training. This means that it is necessary to prepare the respective study aids and materials and adapt them to the e-learning environment. Under the JELARE project, a "Biomass" study course was developed in Latvia as a component of the overall JELARE study programme.

### Tip 21: Keep up-to-date with technology changes to access the best solutions available at worldwide level

Technological development in renewable energy has been very fast in the last twenty years and it is expected to continue at the same pace in the future. Therefore, it is essential to keep abreast of new technologies, mainly solar and geothermal energy, which are expected to have greater potential in the future. This will enable HEIs to develop high-level research and support their academic staff and students' development at a level that allows them to interact with the international community and the renewable energy industry. It would then be possible to achieve a virtuous circle, a dynamic renewable energy market and world leadership, providing high-quality professionals who are able to use technology and generate market demand. This will prompt technology centres and universities to remain up-to-date and seek interaction with foreign universities, technology centres and companies to find the best technologies on the market.

### Tip 22: Improve technical/ professional knowledge at the same development rate observed for both research and applied projects implemented in the country

In the case of developing countries, growth rates are high compared to those of developed countries, and this may be interpreted as a significant issue that requires a continuous updating and upgrading of infrastructure projects. Thus, this challenge requires that developments achieved in the universities have to focus on the country's needs and also to offer a growth rate that is equal to that of the country. In the case of technical/professional knowledge, universities should be monitoring the way local industry develops in order to meet labour market needs, avoiding the possible emergence of technological barriers that render the development of specific projects difficult. For instance, renewable energy projects require specific personnel with the ability to champion a project demonstrating these characteristics, making it necessary for universities to train their own staff and transfer knowledge to students in a way that will enable them respond as local industry requires.

## Tip 23: Create international internships for students at universities or companies

To deepen the exchange of technology and knowledge as well as the relationship between partner universities and their students, the implementation of an internship exchange programme is recommended. Students will be sent on an exchange to international partner universities. The skills and competences they acquire in terms of culture, society and life will increase the students' self-awareness and life experience, which will be important for their future career. Moreover, professors and lecturers from the home and host university will also gain experience about the situation in the other country when supervising the exchange student.

## Tip 24: Foster student internships and thesis research in organizations from the RE market and public sector

As specialized engineering or multidisciplinary study programmes in the area of renewable energies barely exist in Bolivia, virtually the only possibility of specialization is via internships or thesis research within renewable energy firms and other organizations. In the framework of the JELARE project, contact between companies and students has been fostered, and it has been seen that also industry and NGOs have a great interest in joint research projects with students as a means of strengthening their research and development activities.

## Tip 25: Create an international student exchange programme aimed at improving skills and abilities in the area of renewable energies.

The establishment of an international exchange programme of academics aimed at improving students' skills and abilities in the area of renewable energy is vital to fostering collaboration and innovation. Students will be able to gain the skill and ability to understand diverse community perspectives and cultures, which will further the advancement of their educational experience. An exchange programme is an important means in institutions of fostering global interaction and collaboration in support of furthering the renewable energy and sustainable environments field.

## Tip 26: Develop a programme of renewable energy scholarships

Students may not have the financial ability to remain in school and learn about renewable energy. In this scenario they would not be able to add their intellectual abilities to the growing work within the industry and HEIs. In order to avoid this dilemma a programme of renewable energy scholarships should be developed in order to give everyone the opportunity to use their talents.

## Good Practice:

### Internships for students in partner countries

**Objective(s):**
The main goal of internship programmes is to give an opportunity to increase the international exchange of know-how between universities and its students and to improve partnerships between the partner universities.

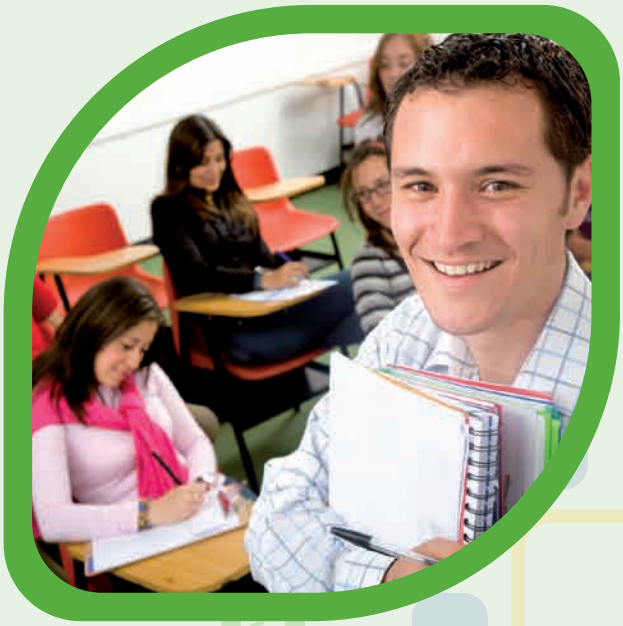
**Activities and results:**
One HAW Hamburg student did a 6-month internship at a small solar enterprise in Bolivia. During the internship the student did the field research for his BSc thesis, whereby he evaluated 60 solar home systems in rural communities. The German and Bolivian JELARE teams helped the student to find this placement.

**Partners involved:**
Falk Solar, Bolivia; Hamburg University of Applied Sciences, Germany; Universidad Católica Boliviana, Bolivia

**Lessons learnt:**
- Such an exchange of students is not only important for the transfer of technology but also deepens the relationship between countries, thereby strengthening trust and reliability for a long and sustainable partnership.
- Students not only improve their knowledge in terms of technology, but also learn about cultural aspects.
- Technical experiences also serve as feedback to the supervising professor at the German university.

**Potential for replication/extension:**
It can be extended for replication in other countries and with regard to other topics

**Country of implementation:**
Germany and Bolivia



In the case of renewable energy scholarships, we would create an effective incentive for young, innovative minds to participate in the effort to create new renewable energy technology.

### Tip 27: Establish an "observatory" for renewable energies and sustainability in universities

The creation of an "observatory" for renewable energies and sustainability in universities is essential for instilling a sense of responsibility among students in developing and engaging with the subject. This will serve as a model to them, providing inspiration and guidance on use of "best practices" at the time of work and research. This is a very important step that needs to be taken in universities and institutions.

## Good Practice:

### Clean energy seminar: diffusion of knowledge in the area of renewable energy

**Objective(s):**

- Knowledge dissemination in the area of renewable energy,
- Development of the important sector of energy generation on the basis of renewable energy.

**Activities and results:**
With the participation of renowned industry professionals operating in different countries in Latin America, the event provided a university environment for the three pillars that move the industry: Knowledge, Sustainability and Integration.

More than 1300 people attended the nine lectures, discussing issues such as the prospects for the sector in Latin America, new sources of energy (mainly alternative sources such as wind and photovoltaic solar energy).

**Partners involved:**
Ideal Institute (Institute for the Development of Alternative Energy in Latin America); Universidade Federal de Santa Catarina (UFSC), Brazil; Fundação Universidade do Sul de Santa Catarina (UNISUL), Brazil (represented by the projects JELARE and REGSA); German Cooperation Development (GIZ in Brazil and KfW); Eletrobras Eletrosul and Centrotherm, Brazil

**Lessons learnt:**
The importance of a multi-stakeholder approach in the field of renewable energy

**Potential for replication/extension:**
This event is now organized once a year in Brazil.

**Country of implementation:** Brazil

### Tip 28: Create an "Excellence University" award for the best essay/work of undergraduate subjects relating to renewable energy and sustainability

The creation of the "Excellence University" award for the best essay and work of undergraduate subjects relating to renewable energy and sustainability is an important means of establishing students' interest in research. This will serve as inspiration for cutting-edge research and will foster innovation. The award should recognize excellence in the field of renewable energy and sustainability. This is an important acknowledgement of merit and should be seen as recognizing excellent accomplishments in universities and institutions.

# 3. Recommendations in the Field of Research

## 3.1 Research: overview

In the renewable energy sector there is still a strong need for research, not only in the technological field but also in the economic, legal and social context.

For every country, it is important for innovative sectors to build up their own research capacity, although the focus might differ depending on the development status of the countries and their access to economic resources to fund such activities. For countries whose economy is strongly based on the export of high technologies, the development of cutting-edge technologies and basic innovations is a matter of great importance.

However, developing a domestic research and development (R&D) capacity is also essential for less developed countries, which usually import technologies from other countries, often at a rather high cost. For these countries, it is most important to identify scientific and technological options, to adapt existing technologies to local needs and to create technologies that are unique to them. Along with education, R&D is crucial to increasing technological capabilities within a country and reducing existing technology gaps, which is also an important prerequisite for international technology transfer to take place, either through trade or foreign direct investment, with a subsequent sustainable impact in the recipient country.

The role that universities, public research institutions and private companies play in the national research landscape differs widely from country to country. The role of universities should not be limited to conducting basic research, but also extend to engaging in applied research that offers solutions for current market and social needs. The support of available know-how and collaboration with the private sector – by means, for example, of joint research projects – are promising forms of co-operation, but their potential is not being fully realized in Latin America.

Changing this state of affairs needs to be a priority in order to place research into renewable energy more prominently in university programmes and to allow them to yield the benefits that such an approach gives rise to.

# 3.2 Research: recommendations

### Tip 1: Identify opportunities associated with renewable energy that offer the capability of technological development at local level

The arrival of renewable energies offers a great opportunity for developing countries. This relates not only to benefits associated with the environment, climate change and energy-mix diversification, but also to technological developments. For instance, in the case of Chile, the integration of renewable energy into power systems is strongly dependent on technology costs, i.e. the competitiveness of the technology as compared to conventional sources; in other words, cheap technologies have a better chance of being integrated into the system. Other mechanisms, such as feed-in tariffs, are not adequate because they are related to subsidies created for technology manufacturers located overseas. Thus, it is important to identify those renewable energy technologies that offer the capability of technological development at local level, such as micro-hydro in the case of Chile. This identification may facilitate the creation of subsidy mechanisms focused on specific technologies that allow technological development and the subsequent creation of potential industries that contribute to the economic growth of the country.

### Tip 2: Concentrate on applied research in the field of renewable energies, especially on processes, reduction of costs, development of new materials and new products

The renewable energy industry in many countries of Latin America (e.g. Bolivia) is very small and made up of formal as well as informal market actors. The market for these technologies is not very big as a result of the lack of regulation, the small paying capacity of users and subsidies for fossil fuels which make renewable energies less competitive. In this context, it has been stated by most market actors that it is highly important to count on the cooperation of universities in applied research, as they have experts who are leaders in their field of study. This cooperation should focus on improvement of technologies, adapting them to the local climatic conditions and, especially, reducing their costs in order to make them accessible to a broader group of consumers, i.e. the poor rural population.

### Tip 3: Improve availability and access to information required for research in RE: energy indicators, resource maps, available technologies, etc.

Research activities focused on renewable energies require a lot of data in order to validate the proposed hypothesis and provide reliable results. Data required for research in renewable energies covers a wide spectrum ranging from energy and economic indicators to resource maps and technology characteristics. Nevertheless, access to this kind of information is not easy, especially in Latin American countries, where institutions focused on promotion of renewable energies have been created only recently and where there is no adequate database ensuring success in data gathering. It is also important to note that this issue not only affects research but also project development because one of the key factors associated with decision-making processes is data availability. Finally, the availability of data is not itself a guarantee; data quality procedures must also be implemented in order to provide good and reliable results for both research and project development.

## Tip 4: Use pilot projects as an opportunity to identify innovation capabilities

Pilot projects are of great value for research, technology transfer and education. Their development, for lab-scale applications, makes them a great educational tool for further students, allowing comparisons between theoretical statements with real experiences; technology transfer is also improved in two ways: as an integration of new knowledge and capabilities coming from overseas and also as a way to disseminate one's own knowledge to other partners/colleagues. In the case of research the main objective is innovation. Innovation is a key issue in development and knowledge dissemination; when new products/knowledge are acquired, they are highly valued by stakeholders. In the case of renewable energies, the possibility to innovate is even higher because these are emerging technologies which have not reached complete maturity (with some exemptions). Thus, according to each country's needs, some renewable energy technology by itself will offer a good opportunity to innovate.

## Tip 5: Improve infrastructure research to facilitate the development of applied solutions on a pilot scale for subsequent on-site application

One of the key issues relating to research is the existence of an adequate infrastructure, which makes it possible to produce developments that respond not only to local needs, but which are also at the same level as the latest developments worldwide. Only good research infrastructure allows researchers to publish, participate in international conferences and develop in specific research areas. In the case of pilot-scale solutions, which are based on lab-based developments, infrastructure plays a significant role. If there is not

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## Good Practice:

### Technology transfer pilot module – Micro-Hydro Plug & Play

**Objective(s):**
The main goal of the module was to develop one renewable generation unit at lab scale for application in rural electrification. Another objective of the project was to create exchange opportunities among partners in order to disseminate knowledge and experiences related to the application and development of renewable generation units in the area of rural electrification. Finally, it was also hoped to provide feedback to other partners in the field of renewable energy applications.

**Activities and results:**
The development of a Micro-Hydro Plug and Play unit is focused on the following aspects:

- Automation: a completely automatic unit enables it to be acquired from users without a technical background.
- Grid connection: though it is capable operating as an isolated generator, this micro-hydro unit can operate as a distributed generator when a distribution network is available.
- "Plug & Play" concept: with this concept, micro-hydro is the product of an easy and standardized installation, making it competitive with a standard combustion engine of about the same size.

**Partners involved:** Universidad de Chile

**Lessons learnt:**
Development of new/innovative products requires a lot of learning. More detailed planning is required to ensure that the final objective is focused on on-site applications.

**Potential for replication/extension:**
The micro-hydro unit is completely replicable and extendible to other hydro applications that may require different kind of turbines / different water resources.

**Country of implementation:** Chile

adequate infrastructure, pilot developments would not be of the quality required to guarantee the expected results. Difficulties in developing certified and good quality products of pilot projects, at lab scale, make it impossible to devise and develop a solution for on-site application. With regard to renewable energy projects, lab-scale developments play a significant role because they allow potential weaknesses and advantages to be identified as well as adjusting the dimensions of the project application for on-site requirements.

## Tip 6: Evaluate renewable energy resources and develop potential registers of use on a national scale

In some countries where the renewable energy sector has only recently been developing, e.g. the Republic of Latvia, the quantity of all renewable energy resources (water, wind, solar, biomass energy) and the potential and intensity of each source of energy in respective regions have not in many countries been fully evaluated. To promote the development of a sustainable programme for the use of renewable energy resources and territorial planning of rational means of energy production, it is necessary to be aware of the qualitative parameters of the energy resource, their possible changes over time and under various conditions and the stability of resource intensity in time and space.

**Complex research is therefore needed involving:**

- Assessment of how to evaluate renewable energy resources and their intensity within the certain territory;
- Research into the total quantity of renewable energy resources and the potential, economical and ecological capacity available for their use.
- Establishment of a complete register of national renewable energy resources based on the research referred to above.

## Good Practice:

### Capacity-building seminars on EU research funds

**Objective(s):**
The general objective of this seminar was to inform staff of the Hamburg University of Applied Sciences about the specific funding opportunities of EuropeAid and the 7th Framework Programme and to increase their capacity to apply for research and project funds from the EU.

**Activities and results:**
Two seminars were organized where the participants gained an overview of the funding programmes and tips for setting up project applications. The participants received answers to the following questions:

- Where do I find the call?
- What are the overall objectives of the funding sources?
- What is the target group of the funding source?
- What are the factors for success in applying for this funding?
- How is the application form structured?
- What is the logic behind the creation of the budget?
- Which supporting documents are required?
- Where can I find additional information to the application process?

**Partners involved:**
Hamburg University of Applied Sciences, Germany; EU Office of the German Ministry of Education and Research

**Lessons learnt:**
The seminars were an appropriate tool for introducing funding opportunities; however, the allocated time of 2 hours for each programme was too short to go into detail.

**Potential for replication/extension:**
This capacity seminar can be extended to other research funds and also to workshops at which HEI staff can receive practical exercises or even coaching from researchers working on a specific proposal.

**Country of implementation:** Germany

## Tip 7: Create a rational complementarity of various renewable energy sources in order to increase the effectiveness of resource energy generation

In order to increase the effectiveness of using renewable energy and eliminate the instability of a separate source of energy in time and territory, it is necessary to use various kinds of energy-generating resources – wind power, solar energy, biomass, hydropower – simultaneously in such a way that one source supplements the other or, in certain periods, is substituted by another.

Research into rational complementing of energy sources is needed which takes account of ecological and economic restrictions and an increase in energy efficiency.

Research is currently being implemented involving samples of complex use for autonomous power supply to individual, and especially rural, buildings.

In such cases the main problem is the large capital expenditure required to install combinations of equipment (for example, a wind generator and solar collector). It is becoming too expensive for each individual consumer. A broader complex is needed which can include the energy supply to the respective area, city/town or region, but this requires a range of different research.

## Tip 8: Arrange and attend capacity-building seminars for HEI's staff in "applying for research funds" to increase funding for projects in the field of renewable energy

Capacity-building seminars for HEI's staff are of critical importance, especially with regard to applying for research funds for new

projects in renewable energy. A knowledge of different funding institutions and skills in drafting applications are necessary in order to be successful in receiving grants. Therefore, capacity-building seminars on topics related to research funds are recommended for every HEI interested in fostering research in renewable energy.

## Tip 9: Use ongoing projects to prepare new project proposals - regular project meetings can already be used to discuss new project ideas

A project stands not only for itself but should also stand for sustainability. To realize sustainability, it is important to make use of ongoing projects in order to prepare new project proposals. Project meetings can be used to discuss new project ideas for future research. This would enable the relationship between partners and technology transfer to be sustainable.

## Good Practice:

### Developing new project proposals

**Objective(s):**
The main goal of the activity was to cover the need for additional funding or follow-up funding for ongoing projects. Collaboration with existing partners should be deepened or expanded to include other topics with a greater number of partners. This should ensure the sustainability of current projects and exploit synergies between several projects.

**Activities and results:**
During the JELARE project, HAW Hamburg applied for several project funds with some partners from the JELARE project. So far, two projects, REGSA and CELA, have been approved. The REGSA (Renewable Electricity Generation in South America) is an example of how the subject matter and collaboration with partners from a previous project is reinforced. The CELA (Network of Climate Change Technology Transfer Centres in Europe and Latin America) is an example of how collaboration can be expanded to a new but related topic and the network extended to other countries by involving new partners.

**Partners involved:**
Hamburg University of Applied Sciences, Germany; Universidad Católica Boliviana (UCB), Bolivia; Fundação Universidade do Sul de Santa Catarina (UNISUL), Brazil; Universidad de Chile, Chile; Tallinna Tehnikaülikool (TUT), Estonia; Universidad de Ciencias Comerciales (UCC), Nicaragua; Pontificia Universidad Católica del Perú (PUCP), Peru

**Lessons learnt:**
The process of preparing applications is very efficient and effective if the consortium comprises at least some partners that have already worked jointly on related topics. This also applies to the starting phase of new projects since the consortium can build on the working relationship developed in the previous projects

**Country of implementation:**
Germany and Latin America

## Tip 10: Facilitate the access of universities and technology centres to funds for RE research that may also involve the private sector

Access to research funds is a major problem in developing countries, particularly at a regional level. The low level of funds allocated by governments to developing R&D in these countries increases the difficulties of research groups from universities and research centres working in the area of renewable energy, which requires access to laboratories, prototype development and an expertise that is not always easy to find in the country. The ability to access new sources of funding from developed countries relating to climate change and sustainable development is an important opportunity that research groups can use. Similarly, European Union funds for cooperation with Latin American countries are an interesting option to continue using in the future. To take advantage of these opportunities, it is important to deliver timely information on these matters and to train decision-makers and researchers in universities so that they are able to allocate the available resources more efficiently.

## Tip 11: Build up a dedicated long-term research fund for renewable energies

In order to understand the complex factors that combine to determine the reality regarding sustainability and renewable energy, time and investment are required. Thus, any short-term research project with a low budget will not have enough resources to complete the task in hand.

The JELARE survey in Bolivia has shown that research activities in renewable energies in most of Bolivia's universities are not constant over time and do not follow a structured long-term planning. In most cases, and not only in Bolivia, the problem is that research funds are

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not stable. A long-term research fund for renewable energies is therefore vital to fostering sustainable research in the field.

## Tip 12. Establish prior state financial and technical support for innovative research and technologies in the field of renewable energy

State regulations and corresponding financial support are needed not only for power producers but also for scientifically practical and innovative research. Without research, the development and modernization of technologies cannot be achieved. Thus, scientific support for energy producers will be ineffective if the company operates on the basis of outdated technologies. Renewable energy must become competitive with fossil energy.

State subsidies, not only for energy producers but also for research and experiments in this field, will provide an impulse for the development of power production and will thus make it easier for renewable energy to succeed in the competition with fossil energy. As a result, there will be no need for subsidies to renewable energy producers.

## Good Practice:

### Development of a strategic plan for the Energy Center

**Objective(s):**
The aim of developing a strategic plan is to review key definitions making up the organizational strategy: identification of principal stakeholders, their motivation and objectives, university, school and department-level visions, the Center's own vision and mission, scope of activities, "products" and services to be offered, corporate strategic objectives, sources of funding, etc.

**Activities and results:**
Exploration of the most important lines of action for the Center to follow on a short, medium (3-year) and long-term (5-year) basis. These would be incorporated into an action plan with between 8 and 10 main areas of focus. With this structure in place, prior actions would be classified and future actions identified. The end result is a summary record to include the key organizational strategic definitions, together with a map of prioritized areas and lines of action to be implemented in the medium and long term.

**Partners involved:**
Energy Center of Universidad de Chile

**Lessons learnt:**
The strategic plan was a helpful exercise in clustering the Center's thematic areas into three groups (intelligent network systems and distributed generation units, development of electric vehicles and storage systems, development of studies and tools to support decision-making) and provides guidance for future research work.

**Potential for replication/extension:**
Technological centres related to renewable energies are an important contribution to applied research in the countries and the region.

**Country of implementation:** Chile

## Tip 13: Intensify core research areas by fostering research qualifications with scholarships

Research activities are still very poor in many Latin American universities. The reasons are, inter alia, a lack of research qualifications, funding and incentives. One important barrier for research, for example in Bolivia, is the fact that the majority of university staff do not have a doctorate or even a master's degree. By allowing staff members to obtain a higher degree and dedicate time to research in the framework of a scholarship, the university can invest in future research activities. It is therefore recommended that research clusters be developed for specific topics, such as in the area of renewable energies, in order to allow a research team to be built up that is able to conduct larger and more sustainable research projects.

## Tip 14: Create interdisciplinary research teams

The field of renewable energies has many facets and the different aspects, such as technical, economic, social and ecological, are often interrelated and have to be investigated as such. Therefore, it is highly recommended that multidisciplinary research teams be created with experts from different fields: engineering, economics, sociology, architecture, business administration, political sciences, ecology, urban development etc. The need for a project encompassing all these subjects results from the importance of not only developing technologies but also supplying, financing, managing, and establishing levels of productions for industries.

## Good Practice:

### Capacity-building on Smart Grids and Distributed Generation

**Objective(s):**
The aim of this kind of measure/activity is to provide Chilean researchers and electrical engineering professionals with exposure to cutting-edge research in the field. Additionally, the workshop provided significant feedback for the Chilean researchers, while allowing them to form collaborative networks. No less importantly, this exchange of ideas put Chilean professionals into contact with national and foreign academics, significantly strengthening external links.

**Activities and results:**
The main topic of discussion in the workshop was the development of new electricity generating technologies and the paradigm shift being created by the migration of power systems from large plants to small Distributed Generators (DG).

**Partners involved:**
Energy Center Universidad de Chile; Millennium Institute for Complex Engineering Systems, University of Wisconsin-Madison, USA; University of Denver, USA; Utilicount GmbH & Co. KG ,Germany; Renewable Energies Center

**Lessons learnt:**
The development of training activities involving the institutions of government, private companies and universities enable experiences to be shared and common positions to be found regarding the countrys' technological development in renewable energy.

**Potential for replication/extension:**
Such experiences can be replicated at the national and regional level incorporating similar institutions and even representatives of the community.

**Country of implementation:** Chile

## Tip 15: Initiate cross-border projects in the field of rational integral use of renewable energy resources

Depending on geographical and climatic conditions and the industrial branch being developed, each country has its typical complex of renewable energy resources.

The use of these kinds of energy only within the country is economically and technically disadvantageous sometimes. At the same time, there might be energy resources in a bordering country which can be used more efficiently by combining them with those of neighbouring countries. At the same time, this situation can be solved at the border area. Therefore, there is an objective necessity to research the opportunities for integral use of energy resources in the border areas of countries. For example, the Daugava, the main river of Latvia, flows through the territories of Russia and Belarus. If, in the future, it is planned to build a hydropower station, the choice of site should be made regardless of state borders, i.e. where it has the least impact on the environment and the smallest losses for all countries and where it is most economically beneficial.

## Good Practice:

### Appointment of the Vice President of the Galileo University as supervisor of the JELARE project


**Objective(s):**
One of the key issues of research projects is to provide them with constant support from university authorities. The aim of involving the Vice President of the Galileo University was to strengthen the JELARE project at the highest decision-making level in order to improve the performance and influence of the project.

**Activities and results:**
Discuss and reach agreements with the highest authorities to obtain their support for carrying out project activities such as the research done, the strategic plan, e-learning modalities, training events and visibility suggestions. As a result, an appeal has been made to all faculties and programmes at the Galileo University to engage in research and project formulation.

**Partners involved:**
Guatemala (General Vice President's Office at the Galileo University, precisely where the JELARE project is located) but involves all structures at the university.

**Lessons learnt:**
There is better support to implement projects when an authority at a higher level in the decision-making structure is directing and initiating them.

**Potential for replication/extension:**
It can easily be replicated with high-level authorities in other universities elsewhere.

**Country of implementation:** Guatemala

## Tip 16: Improve the relationship between universities and industry in gathering the needs of private and academic work, and facilitate applied work for students and researchers

A close relationship between HEIs and industry users and producers of renewable energy is essential for the development of profitable research at universities in the countries of the region. Thus, it is possible to overcome a number of barriers that reduce the development of these technologies in the region. Firstly, we can learn more about the needs of the industry so that we can directly solve its problems and requirements. This was one of the criticisms from industry to universities in a recently conducted survey. Secondly, the work of academics and students allows for fruitful interaction in the development of research to be applied and aimed at solving real problems in the industry. Finally, this interaction allows for a permanent flow of students to industry and professionals from the industry returning to universities to disseminate new products that have supported the development of the market.

## Tip 17: Define a strategy to place research projects at the highest level of the institutional hierarchy

Experience has shown that it is beneficial to involve the high levels of university hierarchy in project implementation for the short and long-term impact of projects. This paves the way for ensuring some influence on university dynamics and facilitating work in the areas of research design, training and product implementation; the main reason is, however, that decisions usually have to be made promptly. The higher the project is placed in the hierarchy of decision-making, the more it is possible to influence the decisions of the entity in which the project is situated and to connect with external actors working with the subject of the project.

# 4. Recommendations in the Field of Technology Transfer

## 4.1 Technology Transfer: overview

Technology transfer is taking place at different levels and between different institutions. In the context of cooperation between European and Latin American universities, the two main forms of technology transfer, commonly described as university technology transfer (UTT) and international technology transfer (ITT), are the most relevant.

University technology transfer refers to the transfer of knowledge and technologies developed at universities to industry or public institutions for practical applications. University technology transfer is often described as the third mission of universities (education and research being the first and second missions). The concept of university technology transfer has emerged in recent decades, particularly in the USA and Europe and in other highly developed countries, and has become an important source of income to universities. In Latin America, most universities have only recently started to engage in technology transfer activities.

UTT is mostly associated with formal channels of transfer, such as patents, licensing or spin-offs, and many universities have set up dedicated technology transfer offices (TTOs) that deal with the marketing of research and innovations by their researchers. However, technology transfer also takes place on an informal level, in the form of joint projects, student internships, study visits and seminars. The experiences gained during the JELARE project have shown that, especially in Latin America, the level of communication and collaboration of universities with market actors in the renewable energy sector is still very low. One reason – according to the JELARE survey – might be that most enterprises consider universities at present to be behind the current needs of the renewable energy market. Engaging in more communication and joint activities between universities and industry or public-sector institutions can offer valuable opportunities for both sides. Universities can align their activities better to the needs of the market and develop new business fields e.g. in applied research, and companies can benefit from scientific support for their renewable energy activities.

International Technology Transfer (ITT) is, for its part, usually associated with the transfer of technologies or knowledge from more developed countries to less developed ones, often also being described as north-south technology transfer. Currently, ITT is predominantly carried out via joint projects, trade relations or foreign direct investment. In the context of international technology transfer, the role of universities can be seen as supporting local companies in adapting imported technologies to fit local market needs.

However, ITT flows take place not only in the form of products, but also via individuals – through meetings, projects, staff exchange and informal networking – which are key activities for universities operating internationally. There are also many examples of successful technology transfer between two or more less developed countries. The JELARE project has also gained positive experiences in knowledge transfer, not only between two universities from less developed countries, but also from a less developed to a highly developed country.

# 4.2 Technology Transfer: recommendations

### Tip 1: Promote strategic alliances for the promotion and development of RE projects

The promotion of strategic alliances between government, private companies and universities for the promotion and development of renewable energy is a key activity for positioning the new technologies in the country, private enterprise and teaching in higher education institutions. In addition, such partnerships foster applied research and the training of professionals who can work in private companies and support the research of universities with their master's and doctoral theses. These alliances allow for a more fluid relationship that fosters the development of projects and long-term partnerships contributing to the sustainable development of the country. On the other hand, the proximity between universities, private companies and government allows research and technology transfer to be developed more efficiently and enables the rapid and widespread penetration of the different renewable technologies in various productive sectors, social groups and government agencies.

### Tip 2: Create advisory councils for information-sharing and exchange of knowledge between the market, the government and the University

The creation of advisory councils, comprising directors, universities' coordinators, researchers, entrepreneurs, government officials and other "decision-makers", encourages information-sharing and exchange of knowledge between the market, government, and institutions. Advisory councils will direct and pioneer the renewable energy fields. These diverse and collaborative advisory councils will speak on behalf of stakeholders in the renewable energy field.

### Tip 3: Implementation of a Technology Transfer Centre for a national and international exchange between HEIs and private enterprises

The setting-up of a Technology Transfer Centre specifically devoted to renewable energy is important to increase technology transfer and exchange with different countries. It also gives a solid basis for students, teachers and representatives from industry interested in engaging in national and international project collaboration. In addition, such centres can be used to organize capacity-building seminars, workshops and national and international conferences. They represent an invaluable infrastructure and contact point, systematically supporting national and international technology transfer and exchange.

### Tip 4: Organize international networking events for technology transfer

International networking events are of critical importance for sustainable collaboration with partners around the world. Such a network can be used as a solid basis for technology transfer, which is very important, especially for developing countries. Such regular events can enlarge the network and can deepen relationships between partners. It also provides a platform where people can exchange and discuss new technology approaches regarding renewable energy or other related topics.

## Good Practice:

### Renewable Energy Technology Transfer Centre

**Objective(s):**
The Research and Transfer Centre "Application of Life Sciences" (FTZ-ALS) of the HAW Hamburg aims to become recognized as a leading international technology transfer institution in the field of renewable energy. It thereby wishes to enhance the diffusion of renewable energies in order to support sustainable development on a local and global scale.

**Activities and results:**
The FTZ-ALS has developed a strategy for its international technology transfer activities. The main focus lies in: increasing networking with international actors in science, R&D and KTT, enhancing science marketing, communication and visibility, organizing events and workshops, and encouraging large-scale international projects.
So far, many capacity buildings seminars have been organized, such as a research funds seminar, a Spanish course for academics interested in cooperating with South America and a seminar on survey methods. New projects have been realized, such as the REGSA and CELA project in renewable energy.
Also, the centre facilitates a regular exchange between partners from all over the world. It has thus been possible to date to organize student exchanges in the form of internships.

**Partners involved:**
Hamburg University of Applied Sciences, Germany

**Lessons learnt:**
The importance of the transfer of technology is its ability to strengthen the exchange of knowledge and know-how between different universities, private enterprises and countries, locally as well as internationally.

**Potential for replication/extension:**
May be replicated to other topics beyond renewable energies.

**Country of implementation:** Germany

## Tip 5: Foster networking in order to promote local technology and knowledge transfer

Within the JELARE project, the Bolivian Catholic University has carried out several networking and dissemination events in the field of renewable energies which have helped to create a huge network of experts and professionals from the field. These contacts have been very helpful to the different activities which have been implemented afterwards, such as the elaboration of study programmes and research concepts and the realization of capacity-building and other events. Furthermore, these seminars have contributed to building a platform for actors within the relevant sectors for the exchange of knowledge and ideas and the launch of cooperation within research and other projects.

## Tip 6: Promote seminars, congresses, and workshops focused on renewable energies

The promotion of national and international seminars, congresses, and workshops focused on renewable energies is a great help for demonstrating technologies, expanding relationships and lecturing researchers, students, politicians and business people. This is a great advantage in ensuring that programmes receive recognition, sponsorship and recommendations, as well as in showing audiences the work and technologies of people who are seeking to build a better world.

## Good Practice:

### Renewable Energy Fair at the Bolivian Catholic University

**Objective(s):**
The objective of the Renewable Energy Fair as one of the JELARE networking events was to bring together market actors from the Bolivian renewable energy sector from the entire country in order to foster technology transfer and knowledge exchange and to give students and other stakeholders the opportunity to get in contact with RE companies and organizations.

**Activities and results:**
The fair was organized as part of a two-day dissemination seminar about renewable energies. Twenty-five companies and NGOs from all over the country were present, exhibiting equipment and information. More than 200 students and other participants visited the fair.

**Partners involved:**
Universidad Católica Boliviana, Bolivia

**Lessons learnt:**
The Renewable Energy Fair was a very successful event in terms of networking, technology transfer and business contacts.

**Potential for replication/extension:**
The Renewable Energy Fair could be replicated on other campuses of the Bolivian Catholic University in different parts of the country.

**Country of implementation:** Bolivia

## Tip 7: Extend cooperation between educational establishments and production, intensify the innovation process based on mutual-cooperation contracts

It is typical that the survey results in all 6 states participating in the JELARE project indicate that there is almost no stable, close and long-term cooperation between universities and production. This is a very serious drawback for universities because it impedes the training of specialists in accordance with demand in the labour market, and university graduates have a long adaptation period in order to enter the labour market, and in some cases they have to re-qualify, i.e. gain new skills and practical knowledge.

On the other hand, companies do not cooperate with universities and do not use their extensive scientific potential and students' labour resources for their development.

It is crucial that this problem is resolved quickly. It is necessary for real mutual-cooperation contracts to be concluded between universities and companies. These should include very precise tasks and the rights and duties of each party to make them work in reality.

## Tip 8: Organize regular training seminars for company managers and engineering personnel

Regular seminars should be organized in the university technology transfer centre as a means of disseminating progressive experience in the field of renewable energy.

University academic staff and scientists as well as specialists of leading companies should be involved in delivering seminars. There might be two kinds of interchangeable seminars. It would be useful to provide information on the latest legislation, state programmes and economic aspects related to the exploit-

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## Good Practice:

### Creation of an informative database and network of renewable energy technologies for the engineering personnel of companies

**Objective(s):**
To provide a tool for effective and fast access to the latest information and technical solutions in the modernization process of companies – the key to a dynamic technology transfer process.

**Activities and results:**
Rēzeknes Augstskola has developed an algorithm for information exchange between companies and the technology transfer point, which provides an opportunity for the engineering personnel of companies to obtain the information necessary for problem-solving, to request the technology transfer point to prepare the required materials, and academic staff or scientific institute researchers to be informed of real problems faced by companies and thus to conduct research aimed at resolving topical issues.

The project produced a catalogue of information and works offered by the environmental technologies transfer point, a regional companies catalogue, and a catalogue of internet sources on environmental technologies.

**Partners involved:**
Rēzeknes Augstskola, Latvia; companies in Latvia, branches of manufacturing industry, food industry, water and energy supply and agriculture.

**Lessons learnt:**
The informative database is used in companies because, as the company survey showed, one of the obstacles for operative company performance is the lack of information and difficulties of access to it.

**Potential for replication/extension:**
Extension of the informative network to include more companies, cooperation with other technology transfer points for the coordination of activities.

**Country of implementation:** Latvia

ation of renewable energy to the leading staff of companies.

The engineering and technical personnel of companies are provided with knowledge about the specific issues of equipment and technologies and specialists' experience in resolving problems. The recommended duration of seminars is 2–3 days. After the seminar and test assignment, each participant receives a certificate.

## Tip 9: Use information technology to collaborate internationally and disseminate knowledge to a wider audience

E-learning is not only a useful tool for disseminating the latest technological knowledge to an international audience. It is also easier to incorporate the expertise and knowledge of other international partners in the courses. Moreover, when implementing e-learning courses in the context of international cooperation between various partner universities, this also leads to knowledge and technology transfer of the participating universities. The process of implementing joint e-learning programmes can also be supported by IT technologies such as video conferences.

## Tip 10: Participate in events related to renewable energies

Universities should try to give research projects a permanent and frequent presence in the RE area by participating in workshops, conferences, fairs and other events. This can range from giving presentations, chairing sessions, contributing to panel discussions or academic advisory boards or displaying RE activities with posters or small exhibition stands. Participating in these activities allows research projects and the universities involved to remain visible in the international arena and to develop new ideas or establish international exchange.

## Tip 11. Design technology and knowledge transfer concepts with multiple functions, stakeholders and beneficiaries for greater sustainability

Technology and knowledge transfer is very complex. In many cases good intentions do not result in an effective transfer with an impact in the development or competitiveness of the recipients. Within the JELARE project, experience has shown that a technology transfer concept developed by a number of different stakeholders and experts from various institutions, which serves multiple functions and methods of technology transfer and is geared towards a variety of stakeholders and beneficiaries, can be very successful and sustainable. It can achieve a high level of acceptance by the different groups which benefit from it.

## Tip 12: Develop marketing, communication and visibility strategies for technology transfer

To secure technology transfer between countries and reach other countries, researchers, NGOs, governmental institutions and private enterprises, marketing, communication and visibility strategies are essential. Publications about new technology, Web 2.0 and other social media channels as well as a proper marketing strategy are important for promoting the transfer of technology among stakeholders.

## Tip 13: Intensify south-north technology transfer

South-south technology transfer has been widely discussed as an alternative to the traditional transfer from the more developed countries in the North to the less developed in the South. Nevertheless, the JELARE project has shown that there is also a strong justi-

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## Good Practice:

### Capacity-building seminar "Renewable energy – theory, technology, economics, education"

**Objective(s):**
Information on renewable energy topics in the region and in the world.

**Activities and results:**
The seminar was attended by 67 participants, mostly staff and students of Rēzeknes Augstskola. Presentations were given by the representatives of the University of Latvia, Riga Technical University, New Fuels Ltd. and Rēzeknes Augstskola. Each participant received a certificate issued by JELARE team Latvia. According to the participants' survey, the overall evaluation of the seminar may be regarded as very good.

**Partners involved:**
Rēzeknes Augstskola, Latvia; University of Latvia, Latvia; Riga Technical University, New Fuels Ltd.

**Lessons learnt:**
Issuing certificates of attendance helps increase the number of participants significantly.

**Potential for replication/extension:**
The capacity-building events have very high potential for replication at any educational institution.

**Country of implementation:** Latvia

fication for technology and knowledge transfer from the South to the North. For example, in the case of study programmes aimed at professionals with an interest in development cooperation, technical assistance or international trade with developing countries, it can be very useful for universities to receive technology and knowledge transfer from the South in order to learn more about cultural, economic and social conditions in a bottom-up approach. This can help to prevent the failures which often occur within north-south cooperation when the approach is top-down.

### Tip 14: Create cooperation agreements and foster south-south technology transfer by supporting other universities with technology and experience

One of the main lines of activity and objectives of the JELARE project was internal capacity-building in order to contribute to the strengthening of the partner universities and to reach the overall objectives of the project. The main task of the partner institutions was to assist other universities with technology when the levels were unequal and when there was the need to support any partner. This kind of technology transfer might have a south-south exchange characteristic to it, unlike those agreements usually produced in the North and geared towards the South. This happened between Bolivia and Guatemala with the design of the Postgraduate Degree in Sustainable Development, Environment and Renewable Energy, where personnel from the Bolivian Catholic University were trained by Galileo University.

### Tip 15: Create courses for capacity-building in strategic planning, management, energy economics, marketing and natural resources economy for prospective engineers and technicians in renewable energies industries and government

Students at the universities are in a unique position in that their education is their primary focus. Once they leave for whichever industry they choose, acquiring knowledge will no longer be their primary focus. For this reason, students should be academically exposed to the areas in which they will subsequently work. Both engineers and technicians of energy companies and members of governmental organizations should already be confronted with topics like planning and administration, strategy, economy and energy, marketing and the economy of natural resources during their academic education. Experiences gained in the university context can have a positive influence on the industry decisions once they are in it. To fill the gap in this area, such college programmes ought to be created.

## Good Practice:

### Mercosur post-Copenhagen seminar

**Objective(s):**
Climate change is an important issue on the global economic and political agenda. The recent disasters on the American continent, including in Santa Catarina and Rio Grande do Sul (both in Brazil), have made action necessary to mitigate and adapt to climate change. However, such action has no impact if only carried out locally; it must be the subject of joint action between states and even between countries. The main goal of the seminar was to discuss renewable energies, regional integration and what is being proposed in Brazil to face the consequences of climate change.

**Activities and results:**
In the seminar, Guilherme Cassel, Agrarian Development Minister, talked about the generation of green jobs. Speakers from the Mercosur Parliament and from institutions dedicated to regional integration, diplomacy and renewable energies represented the four MERCOSUR countries.

**Partners involved:**
The seminar was an initiative of Regional Integration Center – Cefir, Uruguay; Instituto IDEAL; Universidade Federal de Santa Catarina (UFSC), Brazil; Fundação Universidade do Sul de Santa Catarina (UNISUL), Brazil

**Lessons learnt:**
The importance of a multi-stakeholders approach in the field of renewable energies.

**Potential for replication/extension:**
This event now takes place once a year in Brazil and the organization has been invited to promote it in other South American countries.

**Country of implementation:** Brazil

## Tip 16: Support master's and doctoral theses which focus on the solution of problems in a specific company

It is useful to gear master's and doctoral theses towards the solution of problems in a specific company. Research should be company-based and conducted within production, enabling the innovative results of this work to be immediately implemented.

In cases where a doctoral student works on a completely new subject not directly related to the operation of the company, the results of his/her research should be approved by the company.

New non-trivial solutions can provide an impulse for improving or even changing the operation of the company.

## Tip 17: Initiate exchange programmes between HEIs and the RE market allowing internships for students in RE companies

Due to the complementary nature of the relationship between academia and the renew able energy industry, both sides ought to understand the work done by the other side and the process required to achieve that work. This can best be done through an exchange programme or internship within the two organizations. Through a free flow of human capital within these institutions, the academic side will understand how research is applied, and industry will understand how the research is obtained. This understanding should ultimately result in an increase in productivity.

### Tip 18: Invest in the identification of real needs

Especially in developing countries, the technology transfer projects carried out on the basis of international cooperation and by universities often lack a connection with the real needs of recipients and are therefore not sustainable. It has proved very successful to invest time and resources in the identification of real needs, e.g. by conducting surveys and interviews, focus groups, field visits, etc.

### Tip 19: Create an economic administrative regulating base nationwide to create favourable conditions for the development of renewable energy resource use

It is obvious that companies need significant state support to exploit renewable energy resources at the development stage. However, not all issues regulating extraction of renewable energy resources, their processing, support for modernization of equipment and technologies are specified in many countries. In order to increase the development of RE resources, it is essential to create an instrument for economic support in terms of additional payments for selling electric power generated from renewable energy resources and support for connecting small power units to the power grid.

### Tip 20: Link RE developments with environmental obligations, local development and climate change-related requirements

The countries of the region are involved in the development of new regulations and obligations relating to environmental issues, impacts on climate change and sustainable development, particularly the country's growth

as decoupled from growth in energy consumption. Under this scenario, the development of renewable energy makes an important contribution to reducing local and global emissions, and together with energy efficiency is one of the most effective tools for reducing fossil fuel consumption in these countries. Local governments have developed a set of instruments to promote renewable energy at the expense of fossil fuels and at international level. The Clean Development Mechanism and other instruments of the Kyoto Protocol, have allowed several projects to be developed that do not follow the "business as usual" electrification model in developing countries and have allowed new renewable projects to be incorporated into the energy matrix. Additionally, the development of Nationally Appropriate Mitigation Actions (NAMAs) are helping to give new impetus to renewable energy due to the significant potential for reducing emissions of greenhouse gases that still exists in this sector.

## Tip 21: Promote the creation of support services associated with renewable energy technologies

One of the common challenges for countries where renewable energy technologies are in their first stage of integration is the creation of an adequate services platform that provides both spares supply and technical support. Nowadays, these kinds of services require support that comes directly from the source, i.e. from the manufacturer or some foreign company that provides the service. This implies higher operation and maintenance costs, which goes against promoting renewable energy technologies. Thus, adequate technology transfer procedures are needed focusing on two main aspects: lack of knowledge, which means increasing capacity-building for local staff, and technology knowledge associated with spare-parts buying, technical specifications and so on. This technology transfer should also be focused on promoting the creation of SMEs (small and medium-sized enterprises) that will be able to provide support services for the growing renewable energies industry.

## Tip 22: Create a database and information network of renewable energy technologies – "University – Technology Transfer Centre – Companies"

As regards renewable energy resources, it is possible to distinguish between traditional resources, e.g. hydropower, and alternative non-traditional resources, e.g. solar energy, biomass processing energy.

Companies specializing in the field of renewable resources first need permanent and operative access to new technologies, new equipment, and contemporary trends in acquisition, conversion and the use of renewable energy to compete with traditional technologies and modern technologies.

Despite the availability of extensive informative databases on the Internet, engineering and technical personnel face difficulties in finding answers to the questions they are interested in due to this wealth of information.

A systematized database of specific data and information should be created according to each kind of renewable resource. In addition, it is important to develop an information network enabling production employees to gain the necessary information and instructions for further activities to transfer new technologies and techniques operationally to their companies.

## Tip 23: Create a permanent polygon for demonstrations of and training in new technologies in the area of renewable energy

A significant role in the development of renewable energy is attributed to the opportunities of engineering and technical personnel to be introduced to aggregates and equipment

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## Good Practice:

### The Renewable Energy Technology Demonstration Centre at the rural unit of the Bolivian Catholic University

**Objective(s):**
To foster education in renewable energies at the Bolivian Catholic University and to transfer knowledge about these technologies to rural areas.

**Activities and results:**
The Renewable Energy Technology Demonstration Centre has been implemented in the framework of the pilot module "Technology and Knowledge Transfer for Rural Energization with Renewable Energies". It consists of eight different types of RE technologies which are the most used in Bolivia's rural areas, integrated into the agro-industrial production of the rural academic unit of the university, as well as some measurement equipment such as an anemometer and a radiometer. The main purpose of the centre is to serve as a practical laboratory for engineering and architecture students. It also serves both capacity-building and dissemination purposes.

**Partners involved:**
Universidad Católica Boliviana, Bolivia; Hamburg University of Applied Sciences, Germany; Fundação Universidade do Sul de Santa Catarina (UNISUL), Brazil

**Lessons learnt:**
The multiple functions of the Demonstration Centre make it attractive to a variety of different stakeholders. University students, municipal technicians, members of NGOs as well as poor rural community members have been educated and informed through the Centre and the related capacity-building events.

**Potential for replication/extension:**
The Bolivian Vice Ministry of Science and Technology has shown interest in replicating the RE Technology Demonstration Centre in other parts of the country in order to meet its objective of strengthening renewable energy education in schools and universities.

**Country of implementation:** Bolivia

in reality. Introductory visits to modern companies in other countries cannot be made in large numbers and are not economically justifiable.

Thus, it is very important to establish all the exploitation technologies of various kinds of energy in a single demonstration polygon, providing an opportunity for the engineering and technical personnel of companies to gain information and skills in the use of new techniques.

The demonstration polygon will perform its functions fully only in case the technologies and techniques represented there are continuously developed and regularly substituted by new modern technologies. For this reason, cooperation with companies and firms generating this technology is needed. Companies can use such a polygon to demonstrate and advertise their equipment.

## Tip 24: Develop energy-supply projects based on RE at local community level that can be replicated at both national and regional level

Latin American countries still face the challenge of achieving a 100% electricity supply for all their population. In this context, there are a lot of isolated communities that still require electrification solutions for a continuous power supply. On the other hand, these communities are frequently located in places with plenty of natural resources (solar radiation, wind, hydro, biomass, etc.) that offer the opportunity of renewable energy projects. Against this background, there are a lot of opportunities for developing power-supply projects based on renewable energy that may offer a continuous service to these isolated communities. These supply projects are being developed under the umbrella of Smart Grid solutions, allowing an efficient use of the natural resources and also demanding response programmes that complement this objective.

The implementation of these projects requires technology transfer procedures that allow correct equipment identification and training to be able to achieve their objectives.

## Tip 25: Create agreements between different institutions and develop joint promotional activities with government and private companies

Both government and private companies require a higher level of knowledge on renewable energy and technological development so they can make better decisions about the energy resources and technologies to be used and promote their effective use. Universities and technology centres in the country are the institutions that should be able to coordinate joint activities and get to know the opinion of these sectors, seeking to reach a consensus on future developments and on which technological approaches should be pursued in the medium and long term. The development of workshops and training activities is a useful means of achieving such interaction by bringing together key stakeholders, representatives of government institutions and executives from private companies. Additionally, the preparation of educational and promotional material is an excellent tool for promoting new technologies and identifying the working groups capable of transferring these technologies to industry.

The signing of cooperation agreements between universities and public or private institutions can enhance the impact as joint events or publications can then be certified by higher education institutions.

## Good Practice:

### International cooperation agreement for intense capacity-building and knowledge transfer in e-learning

**Objective(s):**
The objective of this cooperation exercise was to build capacities in the Bolivian Catholic University in the field of e-learning.

**Activities and results:**
In the framework of JELARE pilot module 1, the partners from Bolivia, Brazil, Guatemala and Latvia developed a joint postgraduate programme in "Sustainability, Environment and Renewable Energies" in a 100% virtual modus. In this context, the Galileo University of Guatemala provided the Bolivian Catholic University with the technology to build up a virtual platform for e-learning programmes as well as with an intense capacity-building in the field. Several on-site and virtual courses were given to university professors in the topics of instructional design, e-moderation, e-activities, etc., and to system engineers in programming and personalizing the e-learning platform until the university was able to create a new team made up of professors and technicians responsible for the implementation of the JELARE postgraduate programme and future e-learning initiatives.

**Partners involved:**
Universidad Católica Boliviana, Bolivia;
Universidad Galileo, Guatemala

**Lessons learnt:**
The cooperation agreement has led to an intense technology and knowledge transfer which helped to build up new capacities in the Bolivian Catholic University.

**Potential for replication/extension:**
The cooperation agreement has already been extended to include further capacity-building activities with more professors and cooperation in the digitalization of e-learning content.

**Country of implementation:**
Bolivia and Guatemala

## Tip 26: Promote the development of RE projects with private companies in the context of corporate social responsibility

An interesting way of raising funds for the development of RE projects is through the corporate social responsibility of large companies located in small communities or in isolated areas where it is difficult to access energy resources. These companies should also work with universities and technology centres as well as with the communities which will benefit from rural electrification projects using renewable energy that contribute to sustainable development in these locations. Corporate social responsibility is a business vision that integrates respect for values and ethics, workers, community and the environment into the company's management. This is an interesting option for large companies as a means of contributing to the development of local communities and reducing emissions of greenhouse gases that may be useful in environmental and management performance at both national and international level. Such experiences require the involvement of executives and employees from these companies and residents of the recipient communities, which is beneficial for knowledge and training on these new technologies in the country.

## Tip 27: Use synergies between project work and regular university activities e.g. co-organization of events

The project work should be combined with regular university activities. Such cooperation will support the effect of synergies between them and strengthen collaboration and knowledge know-how. Co-organization of events, workshops and seminars will support such synergies, which can be used to develop and expand knowledge.

## Tip 28: Implement environmental principles at own university

When universities are involved in environmental projects it is appropriate that the principles of the research are also applied at own institutions, for example by establishing an environment management system at the university. Changes should concern students and academic personnel, as well as buildings and campus in general. The aim of these activities is to give good examples which show that the principles of the project and the academic institution are not only of a theoretical nature but are also matched by their actions.

## Good Practice:

### Participation by other universities, companies and the public sector in JELARE activities

**Objective(s):**
To contribute to the proper development of the project and its activities with the participation of other universities, companies and the public sector, catalyzing cooperation, information dissemination, networking and the transfer of appropriate technologies, which may support academic and industrial cooperation.

**Activities and results:**
Agreements, letters of understanding and informal cooperative links have been established with various private and public institutions. This has fostered collaboration with many stakeholders in organizing panels, forums, seminars, fairs, courses, etc.

**Partners involved:**
Universidad Galileo, Guatemala and 4 other universities, 2 ministries, at least 10 companies.

**Lessons learnt:**
Potential activities that allow for a positive evolution of the project activities by creating networks that motivate two-way participation in all the activities that might arise.

**Potential for replication/extension:**
Could potentially be replicated in other entities and for other topics.

**Country of implementation:** Guatemala

## Tip 29: Guarantee the sustainability of the activities initiated by the project

One of the major aims of the RE projects is to ensure sustainability beyond their duration and to establish the continuity of the activities pursued. The recommended strategy for achieving this goal is to create an entity within the university in which the activities or plans initiated by the project can be followed up. Experience with the JELARE project shows that the responsibility of these entities grows gradually over time. When the project ends, they are able to follow the lead of the actions initiated by the project and continue working with them. In this respect, the strategic plan or guideline of these actions and the specific entity should be taken into consideration in a timely fashion.

## Tip 30: Create university-industry exchange networks in order to improve teaching and, at the same time, meet market needs

As a result of the survey, exchange networks were set up involving industries and Galileo University from which interaction, including diploma courses and a postgraduate degree programme, have emerged with the aim of satisfying the needs of the market.

This is fed by public presentations of the results, the distribution of books and publications and the constant advertising by e-mail of the national networks established and widened by the projects.

# 5. Conclusion

These recommendations are based on the experiences gained by the JELARE partners during the three-year project and are addressed to other European and Latin American universities that also plan to increase the level of attention currently given to renewable energy in their research and teaching activities.

The experiences gathered during the JELARE project mostly derive from the insights gained from the JELARE labour market and university staff survey, during the development of teaching and research concepts, during the implementation of the pilot module and as feedback was received from stakeholders from the private and public sectors during networking events or dedicated round tables. These are now outlined below.

## Education

There is at present a strong need for additional qualification programmes in the field of renewable energy. In a young and dynamic sector such as renewable energy, lifelong-learning concepts are crucial to keeping abreast of the latest technological developments.

The tips and practical examples given for education in this report can be clustered as follows:

- Develop new degree courses dedicated to renewable energy, and integrate the topic of renewable energy into existing study programmes;
- Introduce the subject of renewable energy into engineering degree programmes as well as into related disciplines, such as business or law;
- Offer multi-disciplinary or international courses;
- Offer e-learning, blended learning courses or short-term training courses for companies, especially in the context of life-long learning;

- Collaborate with other universities or other institutions in the private or public sector in designing or offering educational courses;
- Offer regular capacity-building to in-house staff too;
- Foster practical learning among students by integrating practical elements such as projects, real-life laboratories or student internships at renewable energy companies;

This shows that higher-education institutions have an opportunity to engage in a broad range of teaching options supporting the development of the renewable-energy sector, and that they ought to take advantage of the many benefits to which this may give rise.

## Research

It is important for innovative sectors like renewable energy that higher education institutions build up their own research capacity. The role of universities should not be limited to conducting basic research but also extend to engaging in applied research that offers solutions for current market and social needs. To place research on renewable energy more prominently in universities' programmes, the


tips contained in this report stress the following aspects in particular:

- Focus on applied research, including the implementation of pilot projects;
- In the renewable energy sector there is still a strong need for research, not only in the technological field but also in the economic, legal and social context;
- Improve research infrastructure;
- Increase HEI capacity to apply for research funds;
- Broaden research collaboration between different disciplines, cross-border or with public or private-sector institutions.

By increasing research activities at higher-education institutions, an essential contribution can be made to national innovation performance in the renewable energy sector.

## Technology transfer

International and university technology transfer are the most relevant to European and Latin American universities seeking to contribute to the socio-economic development of their countries and of the whole region. The tips contained in this report are intended to increase the outreach of universities in the renewable energy sector and can be summarized as follows:

- Promote strategic alliances between government, private enterprises and universities;
- Foster networking locally as well as internationally, e.g. by organizing or attending fairs, workshops and conferences;
- Engage not only in south-north but also south-south technology transfer;
- Participate in joint collaboration projects with research partners outside one's own institution;
- Create support services for renewable energy, e.g. databases, demonstration plants;
- Implement practical (pilot) projects in collaboration with local communities.

It is hoped that this recommendation report will be a valuable source of inspiration to other higher-education institutions in Europe and Latin America in fostering renewable energy education, research and technology transfer within their own organizations.

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# Partnership

## Germany • Lead partner

Hamburg University of Applied Sciences
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