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(eds.)

Educational and Technological Approaches to Renewable Energy

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Preface

The search for the means to promote renewable energy is a matter of great international concern, not only due to the high prices of conventional fossil fuels, but also because of the negative impacts of CO_2 emissions on the world's climate. Even though the theme "renewable energy" has been treated as a matter of marginal relevance in the past, it is a key issue in the present and a matter whose relevance is likely to increase in the future. The reasons for this are twofold.

Firstly, as the world population reaches the 7 billion mark, energy demands are expected to rise. Based on the forecasts on energy production, which seem to indicate that conventional fossil fuels will become less and less available, and – due to their progressive limitation – prices are likely to increase, there is a pressing need to look for alternatives to meet current and future energy needs,

Secondly, if we are to find alternatives to fossil fuels, we need to find effective means to produce energy from biomass, from the sun and wind. In this context, research on the one hand, but also concrete applications on the other, are greatly needed.

According to the International Energy Agency (EIA), the world energy consumption is projected to grow by 50 percent between 2005 and 2030. Due to the fact that less fossil fuels will be available to meet such needs, there seems inevitable that renewable energy sources will be used, to meet at least part of the growing demands for energy.

Against this background, HAW Hamburg has created a Competence Centre on Renewable Energy and Energy Efficiency (CC4E) and a Technology Transfer Centre on Renewable Energy, whose goals are to undertake research and projects aimed at fostering the cause of renewable energy, and use technology transfer as a tool to helping developing countries to meet their needs. And since there is a paucity of publications which specifically address matters related to renewable energy in developing countries, we thought a book on educational and technological would be a timely contribution to the international debate on the topic.

This book therefore documents and disseminates a number of educational and technological approaches to renewable energy, with a special emphasis to European and Latin American experiences, but also with experiences from other parts of the world. It was prepared as part of the project JELARE (Joint European-Latin American Universities Renewable Energy Project), undertaken as part of

the ALFA III Programme of the European Commission and involving countries in Latin America (e.g. Bolivia, Brazil, Chile, Guatemala) and in Europe (Germany and Latvia). Thanks to its approach and structure, this book will prove useful to all those active in the development of the renewable energy sector, especially those concerned with the problems posed by lack of expertise and lack of training in this important field.

A word of thanks goes to all authors who have contributed to this volume, as well as to all JELARE project partners, who made the project such a great success. It is hoped that this book will catalyse the development of further educational approaches in the field of renewable energy, and encourage their use in implementing new technologies. Enjoy your reading.

Walter Leal Filho & Julia Gottwald
Winter 2011/2012

"Renewable Energies in the Light of Development Experiences in Fifty Years, 1960-2010"

Nelson Amaro[1]

Abstract

Political, socio-economic and environmental trends are examined in the past fifty years. Three periods are distinguished in this time span. The first one is the "optimistic" phase (1960-70). Concerns about renewable energy were absent. The motto here is "development without any frontier". The second phase is the "pessimistic" stage (1970-85), where "the limits of growth" are emphasised. Interest in renewable energy is strongly brought to the fore at this stage. An environmental catastrophe is predicted if development patterns continue. Renewable energy becomes a viable alternative to expensive and contaminating fuel energy during this stage. The final phase, which we call "realistic", is being witnessed now (1985-present) where attempts are being made to reconcile development and environmental goals. These trends help to distinguish four paradigms that have oriented global development and renewable energy in the past sixty years: the "Modernisation" and "Neo-liberalism" school, which contributes to the optimistic vision of the sixties; Secondly "Dependence" theories followed by "World-Systems" schools, less concerned with renewable energies but looking at oil predominance as an instrument of big corporations and something serving the interests of rich countries. The "Club of Rome" paradigm, on the other hand, emphasises scepticism about all kinds of development efforts. In the "pessimistic stage" it predicted catastrophe if exploitation patterns continued without regard to environmental and clean energy concerns. The prevalent paradigm nowadays, however, is the "Sustainable Development" approach, which seems to be a synthesis of past experiences amenable to the "realistic" stage. This realisation will help to build bridges among extremist ideologies that continue defending the "development at all costs" that many proclaimed in the seventies. Universities

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may play an objective role in favour of renewable energies at this point in time. This effort might become an important contribution to the 450 Scenario endorsed by the International Energy Agency, which envisages limiting the global temperature rise to 2°C above pre-industrial levels by the year 2030.

Latin America and the world have experienced big swings from the "First" to the "Fifth Development Decade" (1960-2010), following the denomination coined by the United Nations (UN). Public policies had initiatives with ups and downs similar to the major trends of the time. The oil crisis reached it maximum point in 2008, when its price reached US$147 in July. This event, unique in the history of fuel, immediately led to a series of measures to achieve more energy efficiency. The responsible bodies of many countries made energy production matrixes that, for the future, presented a gradual reduction of fossil fuels in favour of different renewable energy alternatives.

This effort still needs more time to be evaluated, but it is adequate to appraise it in the light of the development context where it has taken place. The crucial question for the future is: will past patterns continue into the present, or will the contexts in which this situation has emerged change sufficiently to produce new results? Since 1960 the rise in oil prices has determined most initiatives in renewable energies, which have gone forward as high costs have prevailed. Experience shows that when the price of oil has declined, efforts to design, boost, invest and produce these energies lose impetus.

In this document, we will analyse the different development contexts that have taken place in the last 50 years. We will make the paradigms that have influenced this result clear, determine its impact in the dilemma of fossil fuels-pollution versus renewable energies, and infer from this analysis the probable course of the trend, in order to derive lessons in sustainable development for the present and the future, – especially with regard to the role that universities may play in this dilemma.[1]

I. Background

The 1960s had the "blessing" of the world community, calling this period "The First Development Decade". This "baptism" does not mean that inequality among nations was not examined by classical theoreticians as far back as the 19th and early 20th centuries (e.g. Adam Smith, David Ricardo, Auguste Comte, Herbert Spencer, Karl Marx and Max Weber to name only a few). Nevertheless, less favoured or less developed nations were regarded more as simple societies that had not yet undergone sufficient evolution, or simply as objects of the colonial and imperialist policies of the most advanced capitalist countries. Also, these

thinkers did not use the concept of "development" as such for their analysis. They referred to similar processes as examples of "evolution", probably influenced by Charles Darwin.[2]

By the period immediately after the Second World War nations were gradually beginning to find consensus on a vision of development. This vision, as we know it today, starts to be legitimate in the period after the foundation of the United Nations, the creation of the Marshall Plan for the recovery of Europe (1947-51), and the creation of President Truman's Point Four Program (1949). (The latter preceded incidentally the creation of the United States Agency for International Development [USAID] in the sixties, which would also take part in the stages to come.)

However, while this profile was being created by the decision-makers at the top, the popular image of the developing world before World War II might be inferred from the famous Tarzan movies of the time, the novels of Edgar Rice Burroughs or even, more recently, the Hollywood adventures of Harrison Ford as Indiana Jones. In order to emphasise the public perception of the changes to come in the sixties, it is important to look at a few nostalgic aspects from the fifties. It is looked at as a "time of innocence". Music, some movies and documentaries, social centres with gramophones and "big band" music, drive-ins, cafeterias with decorations from this epoch etc, are a clear sign that social practices had a sudden change, and that these former times were yearned for.

This evolution and the way public policies are conceived in the "*Development Decades*" can be summarised, after these precedents, in 3 phases: one might be called "optimistic", the second "pessimistic" and the third – still facing us today – might be labelled "realistic". Next, we will set out the characteristics of each phase and examine the role played by efforts to promote renewable energies in this context.

II. Development Phases

A. Optimistic Phase

Spanning from 1960 to the beginning of 1970, this is the "First Decade of Development", as the United Nations System called it. A series of singular events point towards changing times:

- The independence of the African countries from their colonial rulers.
- The promise made by the most advanced countries (confirmed in United Nations conclaves) to help developing countries with 0.7% of GNP. (This

goal was incidentally resurrected by world heads of state evaluating the Millennium Objectives in New York at the end of 2010.)

- Defence of civil rights together with generational and student protests represented by the "hippie" movement.
- The "May Movement" in 1969 in France, under the motto "Imagination takes Power", which challenged the Establishment and kept the country in a constant state of agitation with street marches and confrontations with the security authorities.
- De-Stalinisation in the Soviet Union, promoted by the 20th Congress of the Communist Party in the fifties and sixties, when the main guidelines of the Stalinist period were criticised and rejected.
- The guerrilla movements in Latin America, spurred by Che Guevara's call to instigate a series of "Vietnams" on the continent.
- The call for reforms from the Second Vatican Council.
- The unique influence of the coincidence of reformist personalities in key decision-making positions around the world, such as John Kennedy, Nikita Khrushchev and John Paul II.

All these events anticipated a better future regardless of the different ideological approaches, and even though these events occurred in the context of a "Cold War" mentality.

1. The Role of Renewable Energy

Following the premises of "unlimited growth", oil was barely acknowledged as a strategic and non-renewable resource for industrial societies in general, or for the development of "emerging" countries, as they have been recently named. In addition, by all accounts, oil followed market laws, and – compared to recent trends – was extremely cheap. Big multinational entities controlled oil production, especially in Arab countries, and its major sources besides the Middle Eastern countries were the great powers: the USA and the Soviet Union. This started a confrontation after World War II that lasted for almost the remainder of the 20th Century.

The ideas through paradigms that influence this outcome will be examined later on. At this point it suffices to highlight that renewable energy or "energy alternatives" to oil hardly received any attention. The need was not felt. The puzzle that all parties wanted to solve at this stage was how to bridge the differences between developed and developing nations. In any event, during the sixties all the main players contributed to the prevailing mood: an optimism that promised a world without inequalities and a better future for everyone. This outlook was explicitly voiced in the United Nations' "Declaration on Social Progress and Development" (1969).[3] This document does not contain a single reference to the

energy problem. As a result, this predominant vision did not include environmental concerns. Natural resources, including renewable energy sources, were regarded either as instruments of the colonial powers or merely as signs that the system had failed to exploit this wealth in favour of the poorest.

B. Pessimistic Phase

This approach and the spirit of the time started to change at the end of the sixties. The transition is described by Dumar Suárez as follows, depicting to a great extent the rise of the Organisation of Petroleum Exporting Countries, OPEC:

> "Until the early seventies, oil supply did not seem to constitute a problem, given that the demand grew almost in parallel with the discovery of new oil wells, and prices kept low… However, during that time, a slow but firm rise in prices started, and it became abrupt in 1973 and 1974. After that, it was soft again, and in 1979 it was again abrupt. (It is important to take into account that before, in 1972, the Suez Canal was blocked by the Yom Kippur War, forcing oil companies to go around Africa by the Cape of Good Hope, with the resulting increase in prices, which, along with the increase of 1973, created a panic environment in the stock markets of the world)."[4]

On the other hand, Kenneth Boulding's famous metaphor, which turned out to be prophetic, was precisely suggested when this change began. The "frontier" mindset characterises the optimistic attitude and its vision of the unlimited exploitation of resources and population growth, where movements may occur indefinitely. This mentality is about the conquest of nature, mastered by the intervention of mankind. There are no limitations for that possibility and for the satisfaction of human needs. So, growth is infinite and expansion has no borders.

This vision was coming to an end, just as Boulding predicted in 1969 near the end of the optimistic phase. The vision that came to replace the "frontier" mentality envisaged the whole planet as a spaceship. Earth with its inhabitants is on a long trip into a finite and fragile world. This spaceship is crewed by a population that must take into account the limitations of travel just like passengers on any ship. This image also implies that the available food, water, etc. in the ship is limited (i.e. non-renewable) and that its consumption, with the resulting waste that needs to be managed and pipelined, must therefore be planned and controlled to ensure the final destination is reached.[5]

The end of the optimism that characterised the previous phase can be attributed to many causes, some being more important than others. The following events form a non-exhaustive list:

- The aforementioned oil crisis.
- The recycling of the "petrodollars" suddenly captured by oil-exporting countries and channelled into the western financial and banking system, which were supplied, with facilities, to anyone that could show a certain credit capacity. This included sovereign countries with developing economies and weak fiscal restraints.
- The institutionalisation of "foreign debts", galloping as a consequence of the state of affairs outlined above, in national budgets.
- "Structural Adjustments" corresponding to advice derived from the "Washington Consensus" aiming to "put the house in order".[6]
- The spread of military and authoritarian regimes throughout the world.
- The unprecedented stagnation and inflation arising in the US and influencing the whole world.
- The rise of revolutionary armed movements either as a result of frustration after independence failed to materialise in the sixties, as in Mozambique or Angola, or insurgent movements as in Central America. In Nicaragua, following one such insurrection, a regime similar to the one in Cuba took power; the same happened in Chile through elections, although the regime was overthrown by a coup d'état in 1973. The regime in Nicaragua ended by a majority vote of citizens in 1990.
- Resistance to change by elites in many developing countries fearing being ousted from power.
- The investment contraction that followed the period of post-war prosperity.
- Macroeconomic imbalances and weaknesses in the promotion of the import substitution model of development, especially in Latin America.
- The combined effect of all these factors causes the labelling of this phase as "the Lost Decade" – a claim far from the optimism of the sixties.
- The rise of voices warning of the need to consider "the limits of growth" and the potential disaster caused by environmental erosion.

This situation forced policy and attitudinal changes in the approaches voiced by national and international institutions in charge of development.

The incorporation of *the foreign debt payment* in the annual budgets of most developing countries as a significant percentage, plus the growing influence of regional banks and the World Bank, with the resulting decline in the influence of UN specialised technical assistance organisms (UNESCO, WHO, ILO, UNFPA, etc.), characterises this period. The initial vision of entire organisations dedicated to promoting development becomes impossible when financial organisms with specialised technical branches give their support, donations and loans in the same technical areas that were previously reserved for these specialised international

organisations. Gradually, multinational banks added technical skills that were previously the reserve of these specialised organisations. In turn, financial organisations expanded their scope beyond public finances, which had represented their main duties in the original UN design. This change weakened the action of these specialised international organisms and the UN as a whole.

On the other hand, it was at this stage that bilateral external aid started to reduce the amount allocated to development aid. Parliaments and congresses of donor countries started to cast doubt upon these expenditures. In particular, the illicit enrichment of many leaders in recipient countries contributed to this discomfort. The established goal of developed countries in the sixties of contributing 0.7% of GDP found significant opposition in the years afterwards, especially from countries with higher income. However, 50 years later some smaller countries in Europe, such as Holland and a few Scandinavian countries, reached this number and have even exceeded it.

These alarms took most Latin American and Caribbean countries by surprise. The role of the UN as a bridge between the countries of the northern hemisphere and Africa and Asia made their situation even more vulnerable. There were some "middle class" countries with more credit capacity, avid for resources that were translated into debt, with governments that quickly realised the inter-temporary inflexibility of budgets – especially in those items related to defence, salaries and purchases. Those who ignored this reality went into an inflationary spiral and experienced economic misfortunes that soon made them reconsider their expenditures. Public expenditure became the most important area for reform to counter treasury shortfall. The general public policy in this period was to control resources allocated in the social area, especially in education and health, in order to even the negative cash balance of inflation, current account deficits and increasing foreign payment debts.

Mexico's inability to honour its debt in 1982 was an alert for the whole region, and countries became aware of the necessary reforms. The international community shuddered in the mid-eighties when Carlos Andres Pérez, the President of Venezuela, embarked on a series of reforms in his second term that sparked a popular protest in which supermarkets were sacked and many people were killed. Those deaths were attributed to the repercussions of reforms on the poorest groups, especially the measures designed to put Venezuelan finances "in order".

Economic growth rates, encouraged at first by this sudden incorporation of resources, increased in the seventies, but started to fall in the eighties and were in fact dramatically reverted by the end of the decade. The spirit of the time was "pessimism" as opposed to the attitude prevailing in the sixties. To crown this trend, a claim was made that it had been a "lost decade" in Latin America and the Caribbean, instead of putting emphasis on the development goals actually

reached. The crisis determined severe financial restrictions on public expenditure. Two options were presented: either tax collection was increased and/or public expenditure was reduced. The first option became virtually impossible due to the traditional tax evasion, investment discouragement and capital flight, especially in a recessive period.[7] The remedy would have been worse than the disease. Therefore, a reduction in public expenditure became imperative.

1. The Role of Renewable Energy

An enthusiasm for producing renewable energy starts to appear at this stage. Brazil is the best example. The coup d'état of 1964 started the first in a series of military regimes that lasted until 1985. Before the events of the seventies, one of the regime's top priorities was to accelerate the process of making Brazil one of the most developed countries in the world. Gradually these efforts were frustrated, to a great extent because of oil dependence. Nowadays, however, along with the USA, the country generates more than 70% of the ethanol produced worldwide, and its distribution throughout the world is part of Brazilian foreign policy. Today, despite the problems in the nineties, most vehicles in Brazil run on ethanol. Nevertheless, it is essential to acknowledge the origins of this effort. David Sandalow says:

> "The early 1970s were a boom time in Brazil, with many observers heralding the 'Brazilian economic miracle.' Yet President Ernesto Geisel faced twin problems. First, the cost of Brazil's oil imports tripled in late 1973, due to the Arab oil embargo. Second, world sugar prices, which had been climbing upward since the mid-1960s, declined sharply in 1974. Faced with these problems, Geisel launched the Brazilian National Alcohol Program in late 1975. The program was intended to reduce the need for oil imports and provide an additional market for Brazilian sugar. As a first step, the federal government immediately began promoting the production of ethanol for blending into gasoline, to the maximum extent feasible in existing vehicles (approximately 20% by volume) … The results were dramatic. Between 1975 and 1979, ethanol production increased more than 500%."[8]

Nevertheless, alarmed voices were making themselves heard at the beginning of this period. Curiously enough, those voices were backed by university research and based on findings gathered by major scholars regarding the overexploitation of resources by humans. Simultaneously, international organisations began to use this research to encourage agreement among nations. Systematic approaches along these lines were articulated to develop true "paradigms", which eventually feed into the development phases described. Thomas Kuhn coined this term to describe the "puzzle", where the practice of science, far from being a uniform, gradual and accumulative process, takes different directions in the light of new premises.[9] In the next section the prevailing ideas of these periods will be examined and the different development "paradigms" influencing these events will be identified.

C. Present Situation: Realistic Phase

Voices demanding "reform with a human face" started to be heard in the mid-eighties. The Bolivian stabilisation programme, successfully carried out in 1985, offered a more realistic approach, especially because of its sensibility, through the "Emergency Social Fund", to the "poorest of the poor". Many countries worldwide approved the Social Investment Funds, and some other measures were enacted to alleviate the consequences of the reforms, building "safety nets" for the poor.[10]

Most countries in the area adopted the so-called "first generation" measures suggested by the Washington Consensus.[11] The "second generation" measures, which are still incomplete, are related to institutional strengthening (e.g. independent Central Banks, decentralisation, commissions around fiscal matters, justice reform aiming to reinforce the rule of law, educational reform, etc.). The launching of these policies at this stage allowed expansion into the next phase (1990 until now). Nevertheless, the implementation of these policies has been different in each country. The depth of reforms varies at this stage. These differences are showed in studies from the mid-nineties.[12]

The phase that we are experiencing now is a kind of synthesis integrating the previous two phases. The concept of "Sustainable Development" sums up the logic of these events. It is exactly a midpoint between the "optimism" of the sixties and the "pessimism" of the seventies. This phase refers to a growth with ecological limits, aiming at a temporary horizon that goes beyond one generation. There is a call for more pragmatism. Just as was pointed out in an international conclave at the beginning of the 21st century: "A more empirical pragmatic approach is needed".[13] Some factors that have influenced this transition are listed below:

- In Latin America, there is some economic recovery after the suffocation of the "Tequila Effect" that devastated Mexico in 1994, and the Asian crisis that affected, among others, Brazil in 1998. In both cases, the negative multiplicative effects that were expected did not materialise.
- Basic social indicators kept rising during the eighties, to a great extent due to inertia; the diffusion of technological development in health and access to medicines was similar, aside from governmental policies.
- As the 21st century continues, macroeconomic indicators in most countries are recovering. The "debt crisis" that many said was unaffordable has been reduced and become less of a real issue.
- Significant drops in the market, especially in technology and mainly in development centres like the USA, have been overcome since 2000, thus increasing incentive for investment in less developed countries.

- The measures taken by the Washington Consensus definitely helped achieve this result, although many have been keen to point out that these objectives have been achieved, to a great extent, at the expense of greater inequality in wealth distribution in most countries.
- However, the world financial crisis that we are facing today finds developing countries in a better position than in the nineties, in terms of macroeconomic indicators including debt.
- This all means that results have mainly been achieved by putting less emphasis on ideologies, or by adapting them to better correspond to reality. Two examples will suffice: the democratic coalition in Chile respected the macroeconomic decisions made during the time of Pinochet. Also, the flight of capital from financial centres that occurred immediately after the election of Lula in Brazil gradually ceased, and he proved to have a great respect for macroeconomic balances, which restored trust.
- Since the latter years of the last decade we have been facing a great paradox: concerns about debt and fiscal crisis have been transferred to the developed countries and no longer originate principally in developing or "emerging" countries.

1. The Role of Renewable Energy

At this stage, the availability of fossil fuels and their effects on the environment are a major concern in the world. Projections show that the availability of fossil fuels will be in danger in only a few decades and, consequently, prices will tend to increase.[14] In the past, this situation has promoted investment in renewable energy. Many countries have begun to produce energy matrixes for the long and medium-term, with quantitative goals where fossil fuel energy is gradually cut back, and renewable energies are gaining higher percentages over time.

A characteristic of the current period is that concerns over how to reconcile development and environment now extend over all society, and for the first time it is possible to detect a grassroots movement behind these propositions. Nevertheless, not all institutions have responded to the challenge at the same pace. Governments have been slow in tackling the questions of energy and mines exploitation. However, many governments have set up ministries and dependencies to take responsibility for the environment and the use of natural resources. In the case of Guatemala, for example, the Ministry of Environment and Natural Resources had a greater budget than the Ministry of Energy and Mines.

Active grassroots movements and international organisations have been faster in acting. Universities increasingly are adapting to the new situation because of demand not only from the market, but from government and pressure groups. But

again, one sees greater effort put into environmental issues and natural resources, and less in energy and mines. As renewable energy is considered to come under the latter category, development tends to have a slower pace.

III. Paradigms of Each Phase of Development

The preceding sections have described the characteristics of development phases over time and highlighted how renewable energy has been perceived in each context. The next question to answer is the following: To what extent have the prevailing ideas in this context influenced these characteristics that have been outlined? Keynes says:

> "The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men, who believe themselves to be quite exempt from any intellectual influence, are usually the slaves of some defunct economist."[15]

In this section, we will outline the main intellectual arguments and their roots, which have since influenced policy in the periods we have discussed. In doing so, we will follow Thomas Kuhn's concept of "paradigm", the "puzzle" in which every group in the scientific community helps produce new research that may eventually lead to "scientific revolutions". Thus the practice of science, far from being a uniform, gradual and accumulative process, takes different directions in the light of new premises, launching real thought-revolutions during specific periods.[16]

A. Modernisation Theoreticians

Many of the intellectuals who defined the pace of the sixties could be described as modernisation theoreticians. Walter Rostow was perhaps the most emblematic figure of the times, but the classic authors who helped launch and strengthen sociology as a science included Auguste Comte, Herbert Spencer, Emile Durkheim and others. What common elements can be highlighted between these authors?

- There is a common conception of progress as some sort of improvement, e.g. societies based on theological knowledge that grow to become metaphysic and scientific (Comte), or human groups that go from simple to complex composed societies (Spencer), or from mechanical to organic societies (Durkheim). Recently, a commonly mentioned trajectory has been that from

traditional to modern societies (Parsons, Germani, Rostow, Lerner, McLelland, Hagen, Germani).[17]

- A more recent version is linked to the drastic fall of the socialist world, projecting images of a future without challenges, visualising the "end of history" – inferred from the work of Fukuyama, or the rescue of libertarian values proposed by Vargas Llosa, or Harrison and Rangel's outlines for adopting the right values of modernisation. All of them have a connection with the "neoliberal" movement that has defined the present time.[18]
- For example, Rostow, following the "social climate" of the sixties, tells us that development seemed to be around the corner. A "big push" was enough for the "traditional society" to reach, in consecutive stages, "The Age of High Mass Consumption", where material concerns gave way to different, less basic priorities, for example having kids (a reference to the "baby boom").[19] The development process, as some critics have pointed out, seemed to be a plane taking off on a one-way flight to the land of wealth!
- Cultural values or societies' intrinsic features produce changes in the economic sphere that are later transferred to family, education, politics, etc., for example "the achievement motivation" or innovations.
- Innovative businessmen and corporations with motivations such as religion or profit-lust, political arrangements, or any values in tune with the resultant changes introduce alterations that are later assimilated by entire national states.
- The main obstacles are related to values that are not suited for development, such as the tendency to enjoy leisure instead of having a work ethic, the right to "family" or "rentier" privileges, corporative ethics together with the presence of "wrong" religious values that reject technical and scientific approaches, especially those that are capable of transforming resources into market goods.
- The time needed to reach an era of abundance can be 40 to 150 years, judging by the example of more developed countries, mainly European countries and the USA. The agricultural stage in all these societies was very long, but in the industrial and service stages time periods become accelerated.
- Public policies emerge that faithfully follow the previous image. Economic aspects are the main concern and social aspects will be gradually solved. Investment rates are assigned to sectoral strategies, by-products of favourable opportunities in the markets. This approach seemed to be the primary mechanism for proceeding from one phase to another. Social development would

generate the "trickle down" effect that would fight poverty, unemployment and marginalisation. Regional development policies are influenced by the concept of "growth poles". Support for innovative businessmen is focused on strategic sectors with explicit or implicit consequences for urban growth, middle-class emergence, orientation towards simple nuclear families and family planning, and the separation of state and religion.

- Their best choices were related to the diffusion of western institutional models into less developed countries. Also, "demographic transition" patterns behave according to the modernisation theoreticians and fertility has decreased following the declining pace of mortality. The popularisation of terms like "big push", "demonstration effect", "sectoral strategies", "dualism", "traditional and modern sectors" or also "post-modernism" may be traced back to this paradigm. The South East Asian countries, the so-called "tigers", follow this trend, perhaps giving more importance to savings rates, investments and education as innovation factors.

1. Position Before Renewable Energies

Their optimistic vision puts no limits on growth, and resources appear static or inert, just waiting for humans to generate wealth with them. That is why there is no vision of what "renewable energy" means for their suggestions, and why their vision fed "optimistic" decision-makers during the sixties. Any perception of the scarce availability of the natural resources needed for development, and the need to take care of these resources after being processed and turned to waste is non-existent and outside their mental framework. They resent the intervention of government in private development activities and generally discount assertions of the dangers attached to pollution and climate change. More extreme positions refuse to acknowledge any limitation to growth or any regulation or control of the exploitation of natural resources. Nonetheless, their position was more acceptable in the sixties, during the "optimistic" phase, than it is now.

A quick glance over the authors that represent this paradigm will show that universities in developed countries, particularly in the USA, are the most relevant proponents of these ideas, which to a great extent follow classic European authors. For example, Parsons, Rostow and Germani were directly or indirectly related to Harvard University; Lerner and Hagen were professors at the Massachussetts Institute of Technology (MIT). Fukuyama, probably the most recent of the modernisation theoreticians, is a graduate of Harvard and a professor at John Hopkins University.

B. The Paradigm of Dependency and the Club of Rome

Even if these two schools of thought are independent in their sources and evolution, they both emerged publicly during the stage that we are calling "pessimistic", at the end of the sixties and in the seventies. The "Dependency Theory" predicted that the stiffness of international stratification would prevent qualitative steps that could allow developing countries to raise their status to that of a developed country. The position of "dependent" countries was necessary so other countries could keep their dominance over them. This road did not lead to development.[20]

The Club of Rome announced that if the current trend of exploiting natural resources and waste management continued, Earth had only a survival capacity of 100 years. This statement meant that in the year 2070, life as we know it would disappear from the face of the Earth.[21] Even though there were differences between these two approaches, on certain points they held common ground: they were born contemporarily and they both announced that if current conditions continue, there would no longer be any possibility of development as we know it on this planet. This is the reason we decided to name them as precedents and influences on the "pessimistic" phase. They both have the following characteristics:

- The intellectual source and influence for both theories differs. The "Dependency Theory" has its foothold in the 19th and early 20th centuries through Marx, Engels and Lenin. Nevertheless, similarities can be found more recently in authors like Wallerstein, Arrighi and Frank.[22] From some perspectives, their ideas seem to have something in common with List and Sombart and the German School, because of their emphasis on national autonomy – although here the approach is more national than global. Antecedents of the Club of Rome can be tracked down to the 19th century, with Thomas Malthus and his work on population growth, including his famous statement about the opposition between the arithmetic growth of food and the geometric increase of population. This would inevitably lead to conflicts and wars as partial-control events, given that the projection would eventually become catastrophic – depending on the scale on which it occurs.
- The Dependency Theory, on the other hand, prioritises its focus on the structural and economic tension between countries in the centre and those on the "periphery", which produces internal and external alliances in order to perpetuate the situation of exploitation. The Club of Rome suggested a structural tension between development and environment, in which the first is pursued in such a way as to disqualify the second. As for the "dependency", the increasing income of transnational vehicles (direct investment, commerce, international cooperation and loans with the consequent external debt) produces

answers that contradict autonomy – they can, however, lead to a sort of precarious autonomy or to a step towards the semi-periphery, a kind of "in-between" state.

- Changes in the analysis of the environment, on the other hand, emphasise the "limits of growth" in such a way that pollution is reduced as the disappearance of non-renewable resources is acknowledged, "habitat" and population become balanced priorities, and industrialisation is moderated, favouring inputs with regulations and governmental control of exploitation activities. Both believe in stabilising action through government, which is rejected by modernisation theoreticians and neoliberals.
- Critics have voiced weaknesses in the conclusions of both theories. The "dependency theory" is, after all, one more dichotomy that is added to the traditional-modern or community society, or organic-mechanic solidarity classical scheme. It is now transformed into a new dichotomy: dependency-liberation (or autonomy). It is regrettable that there are only a few links to specific policies capable of transforming reality. On the other hand, two questions appear: is it inter-dependency or dependency? Why is it applied only to capitalists and not to socialists, when it is stated that there is no development without autonomy?[23] In its more recent World-Systems version, the generalisation is so wide that no link is allowed to specific policies in precise periods. With regard to this new approach, critics state that there is too much emphasis on globalisation without much empirical foundation. After all, the nation-state remains the most important thing, and remains the prevailing system.
- The paradigm of the Club of Rome has been criticised because it leaves some important variables out of its analysis. The evidence of economists, in particular, suggests that findings have not matched its predictions. Non-renewable resources, for example, can be replaced; prices can manipulate the use of resources if they start to be scarce; and alternative environment-friendly technologies can spring up, just as now with so-called "hybrid" cars. The arguments, their critics say, are more aimed at raising awareness, more ideological-political and less scientific, despite its objective appearance.[24] There is little empirical foundation to support the fears generated. For example, it is not the first time that the Earth's temperature has risen: the same thing happened in the Middle Ages, when there was no industrial society and therefore no consequent carbon dioxide (CO_2) emissions. Their proposed actions tend to immobilise economic development and call for more governmental intervention. This is one reason critics have suggested that, in view of socialism's failure elsewhere, discredited "reds" have now become "green" militants.
- In any case it is imperative to show the genuine insights of each theory. The Dependency Theory predicted the current dominance of multinational organi-

sations and international capitalist institutions. The Third World has never been so dependent on external capital flows and international monetary organisations. In its version of World Systems, the abandonment of the socialist system by many countries, led by the Soviet Union, was rightly forecasted. This version consistently predicted that the capitalist system had a worldly nature, and that those regimes were a version of the same just to gain influence. The theory is also pioneering in its forecasting of modern "globalisation", especially in its financial aspects. Its approach to the "underdevelopment of development" (Gunder Frank) is applicable in some areas, for example the north of Chile, where the development of saltpetre has been frustrated, or northern El Salvador, Eastern Guatemala and Western Honduras, where similar situations have arisen with indigo. These areas were engaged in development, which, due to external factors, turned into underdevelopment.

- Despite the critics, the influence of this work can be detected in governmental policies. Dependency Theory encourages a tendency towards economic autarchy with an economic, global, sectoral and vertical planning reinforcement. Also, it worsens tensions between its economic growth model and its social policies, frequently favouring permanent employment guarantees, high custom protectionist rates to defend national products, diversification of crops and exports, avoiding single buyers or importers in international trade. It favours the nationalisation of strategic industries with projections towards other productive areas and food self-sufficiency, stimulating economic flows control. Currently, it has shown a survival capacity in Latin America with the appearance of populist tendencies in countries like Nicaragua, Venezuela, Ecuador and Bolivia.
- With regard to the environmental version, ministries and policies aiming to preserve ecosystems and essential processes have been created in many countries. Action has been taken to preserve biological diversity and environmental conservation. It preconises environmental impact assessments as a prerequisite for authorisation to exploit natural resources. It protects transparency in the handling of information on this subject, should any action affect citizens. Four basic policies can be found: 1. Behaviour control by prices, specifically charging an amount for polluting fluids emission; 2. Pollution rights sale through permission for undesirable, yet controlled amounts; 3. Mandatory and control regulations; and 4. Promotion of renewable energies, although this is still subject to the ups and downs in oil prices.

1. The Role of Renewable Energy

We found these theories were most influential during the seventies and the first half of the eighties. In fact, during this period they raised awareness about the environment, and the issues that have more influence today were first mentioned during this period. Dependency Theory was more a critical series of clauses that challenged the defenders of modernisation theories within the context of the "Cold War". For example, Rostow saw his work as a "Non-Communist Manifesto". Also, Cardoso, probably its most outstanding author, abandoned the Dependency premises when he himself reached a position of political responsibility as President of Brazil. In some ways, energy resources were seen as part of the imperialist domination strategy by Dependency Theory, but a solid position on the use of these resources was lacking. Nevertheless, we should not forget that Brazil's emphasis on ethanol and renewable energy did not change during this period; indeed if anything it was reinforced.[25]

The Club of Rome, on the other hand, was completely focused on the subject and launched a dramatic call to the rest of the world and their intellectual decision-makers. In time, this position started to get more sophisticated and currently exhibits a greater appreciation of the social sciences. For example, there is more focus on economics, sociology and the political sciences in their arguments and proposals. There is consensus about the need to incorporate the environment variable as inherent to the development study processes. For instance, national accounts should incorporate the cost of environmental deterioration, and "environmental impact assessment" studies should be the rule and not the exception in all investment decisions, particularly when support is committed to sensitive areas such as the mining industry or the exploitation of natural reserves.

The Dependence Theory is, to a great extent, a response to the polarisation that occurred elsewhere in the seventies. Curiously enough, in contrast to past tendencies, this outlook has been developed by Latin American authors, attached to Latin American universities and international organisations (e.g. the Economic Commission for Latin America, ECLA, UN and FLACSO). Previously it was usually the case that centres of learning in developed countries were the producers of ideas, and developing countries consumed these ideas. This trend was reversed when this theory was accepted by many scholars from the USA and Europe. Nevertheless, this approach did not contemplate energy alternatives to the prevailing *status quo*. The academics' question was how to attain development, something that, in their opinion, was not possible under the influence of modernisation theories.

A more direct answer came from the Club of Rome. A group of scientists and politicians, including Nobel Prize winners, formed a coalition that gave the re-

sponsibility of researching the human impact on natural resources to the System Dynamics Laboratory of the Massachusetts Institute of Technology (MIT), under the direction of Dennis L. Meadows. Using quantitative methods and statistical models, the report already quoted – on the limits of growth – has proved to be one of the most influential works in more than three generations. The Club of Rome has now become a non-governmental organisation, and still influences public policies today.

C. The Paradigm of Sustainable Development

Gradually, the concept of "sustainability" has been introduced into development discussions since the second half of the 1980s. In 1972, during the Stockholm Conference, the United Nations Environment Programme (UNEP) was created. The change in the scale of environmental problems influences this approach, which turns this issue into a universal problem. Issues like rainfall volume and the influence of climate change have become a point of reference. This outcome might influence agricultural productivity, reduce or stop ocean flows, affect biodiversity or disseminate contagious diseases. The Greenhouse Effect (CO_2), the diffusion of toxic substances, soil acidification and acid rain and the reduction of the ozone layer (CFC) are part of these concerns. These threats contribute to the exaggeration of current perceptions regarding the security of energy supply, unequal access to energy across great swathes of population, and the problem of investment in an infrastructure capable of supplying energy.[26]

This recent evolution, however, anticipated the conclusion that, besides the theoretical positions that were being proclaimed, it was possible to reconcile development with environmental concerns. Development objectives need to be combined with the responsibility to leave a planet suitable to be inhabited and managed by future generations. As time passes, this paradigm becomes more coherent and, since it is proclaimed as a synthesis of past developments, its statements have become more fluid, demanding a kind of centrist position in a discourse where the paradigms of the last twenty years, reviewed above, still survive, and often appear extreme, sometimes polarised in this context.

At this point in the development story, in 1987, the meeting of the World Commission on Environment and Development was held, at which the Brundtland Commission provided an appropriate and timely definition of the concept of "sustainable development" after four years of work. This was defined as follows:

> "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development; and institutional change are all in harmony

> and enhance both current and future potential to meet human needs and aspirations; all this means that human development must be done in ways compatible with ecological processes that support the work of the biosphere."[27]

Since then, publications on the concept of sustainability have multiplied and the subject of "renewable energy" has been discussed, including the problems that arise with its detection, exploitation and use. Probably the most systematic and concrete proposal has been made by the International Energy Agency (IEA).[28] A scenario called "450" is being built. The IEA's plan, expressed in the World Energy Outlook 2009 and entitled "the 450 Scenario", proposes an ambitious timetable of action which sets limits to the long-term concentration of greenhouse gases in the atmosphere of 450 parts per million of carbon-dioxide equivalent. This goal will also limit the global temperature rise to around 2°C above pre-industrial levels by the year 2030, which is considered sustainable. In fact, this goal becomes a paramount objective capable of keeping climate change under control.

- The 450 Scenario depicts a situation where, by 2030, energy efficiency will have induced over half the reduction in greenhouse gas emissions. In addition, by that time, low-carbon energy technologies will generate 60% of global electricity: renewable technologies (37%); nuclear (18%) and energy plants fitted with carbon capture and storage technology (5%). Finally, by 2030 car sales will have shifted dramatically, with hybrids, plug-in hybrids, and electric vehicles reaching nearly 60% of car sales (currently these vehicles represent 1% of car sales). The IEA estimates that this alternative will need an incremental investment of $10.5 trillion by 2030.

Nevertheless, research carried out by IEA and presented in the 2009 report, plus work done by the JELARE Project and other sources, shows many obstacles to reaching these objectives beyond advisable reductions, which puts us in a position to solve problems regarding this paradigm.[29] A synthesis of these problems is related to institutional aspects, which are the following:

- With just a few exceptions, efforts to promote renewable energies started in 2007, which is when oil prices reached unprecedented levels. Therefore, any assessment would have to be made in longer periods and even then, if the tendency continues, according to the IEA's primary demand projections fossil fuels would represent 80% of energy consumed and oil would reach 34% of the total world demand by 2030.
- The above would happen if current energy-use patterns continue. However, if a deliberate effort is made to reduce the use of fossil fuels and strive to attain sustainable climate change goals, extraordinary engagement would be required.

- A quick introduction of these efforts depends to a great extent on governmental support and a sound regulatory framework, given that renewable energy production costs are generally not competitive when compared with other sources of conventional energy at present.[30] This sole fact creates barriers that would take years to overcome. One industrialist participating in a focus group at the Universidad Galileo of Guatemala said:

  "The administration does not do its job right… it only expresses its will to promote renewable energies and never does, it's all talk" … "the law is not done well and definitely favours fossil fuels" … "I have a project of changing the regulation … the law covers all, but the regulation only covers free projects. If you want a solar heater in your house, you have to pay taxes; however, big projects do have free access" … "The government is good if it lets us work, if it does not block us … for example, making revolving funds available for medium and small projects that, in general, do not have access to the big sources like the IADB or BCIE (the Inter-American Development Bank and the Central American Bank for Economic Integration) …"[31]

- The gap between environment and renewable energy tends to be permanent and volatile. In many cases and countries, there is often confrontation between industrialists and investors making "clean energy" proposals, and the cause of environmental preservation, the latter sponsored by activists and national as well as international non-profit and non-governmental organisations. Often they involve the communities where natural resources are found, especially around hydroelectric power stations. Activists encourage communities, and investment is paralysed. Frequently the situation ends in violence. In general, ministries in charge of energy and mines and environment ministries work in different directions.
- In general, the common pattern is a lack of internal and external coordination within each sector (including the university sector), plus poor relations between the universities, the public and private sectors. This situation leads to the following relevant consequences, among others:
  - Little acceptance of external help.
  - Absence of programmes or volatility of existing programmes where coordination is needed between the government, the private sector, NGOs and universities.
  - Little synergy among current programmes inside universities and in different higher education institutions. This deficit might be extended to the private, public sector and non-governmental organisations.
  - Low investment in renewable energies due to lack of legal certainty and an unattractive environment for entrepreneurs.
  - Difference in the number of qualified personnel on these subjects and the demand of the market.

– With the exception of the more developed countries, renewable energy research and the consequent generation of patents, amongst other things, are virtually absent in the rest of the world. This leads to higher-cost technology for developing countries.

1. Renewable Energy and Universities

The postulates presented in the 450 Scenario focus on new sources of energy as an inherent part of its work. To further analyse the institutional problems that have been identified, universities become key in putting its agenda forward in this scenario. Its impact could be manifold. The universities might be able to play a role that could be described as follows:[32]

- There is a permanent demand for qualified personnel in renewable energy. The great majority of findings in the countries involved in the JELARE Project showed that people working in the renewable energy market, besides expressing the difficulty of finding qualified people to employ, considered that higher education institutions were failing to understand what they really needed.
- There is a need for a parallel transformation in the approach of faculties that have traditionally had renewable energy as part of their curriculum, such as in engineering and chemistry. It is necessary to broaden the spectrum of education in disciplines such as information technology, public policy, management, and social sciences such as economics, sociology, political sciences among others.
- To a great extent, the pursuit and acceleration of goals within the 450 Scenario depend on technological innovations emerging from research activities, which is virtually impossible in developing countries. Thus, emphasis on research is warranted.
- At the same time, it is necessary to identify and establish technology transfer mechanisms such as on-line educational programmes that allow the rapid dissemination of knowledge and, at the same time, might encourage research and innovations within the academic activity.
- Another aspect, which is not fully understood but that could mean a bridge between different sectors and increase coordination and synergy between different programmes, would be agreements and joint programmes between universities, certain private sector corporations, non-governmental organisations and institutions in the public sector, where theses and students' contributions could help. This would work together with internships that allow stu-

dents a gradual transition into the labour market and the operational objectives of these institutions.

- A less familiar aspect is the possibility of outsourcing specific tasks where there is a paralysis due to tensions between environmental and clean energy paradigms. That would mean appealing to universities as entities with pre-existing research capacities and conflict resolution techniques, in order to mediate between the opposing parties and thus provide an objective view on the existing differences that could accelerate investments in controversial areas.

IV. Conclusions and Recommendations

1. Fifty years of development have been analysed and three phases have been distinguished during the period 1960-2010.
2. Three visible phases have been detected: the "optimistic" (1960s-1970s), the "pessimistic" (1970s-mid-1980s), and the "realistic" (mid-1980s until the present day). Each of them represents an approximate period of time around the dates we have outlined.
3. The correlation between high oil prices and the promotion of renewable energy seems present at all times, but this trend currently appears permanent, given the uncertainty regarding the shortage of oil and the globalisation of environmental problems as a consequence of the use of fossil fuels.
4. The context of each development phase has also corresponded to the main policies that have attempted to counter both developmental and environmental problems. In the optimistic phase, the spirit of the time looked forward to future abundance, and believed in the persistent application of technology and human effort over time. In the pessimistic phase, the mantra was "putting the house in order", "setting growth boundaries, making "adjustments", reducing consumption, etc. Today, there is a call to pragmatism and the synthesis of previous phases. In this context the concept of "sustainable development" is thrown up, which aims to make striving for a better standard of living compatible with the preservation of the environment.
5. Nevertheless, the operative carriers of these ideas still encourage the arguments that made some paradigms valid during the periods examined.
6. Considering this situation, it is enlightening to go through the main paradigms that informed the different phases, which have been updated over time through different, yet related, intellectual developments.

7. Connections have been established between the promoters of modernisation theories and, more recently, the neoliberals, with an optimistic view of the development process that had its primacy in the sixties.
8. Some similarities have been pointed out between the theories that proclaimed the harmful effects of dependency in the development of countries on the periphery, and global theories that emphasised the extent to which we all depend on global vehicles of change (multinationals, investment, markets, etc.).
9. The above theory is reinforced by the work of the Club of Rome, which carried out, for the first time, a systematic analysis of the harmful consequences of all development efforts for the planet, from an environmental perspective.
10. Also, a correlation between these ideas and the intellectual "climate" of the time was noted: the modernisers belonged more to the optimistic stage, the "dependentists" and the followers of the Club of Rome to the pessimistic stage, and the sustainable development followers to the current realistic stage.
11. The most pragmatic aspect of the work that currently influences the "Sustainable Development" paradigm aims to broaden consensus around efforts to reconcile development and environment, which prevents many parties from participating with "maximalist" visions corresponding more to prior development stages when certain paradigms prevailed largely unchallenged.
12. The most advanced programme for the future has been presented by the International Energy Agency in Scenario 450, whose theoretical reflections and suggested alternatives put the "burden of the proof" on global decision-makers.
13. The difficulties of establishing institutional agreements to facilitate the 450 Scenario proposals were therefore advanced, highlighting that this programme is a sustainable and realistic goal whilst being attainable by the year 2030.
14. Inter-institutional coordination, both internal and external, is needed, aiming in the former instance to achieve inherent synergies of programmes and actions towards different programmes inside institutions, and, in the latter, to maximise relations between the private, public and non-governmental sectors, in order to attain the targets specified in Scenario 450.
15. Inter-institutional inefficiency weakens national capacity for securing external financing, especially important for research, to multiply and disseminate these objectives.
16. The role of universities in this context should place the emphasis on research, curriculum modernisation to encompass multidisciplinary approaches, identification of technology transfer mechanisms and internship agreements, and research contributions, considering close collaborations with other entities in the private, public and non-governmental sectors.
17. In this agenda it is worthwhile to note the need for convergence between "clean energies" promoters and those who proclaim their zeal for environ-

mental preservation in order to reach compromises in sustainable development-oriented concepts.

18. Irreconcilable positions are often assumed by these two groups, often paralysing pertinent action towards these goals, which must be made compatible with each other.
19. Universities have been shown here as institutions that, far from aligning themselves with any polarised attitude, might contribute to the enhancement of the 450 Scenario with their technical and scientific capabilities, providing the objective judgements and agreements that could allow advances in this field, through extensive research and suggestions for conflict resolution.

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[31] See Cyrano Ruiz Cabarrús, Nelson Amaro, Robert Guzmán, Lourdes Socarrás y Ericka Tuquer (2009). Estudio sobre Energía Renovable y Mercado Laboral entre Universidades, Sector Público y Privado en Guatemala (Guatemala: JELARE-Universidad Galileo) 77.

[32] Many of these ideas, can be found in the Supervision Technical Team of the JELARE-Guatemala Project, Strategic Plan 2010-2012. Renewable Energy Capacity Building, Universidad Galileo, 2009.

Acronyms

BCIE	Banco Centroamericano de Integración Económica (Central American Bank for Economic Integration)
IADB	Inter American Development Bank
CO_2	Carbon Dioxide
COCODES	Consejos Comunitarios de Desarrollo (Community Development Councils)
USA	United States of America

IEA	International Energy Agency
IVA	Impuesto al Valor Agregado (Value Added Tax)
JELARE	Joint European-Latin American Universities Renewable Energy Project
ILO	International Labour Organization
WHO	World Health Organization
NGO	Non-Governmental Organization
UN	United Nations Organization
OPEC	Organization of Petroleum Exporting Countries
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development

"E-Learning: Sustainability, Environment and Renewable Energy in Latin America, a Multinational Training Pilot Module at Postgraduate Level"

N. Amaro, F. Buch, and J.B. Salgueirinho Osório de Andrade Guerra[1]

Abstract

A pilot module will be implemented by four of the JELARE project's partners: Bolivia, Brazil, Guatemala and Latvia. Research was carried out by them in their own countries, where a scarcity of multidisciplinary programmes was detected at postgraduate level. The common characteristic was the need to modernize the curriculum by introducing a more diverse outlook. The definitive student profile should aim to provide skills useful to the private and public, non-governmental and academic sectors. The pensum will consist of 13 courses, identified on the basis of an analysis of the competencies needed, contained within three modules: sustainability, environment and renewable energy (with courses such as Sociology of Development and Global Challenges, Environment and Sustainable Development, Energy Matrix Planning, Energy Economics, Policies and Regulations on Energy and Environment as well as courses mainly devoted to renewable energy and its management). The postgraduate programme is to be implemented over four trimesters. Online teaching methods will be introduced high-

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lighting self-study, cooperation and tutorial guidelines. The scheme will launch activities by 1 July 2011; the institutional framework for implementation is currently being worked out among all interested partners.

I. Background

In the international context, there has been a boost in the relevance of environmental and energy topics in academia, business and international governance. Rising awareness of the consequences of climate change, the green energy revolution and the increasing scarcity of water – the interrelation between economic growth and the environment and the challenge of achieving sustainable development that allows industrialised nations to follow their growth path and developing nations to reduce poverty and catch up with the developed world have gained priority in the political agendas of most countries of the world community and have contributed to the creation of a booming technology market.

Within the JELARE project, surveys were conducted on renewable energy and the labour market among universities as well as in firms from both the public and private sectors. The conclusions suggested a need to generate teaching and learning pilot modules to strengthen and deepen the academic programmes of the partner universities. One of the decisions that achieved a complete consensus was the implementation of an Integral Postgraduate Degree in Renewable Energies (RE), in an e-learning mode.

All of the partner countries involved in this pilot module 1, as it is called, namely Bolivia, Brazil, Guatemala and Latvia, are endowed with abundant natural resources and biodiversity, especially renewable energy sources. For this reason, it is necessary to reinforce these sectors with specialized human resources. However, a deficit has been detected in the areas of energy and environment in all of the said countries. If this gap between renewable energy and environment can be closed, it will allow capacities within the private sector to be developed and strengthen research activities in higher education institutions as well as in governmental bodies and international cooperation agencies. These countries lack consolidated educational programmes within this field at postgraduate level. There is also an information gap due to the lack of higher education institutions exclusively dedicated to research, and of programmes able to produce the required knowledge for the definition of public policies, development strategies, technological adaptations and innovations within this field.

In general, many efforts related to the environment appear in local media as confrontations between communities and hydropower plant projects. Frequently, these investments are regarded as environmental pollutants without their charac-

ter as alternative or "clean energies" which are a response to the use of fossil fuels being analysed in depth. On the other hand, after examining the course requirements of the study programmes comprising environmental, sustainability, climate change and renewable energy topics, among others, in different universities, it can be seen that there is a need to generate multidisciplinary content to overcome the gaps between what is purely environmental and what is strictly mentioned as the electricity or energy sector. In general, RE tends to be concentrated in engineering programmes and frequently is not associated with environmental studies or other disciplines of human sciences or information technologies.

These observations may be extended to general multidisciplinary knowledge such as demographics, economics and social, political and cultural sciences as they relate to development processes which tend to influence the energy mix. Also, the influence of public policies and the role of the public sector as a coordinator between the private, public and civil society activities in the promotion of alternative energies tend to be forgotten.

The joint postgraduate programme entitled "Sustainability, Environment and Renewable Energy", which will be offered in cooperation between the said partner countries of the JELARE project, may contribute to the formation of qualified human resources in an area which is relevant for socio-economic development, ranging from the reduction of dependence on imported liquid fossil fuels to the fostering of rural development, the creation of local jobs and the diversification of the economy. The programme will also build human resource capacities with the ability to generate knowledge and information at the academic level which will eventually improve political decision-making processes as well as technological adaptations and innovations.

As the postgraduate programme is executed successfully in its first version, there is a possibility of extending it to a two-year Masters degree programme that might combine specific competencies within disciplines such as economics, business administration, sociology, law and engineering, with the inclusion of the environmental topic as a transversal concern of all modules. These educational efforts are designed in line with the model of education aimed at the development of competencies, i.e. skills that go beyond the acquisition of subject-related knowledge. The required competencies can be divided into three main areas: projects/economics, technology/engineering and environment/sustainable development. It is this multidisciplinary approach that will enable graduates to meet the challenges of the public sector as well as the demand of NGOs, international cooperation and private businesses.

A. What might a professional who has graduated from the Postgraduate degree in Sustainability, Environment and Renewable Energy asked to perform?

These observations aim to highlight the following dimensions demanded by the market:

Research

The graduate professional should have acquired capacities in research and analysis.

Diagnostics in the area of energy generation

Therefore, the postgraduate degree should have as its objective the formation of professionals specialized in resource evaluation, design, technical and economic viability analysis, optimization and management of renewable energy technologies.

Environmental impact evaluation

Graduates should understand and have knowledge of how to apply the fundamentals of environmental impact evaluation, the general concepts that rule this field, and the management of its main tools.

Preparation and evaluation of public policies

The professional should be familiar with the main concepts relating to public policies, the relationship with the legal system of the host countries and the global covenants regarding environmental protection. Furthermore, professionals should be aware of the fiscal and legal instruments and other norms applied in the partner countries and elsewhere.

Preparation of strategic plans in the area of renewable energy

This is an ability to generate strategic plans that should encompass the integral aspects of the renewable energy subject, where socio-economic, environmental, legal and other disciplines are more than necessary elements for an adequate planning that comprises elements such as energy planning, energy economics, environment, etc., aiming to achieve a desirable energy matrix within a determined period of time.

Project management, including renewable energy firms

Such a scheme should provide professionals interested in the postgraduate degree with the managerial tools that will enable them to administer, plan, organize and manage projects and firms in the preparatory phase and pre-investment and investment process. Graduates should be capable of conducting programmes, projects, plans, etc. in the energy sector in an integral manner.

Updates regarding new technologies

Any professional should have information regarding new technologies that are being continually developed within the sector of the utilization of natural resources for energy, including those involving information technologies that give access to this knowledge.

II. Characteristics and profile

This section will examine the added value of the degree, the general and specific objectives, the professional profile and the requirements needed to access the degree as well as the procedures for enrolling in the career.

A. Added value of the degree

This degree aims to be an exchange of experiences in the field of e-learning between the following universities: UNISUL in Brazil; the Bolivian Catholic University; Galileo University of Guatemala; and Rezekne University of Latvia, which are part of the consortium of universities making up the Joint European-Latin American Universities Renewable Energy Project, JELARE, mostly financed by the European Union under the Alfa III Programme. Such exchanges, based on the experiences and developed technology of these higher education institutions, can strengthen the online teaching already being practised in many of these universities and extend this expertise to those that do not have this technology.

Likewise, an educational component will be generated that will provide knowledge to the people interested in it in an e-learning mode. Participants will be exposed to the curriculum of a postgraduate degree in Sustainability, Environment and Renewable Energy which might subsequently be extended to a Masters programme. On the other hand, there will be an analysis of the factors that influence the supply and demand of energy within industrial societies and developing countries which are eager to produce and consume energy that respects the require-

ments of a sound environment. The integral and interdisciplinary characteristics of the postgraduate degree may allow professionals to obtain a wider knowledge which will enable them to move between several positions in various fields of work. This characteristic makes the described degree additionally attractive.

B. General objective

The general objective of the e-learning pilot module entitled "Postgraduate Degree in Sustainability, Environment and Renewable Energy" is to increase the capabilities of the partner universities in virtual education and to implement a postgraduate multidisciplinary study programme relating to the environment and renewable energies in these universities and with other bodies and individuals which eventually might become partners.

C. Specific objectives

1. Develop a postgraduate programme within the field of sustainable development, environment and renewable energy.
2. Develop virtual educational material of high quality related to these topics.
3. Implement this postgraduate programme in "Sustainability, Environment and Renewable Energy" jointly in an e-learning mode among the Bolivian Catholic University, the Universidade do Sul de Santa Catarina of Brazil, the Galileo University of Guatemala and the Rezekne University of Latvia.
4. Conduct an evaluation of the first version of the postgraduate programme in order to improve it, ensure its sustainability and possibly extend it to a Masters degree programme.

D. Expected outcomes

At the end of the implementation of the proposal, the following products are expected:

1. A joint study programme consisting of an international postgraduate degree in "Sustainability, Environment and Renewable Energy", implemented by Universidade do Sul de Santa Catarina in Brazil, the Bolivian Catholic University and the Galileo University of Guatemala with some support from the Rezekne University.
2. 13 online study courses developed.

3. At least 30 graduates at postgraduate level, ten for each of the participating universities.

E. Professional profile and requirements to enrol

A graduate of the postgraduate degree in "Sustainability, Environment and Renewable Energy" will be capable of developing projects that support and promote renewable energy sources and the environment in an integral manner. Graduates will also be capable of generating policies that could contribute to the protection of natural resources. These capabilities will be assets that will enable graduates to perform as a consultant for agencies concerned with the environment, natural resources, renewable energy, climate change, etc. In this sense, the following characteristics are required from students in order for them to truly take advantage of the programme:

- Understanding of the need for a rational and efficient use of all types of energy, fossil or renewable, in order to achieve a more sustainable human development.
- Awareness of the current and future situation of the energy market in a regional and international context and the consequences of the limits, conflicts and impacts of fossil energy for the environment and sustainable development.
- Establishment of a clear perspective of the possibilities and economic viability of renewable energies, linking the multidisciplinary knowledge (social, instrumental and technological) acquired to the environment and sustainable development.
- Detection of environmental threats at national and global levels.
- The basic knowledge to develop a professional activity within the field of the installation, operation, management and maintenance of renewable energy systems, with a basic training regarding the different technologies of these systems.
- Knowledge of the normative and regulatory framework of renewable energy and the environment.
- Awareness of the criteria of energy savings and efficiency enabling him/her, in the exercise of his/her professional duties, to bring about the improvement of the existing energy installations based on the use of fossil fuels.
- Knowledge of the sources of information required remains up-to-date on a permanent and continuous basis as well as of specific tools for searching the relevant information. The objective is to create capabilities for professionals so that they can find the best responses to the problems they face, adapted to their own reality.

- Openness to integrate energy efficiency, renewable energies and energy management, from the perspective of sustainability and an environmental approach in an integral way that is capable of incorporating other fields of knowledge.

The aforementioned criteria will be the topic of a personalized interview with each student and will serve as a guide to identify the student's potential and capability to develop the competencies that the student wishes to learn.

F. Requirements for enrolment (regarding the enrolment procedures)

1. Graduation at a Bachelors or licenciatura's level in related areas.
2. Knowledge and experience in the study areas.
3. Willingness to learn about the required e-learning tools through a personalized interview.
4. Interest in the e-learning mode.

III. Generation of the curriculum based on the required competencies

The required competencies to enrol in the postgraduate degree in "Sustainability, Environment and Renewable Energy" are the result of a study conducted by many countries belonging to the European Union. This study was later extended to Latin American countries in order to fine-tune the competencies and confirm them.[2] The definition of competencies established for Europe and subsequently applied to Latin America, is as follows:

> "Competencies represent a dynamic combination of knowledge, comprehension, capabilities and abilities. To foster them is the purpose of educational programmes. Competencies are formed in several course units and are evaluated at different stages. They can be divided according to whether they are specific to an area of knowledge (field of study) or generic (common to different courses)."[3]

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2 See Pablo Beneitone (Argentina), César Esqueitoni (Ecuador), Julia González (Spain), Maida Marty Maletá (Cuba), Gabriela Sufi (Argentina) y Robert Wagenaar (The Netherlands), Eds., Reflections and perspectives of Higher Education in Latin America, Final report Tuning-América Latina, 2004-2007 (Spain: Universidad de Deusto-Universidad de Groeningen, Project financed by the Alfa Programme of the European Commission, 2007. This research reached (182) universities of almost all of Latin America. Its objective as stated by its text "is to identify shared competencies, that can be generated at any title and that are considered important for certain social groups." (page 15). Available in: http://tuning.unideusto.org/tuningal/index.php?option=content&task=view&id=217&Itemid=246.

3 Tuning Report, p. 37.

A test identifying competencies was undertaken by multiple careers in this extended study that included the majority of the universities of Latin America. The following have been selected for the postgraduate degree, considering only those that were closer to our goals:

A. Generic competencies

1. Capacity for abstraction, analysis and synthesis
2. Social responsibility and commitment to citizenship
3. Ability to use of information and communication technologies
4. Commitment to look after the environment
5. Commitment to socio-cultural environment

B. Specific competencies

6. Improve and innovate administrative processes using information and communication technologies for the processes which allow for its formulation and optimization.
7. Awareness of the responsibilities regarding the environment and the values of urban and architectural heritage as well as the capability of knowing and applying research methods to resolve creatively the demands of the human habitat, in different scales and complexities.
8. Ethical commitment regarding the discipline, manifesting a social consciousness of solidarity and justice, and respect for the environment.
9. Provide advice regarding the use of natural resources in the formulation of development policies, norms, plans and programmes, interacting in interdisciplinary and trans-disciplinary areas.
10. Development of professional activity within a framework of responsibility, legality, security and sustainability, when planning, executing, managing and supervising projects and services focused on the knowledge, use and exploitation of renewable natural resources.
11. Suggest solutions that might contribute to sustainable development, planning, research design and execution with regard to the topic in question.

In Appendix 2, there is a list of 11 characteristics that summarize the concept of competencies. They served the purpose of selecting the courses to be offered. The concept of competencies will be continuously used to ensure the excellence of the programme while the initial selected matrix of course might be improved over time. They will also serve as guidelines for evaluating the implementation of the postgraduate degree as a whole in order to determine later, in 2011, whether the pilot module might be extended to a Masters programme for the

second year. Appendix 2 shows how the selected courses are adapted to the competencies concept.

The courses which finally form part of the postgraduate degree were previously assessed in each university with regard to the extent that these competencies had an impact on the courses selected. The installed capacity of each institution for delivering this learning product was also considered. The next step was a meeting of all participating universities to choose those courses from the total sample which would finally form part of the online postgraduate degree. To this end, a meeting was held in Florianópolis, Brazil. The outcome of this meeting was a definition of the programme's objectives, the selection of the courses, a division of labour among universities and a schedule of activities up to 1 July 2011, the date of the programme's launch.

IV. Description of the curriculum

After the selection of the courses that will form part of the degree, a description of each of them is warranted:

A. Sociology of Development and Global Challenges

This course anticipates that the student has had or will be open to an Introduction to Sociology or elements of General Sociology. The content will examine the perception of change by the classic authors, ranging from Comte, Spencer and Marx to Weber. It will venture into more recent middle-range theories that emerged during the Sixties with Lerner, Hagen, McLelland and others. It will examine the reflections of the Club of Rome and the Dependency Theories characteristic of the 70s and 80s. Afterwards, it will explain the theories of the global system and finish with the post-modernists and considerations regarding sustainable development which have been discussed since the 1990s and still are today. These lessons will establish links with the topics of renewable energies.

Global challenges will be illustrated with continuous references to the development patterns predominant in the least developed countries. In particular, the emergence of Asian countries in that context will be analysed and compared with the situation of Latin American countries. The focus will be on the role of foreign aid, commerce, foreign direct investment and their impact on social structures and political developments. Within this framework, the dimensions of demography, gender and environment and recent challenges will be integrated. Subsequently, the main theoretical and conceptual problems with regard to the sustainable de-

velopment paradigm will be highlighted and their interrelation with renewable energy will be made evident.

B. Environment and Sustainable Development

Introduction to the Environment: The concept of environment, the systems of planet Earth, ecosystems, historic evolution of environmental concerns, global environment, the relationship between human beings and the environment. *Introduction to Sustainable Development:* The concept of sustainable development, the history of sustainable development from Rio de Janeiro to Cochabamba, Agenda 21, the Kyoto Protocol, environmental indicators, sustainable development in developed countries and developing countries. *Sustainable Development, Natural Resources and the Environment:* Poverty and environmental degradation, international trade, growth and environment, loss of biodiversity, climate change, mitigation and adaptation, the role of natural resources. *Sustainable Development and Renewable Energies*: The effect of energy consumption and environmental problems, renewable energies and sustainable development, future prospects for sustainable development.

C. Planning of the Energy Matrix

Introduction to energy policy. Knowing the bases for the development of policies that reinforce the sustainability of the energy sector. Elements for the design of an energy policy. Analysis of energy and integration policies. Energy planning, integrated plans for resources. Investment planning. Energy sustainability with emphasis on energy efficiency policies, the obstacles for the efficient use of energy. *Energy Planning Tool.* Introduction to the tools used for energy planning. Comparative analysis of energy planning models, case studies. Selection of energy planning tools. Use of programming models and detailed operation of *LEAP* (long-range energy alternatives planning system) whose main objective is to bring integrated and reliable support for the development of integrated energy planning studies.

D. Environmental Management and Impact Evaluation

Environmental management. The distribution of competencies within legislation, planning and management of the environment at national and international level. Basic knowledge regarding environmental legislation. Characteristics and princi-

ples. Management instruments. Environmental management in the company. Environmental responsibility. Administrative, civil and legal solutions. Access to environmental information. Current legal framework for the environment. ISO norms. Design of an environmental management system. The environmental audit as an instrument for the company's environmental management. Ecological marketing as an instrument of environmental management. Competence and awareness raising. Communication. Operational control. Preparation and emergency control. Verification. Follow-up and measurement. Evaluation of legal compliance. Non-conformity. Corrective and preventive action. Internal audit. Revision by the direction. Ecological differences of processes and products.

With regard to impact evaluation: Conceptual, legal and institutional framework. Introduction to environmental impact studies. Technical document of project analysis. Identification and evaluation of environmental impacts. Preliminary environmental impact study. Partial environmental impact study. Baseline study or socio-environmental diagnostics. Strategic environmental evaluation. Preventive and corrective measures. Surveillance plan and environmental control. Management procedures of environmental impact studies.

E. Policies and Regulations for Energy and the Environment

Principles of Energy Policy: Analysis of the different principles and criteria of energy policy, environmental objectives within energy policy, scenario analysis and energy policies. *Energy Intensity:* Analysis of energy intensity by sectors that demand it. *Regulation of Tariffs and Prices within Energy Markets:* Bases of regulation, roles of regulatory organisms, structural analysis of tariffs and prices. *Principles of Environmental Policy:* Analysis of the different principles and criteria of environmental policy, scenario analysis of environmental policies. *Instruments of Environmental Policy:* Moral persuasion, environmental norms, economic instruments (taxes, subsidies, emission trading).

F. Energy and Environmental Economics

Introduction to Energy Economics: General aspects of energy, types of energies, energy units. *Energy Trade and Environmental Services:* Conventional and renewable energy commercialization methods, forms of concentration and fixation of prices in different conventional and renewable energy markets, carbon markets and of environmental services. *Analysis of Energy Supply and Demand:* Technical structure of conventional and renewable energy sectors, their economic structure, peculiarities and environmental incidence. Sectors with inten-

sive energy demands, energy costs according to products and processes, environmental impact of energy demand. *Introduction to Environmental Economics:* Externalities, public goods, the Coase theorem, optimum level of pollution. *Economic Valuation of Environmental Quality:* The value of the environment, environmental valuation methods. *Economic Development and Environmental Quality:* Economic growth models that incorporate energy and environmental restrictions, the energy-environment relationship.

G. 4.7 Solar Energy

Fundamentals of Solar Energy: Role of solar energy within the international energy mix. Energy savings and efficiency. Description of the sources of thermal and photovoltaic solar energy and the design, maintenance and operation of installations. Advantages and disadvantages. Environmental, social and economic impact of the technologies. *Solar Thermal Energy:* Solar collection system. The storage and accumulation sub-system. Performance. Description and design of solar thermal installations. Evaluation of the environmental impact of solar thermal energy. Perspectives and development of the legislation regarding solar thermal energy. *Photovoltaic Energy:* Applications of photovoltaic energy. Fundamentals of photovoltaic energy. Components of photovoltaic installation. Design and calculation of installations. Exploitation and maintenance of an installation. Environmental impact of photovoltaic energy.

H. Hydropower

Role of hydropower within the international energy mix. Energy savings and efficiency. Description and design of installations, maintenance and operation. Advantages and disadvantages. Environmental, social and economic impact. The role of hydroelectric energy. Electro-mechanic systems. Environmental impact. Legal and normative aspects. Criteria for the development of hydro power projects. Tools for preparing projects of hydropower stations. Feasibility study sample.

I. Biomass Energy

Role of biomass in the international energy mix. Energy savings and efficiency. Description of the different sources of biomass and the design, maintenance and operation of their installations. Advantages and disadvantages. Environmental, social and economic impact of each of them. Biomass classification. Biomass sources. Physical and chemical characteristics which define a fuel. Processes of conversion

of biomass into energy. Energy applications of biomass. Advantages and disadvantages of the use of biomass. Legislation, incentives and fiscal measures.

J. Wind Energy

Role of wind energy within renewable energies in the international energy mix. Energy savings and efficiency. Description of the different sources of renewable energies and the design, maintenance and exploitation of their installations. Advantages and disadvantages. Environmental, social and economic impact of each of them. Historical evaluation of the use of wind. Meteorological bases for wind energy. Use of wind. The wind potential. Wind generator: composition and function. The wind park. Off-grid wind power installations. Offshore wind energy. Wind energy and the environment. Stages of the development and management of a wind energy project. Legislation.

K. Energy Efficiency

Basic definitions: Energy sources: Primary/secondary. Renewable/non-renewable, *Energy systems:* Primary energy, production and conversion of sources in energy carriers, transport and distribution of energy carriers, net energy. Final use of the energy. Useful energy, supplied service, received benefit. *Flow of energy:* Unit operation, global energy performance. *Energy efficiency: General bases and measurements of EE:* Good operational practices; closed circuit of recycling; substitution of energies; modification and optimization of processes; product reformulation; technological improvement/substitution; *The Energy Diagnostic:* Unitary operations; process flows; focus on diagnostic; balance of energy; thermal energy; electric energy; identification of losses/inefficiencies; consumptions, emissions and specific costs; critical unitary operations; energy efficiency measures; technical – economic evaluation; *Efficiency of the productive processes. Application examples:* Considerations of EE within the energy mix; EE in a system of electricity distribution; Measures of EE in productive systems.

L. Renewable Energy Project Management

The students will be prepared as managers of renewable energy projects and firms, developing capabilities of conceptualizing and managing this type of projects within the current economic scenario. Economical and legal aspects which allow for the development of own business initiatives within the sector. Organi-

zation, planning and coordination of projects of diverse complexity through an ample study of experiences, techniques, tools and methodologies related to project management. Viability and design. Business opportunities, profitability and opportunities for financing. Legal procedures, permits and operations. Analysis of suppliers and products. Management tools: Integrated management of projects. Project planning management. Project cost management. Product quality management and energy efficiency. Project resource management. Project human resource management. Project communications management. Project risk management. Project acquisitions management. Analysis for the reduction of emissions.

V. Modules by Courses

The courses described above pertain to three areas which might become modules. Table 1 shows the relationship that helped to give the postgraduate programme its title.

Table 1: Postgraduate Modules

SUSTAINABILITY	ENVIRONMENT	RENEWABLE ENERGIES
1 Sociology of Development and Global Challenges	4 Environmental Management and Impact Evaluation	7 Solar Energy
2 Environment and Sustainable Development	5 Policies and Regulations for Energy and the Environment	8 Hydro power
3 Planning of the Energy Mix	6 Energy and Environmental Economics	9 Biomass
		10 Wind Energy
		11 Energy Efficiency and Renewable Energy
		12 Renewable Energy Project Management
13 Research Methodology		

Table 2 shows the distribution of courses by trimesters.

Table 2: Distribution of courses by module and trimesters

Modules and courses	Trimesters				
	1st	2nd	3rd	4th	Total courses
Sustainability	Sociology of Development and Global Challenges			Planning of the Energy Mix	**2**
	Environment and Sustainable Development				**1**
Environment		Environmental Management and Impact Evaluation	Policies and Regulations for Energy and the Environment		**3**
		Energy and Environmental Economics			
Energy	Biomass	Solar Energy	Hydropower	Wind Energy	**4**
			Energy Efficiency and Renewable Energy	Renewable Energy Project Management	**2**
Common Area		Research Methodology	Preparation of the final thesis	Preparation of the final thesis	**1**
Total	**3**	**4**	**3**	**3**	**13**

VI. Institutional Framework

The postgraduate degree is a joint effort and as such the work is shared. The following courses will be prepared by the partner universities according to Table 3 in the corresponding countries (the numbering corresponds to the course description stated above).

Table 3: Responsibilities of the participating partners as regards courses

Bolivia	2) + 5) + 6)	3) + 11) will be shared between Guatemala and Bolivia. See note)
Guatemala	1) + 4) + 12)	
Brazil	7) + 8) + 10) + 13)	
Latvia	9)	

Note: Courses 3 and 11 will be shared, with the main responsibility for 3 falling on Guatemala with the support of Bolivia and for 11 on Bolivia with the support of Guatemala.

VII. Periods and Academic Credits

Duration: 1 year divided into 4 trimesters of ten weeks each.
Frequency:
Hours per week:
Distribution of academic credits:

The academic credit is a measurement of the students' working hours to achieve learning goals and allows studies completed in several institutions to be compared and approved. It is also an efficient instrument for achieving of curricular flexibility and planning of the study programme. The credits as well as the assigned hours are detailed in Chart 4.

Table 4: Calendar per trimester and academic credits

Trimesters	Course	Academic Hours	Credits
I – Trimester Jul–Aug–Sept	Sociology of Development and Global Challenges	30	2
	Environment and Sustainable Development	30	2
	Biomass	30	2
II – Trimester Oct–Nov– Dec	Environmental Management and Impact Evaluation	30	2
	Energy and Environmental Economics	30	2
	Solar Energy	30	2
	Research Methods	30	2
III – Trimester Jan–Feb–Mar	Policies and Regulations for Energy and the Environment	30	2
	Hydropower	30	2
	Energy Efficiency and Renewable Energy	30	2
IV – Trimester Apr–May–Jun	Planning of the Energy Mix	30	2
	Wind Energy	30	2
	Renewable Energy Project Management	30	2
	Thesis at the end of the prior courses	0	0
TOTAL		390	26

Note: For lectures, reports and other curricular activities, an average of four additional hours is estimated for each course, which will require each country to provide 442 hours of teaching and personal study in a uniform manner.

VIII. Academic Methodology

A. Research

This component will be present in the application of the online methodology, it being expected that once the curriculum is finished, the student will complete his/her effort with a paper in an area of his/her interest. Likewise, all of the professors will place emphasis on the application of research methodologies, which in themselves are an important part of the curriculum content.

B. Participation: Essential Characteristics of the Programme

The expert or specialist who works as a professor on the course is primarily a facilitator of student's self-study and research activity; the main feature of this profile is not face-to-face presentation. Nevertheless, the online mode must also allow for interaction between students and professors and among students.

C. The Balance Between Theory and Practice

The direction of the degree will ensure that training and activities maintain a balance between theory and practice. Managerial aspects, practical knowledge and systematic actions in real-life situations will be part of the courses.

D. Evaluation

In line with the dynamic, participative and balanced character that the programme wishes to establish, the evaluation exercise will emphasize academic excellence, comprehension, efficiency, feasibility and viability.

IX. E-Learning Methodology

The aforementioned principles must be seen in light of the e-learning mode that will be applied.

A. Learning Mode

The postgraduate degree will be offered entirely in e-learning mode due to two primary motivations:

1. Being able to have a group of excellent experts with multidisciplinary approaches focused on a very specialized topic like renewable energy will encourage the construction of different scenarios.
2. Allowing a wider application, taking into account that, with e-learning, several countries of the world can be reached, allowing for interaction between different peoples and cultures.

The courses offered within the e-learning mode are educational concepts that integrate technological, didactic and administrative support to extend and transfer the contents of any subject of knowledge. These types of courses are based on the application of new Information and Communication Technologies (ICTs) which allow for learning without limitations as to place, time, occupation or age of the students.

B. Principles of the Mode

- Self-study: The course materials as well as the greater part of the practical activities are designed in a way that enables the student to advance at his/her own pace and assess his/her progress at any time.
- Teamwork: The student will not learn in an isolated manner; part of the knowledge will be constructed by the group thanks to the interaction with the rest of the course members.
- Tutorial support: The tutor will guide the group in the learning process, conducting an individual follow-up of their participation, efforts and results during the course.

C. Characteristics of the Model

- The students' participation is not passive – they become the protagonists of the teaching/learning process.
- It is important how the students learn and not how the teachers teach.
- The tutor plays a guiding role.
- It is not suited to all educational levels because it requires much discipline, maturity and commitment.
- The learning must guide the student towards reality.

- More responsibility from the student in the learning process.
- Flexibility in time management. Nevertheless, this does not imply an absence of deadlines for learning activities.

D. Structure, Characteristics and Resources

All courses have been developed by professionals in the subject. Each of the syllabuses is adapted to practice in a way which ensures that they end up being interesting, enjoyable and practical. The common structure is as follows: introduction, contents, activities (case studies), annexes, bibliography and glossary.

Furthermore, each topic comes in the section on Activities with questions that allow the student to fine-tune his/her knowledge and measure his/her rhythm of study. There are also exercises that allow the student's skills to be evaluated. The team of tutors, specialists in the different areas of study, will pay attention to students through email, forums or chats and, if necessary, with a synchronous meeting (video conference).

Learning activities

- Forums, homework, exercises, fieldwork, research, case study
  Use of resources
- Videos, presentations, audio, animations

Student rate per e-moderators

- One for 20 or 30 students

Platform

There are services provided, such as:
- *Communication services:* discussion groups, forums or news, chat or interactive talks, email, working groups, etc.
- *Evaluation services:* tests, questionnaires, auto evaluations, report cards, monitoring tools, wiki.
- *Information services:* glossaries, dictionaries, etc.

Online academic periods

There is an estimate of an average of 390 tutorial hours plus other 52 hours dedicated to reading, studying, discussions, reports and essay elaboration, field

works, elaboration and drafting of a final research project. The total will be 442 hours.

E. A Suggestion for the Marketing Design

An important aspect to consider is the promotion of the postgraduate degree, and even more relevant is contemplating the prospective student. Therefore it is recommended that an induction document be created with the objective of showing the most relevant characteristics of the model. Here are some of the considerations that must be taken into account:

Table of contents

a) Welcome
b) About us
c) How to study?
d) What do you need?
e) Learning about the e-learning mode:
   e.1 Why?
   e.2 Where?
   e.3 When?
   e.4 How?
f) Advantages

F. Start of the Postgraduate Course

Regarding implementation, it is anticipated that the degree of development of the various virtual platforms in the participating universities will provide the opportunity for a technology transfer from one university to another on the base of a collaboration agreement. The agreement will include training, graphic design and instructional methodologies, etc.

Another critical point is the development of content based on a uniform model as well as their virtualization, which will be conducted by experts in the area. It is also necessary to fine-tune the costs and make them uniform for each responsible entity in the universities. A gross estimate of the programme's cost makes it a strategic period for return on investment in the design of contents, instructional advice, and the assembly of content incorporated into virtualization and graphic design (multimedia). The investment during the first year will be the greatest; it will become lower over time with use. This calls for the need to con-

template a feasibility study of the administrative and financial management of this modality.[4]

In the meeting at Florianopolis on 4–8 July 2010, a schedule of activities was developed for implementation in a joint and individual manner. The date for launching of the postgraduate degree in Sustainability, Environment and Renewable Energy was set at 1 July 2011.

Conclusions

This exercise has been reported to highlight the importance of a thorough preparatory approach whenever a new career modality is attempted. Several lessons could be learned from this outcome that might be useful for other similar experiences:

1. Usually, online e-learning is centralized. This characteristic makes planning and implementation easier, which has its advantages. Nevertheless, when this is done by a network of institutions, although introducing the complexities of coordination across institutions and countries, a division of labour among partners considerably reduces costs. On the other hand, strengths developed by different institution when put together, improve the quality of the courses and the overall design.
2. The international flavour that has been added to the design is an additional attraction for enrolment. The endorsement of universities from other countries is an aggregated value which enhances the promotion of e-learning arrangements.
3. Innovations in the content of the courses call for a multidisciplinary effort that breaks down the frontiers between different disciplines. This outcome is proof that this is possible and that collaboration between engineers, economists, environmentalists, social scientists and political scientists may produce a fruitful outcome.
4. The above description of an e-learning postgraduate programme on Sustainability, Environment and Renewable Energy could have followed different methodologies in order to put together a specific course of study. The simplest option is to assemble a collection of courses without questioning further objectives such as to what kind of competencies these courses belong or how will the labour market receive a graduate with such qualifications, or without

4 To give an example regarding the costs of the programme, a similar programme in the Galileo University of Guatemala, a Masters in Telecommunications, has an approximate total cost for the student of US$728.0 per quarter, including US$130.0 per enrollment, 3 payments per month of US$196.0 for all the courses corresponding to the quarter and US$10.0 dollars for electronic services and ID. Per annum it would be approximately US$2912.

considering a permanent evaluation of the suitability of those courses with regard to the competencies that the modality aims to enhance. The design presented here has made a frontal incursion on these quality avenues that should be a permanent challenge for any similar exercise in any career.

5. Another lesson might be inferred for the future with regard to the external cooperation enabled by the European Commission. Sometimes, such assistance lasts as long as funded project continues, without considering sustainability plans beyond the life of the project. In this case, the external assistance made mutual exchanges possible across countries and institutions for a limited period, but took into account the fact that the initial help would eventually place responsibility for the postgraduate programme's full implementation on the institutions' shoulders in each university and country. Therefore, sustainability is ensured beyond the life of the project.

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Appendix 1: Postgraduate examples in countries of Latin-America and the world

Mexico:

Masters in Environment and Renewable Energies, http://www.lumni.com.mx/articulos/index.php?consecutivo=526&se=54&ca=

Renewable Energies, http://maestria.emagister.com.mx/maestria_energias_renovables-cursos-797173.htm

Paraguay:

Masters in Energy for Sustainable Development, Renewable Energies and Energy Efficiency, http://estudios.universia.net/paraguay/estudio/uc-maestria-energia-desarrollo-sostenible-energia-renovables-eficiencia-energetica

Argentina:

Masters in Renewable Energies, http://www.universia.com.ar/contenidos/buscador_carreras/form_alf.php

The UNIVERSIA network has online programmes in the following countries of Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, México, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Dominican Republic , Uruguay and Venezuela.

Examples of postgraduate degrees in European countries:

In *Spain* the following online degrees are examples of what can be achieved due to the simplicity of implementing degrees in an e-learning mode.

Postgraduate Degree in Renewable Energies, http://www.emagister.com/master/master-energias-renovables-kwes-1697.htm

Postgraduate Degree in Renewable Energies, http://www.cursosypostgrados.com/programmeas/postgrado-en-energias-renovables-1856.htm

Postgraduate Degree in Renewable Energy Management and Development, http://www.tumaster.com/Postgrado-en-Gestion-y-Desarrollo-de-Energias-Renovables-mmasinfo18529.htm

Postgraduate Degree in Renewable Energies, http://www.mastersadistancia.com/master/postgrado-en-energias-renovables-1856.html

Solar Energy Study Centre Professional Distance Learning Courses, http://www.construmatica.com/formacion/tag/energias_renovables/6

Masters in Renewable Energies, http://postgrado.ceu.es/energias-renovables/

Masters in Environment and Renewable Energies, http://www.escuelademedioambiente.com/pdf/master-medio-ambiente-y-energias-renovables.pdf

Appendix 2: Competencies selected by courses (those competencies which are relevant to the contents that will be offered are marked with a cross)

Competencies		Courses			
		Sociology of development and global challenges	Environment and sustainable development	Planning of the energy mix	Environmental management and impact evaluation
1.	Capacity for abstraction, analysis and synthesis	X	X	X	
2.	Social responsibility and commitment to citizenship	X	X		X
3.	Ability to use of information and communication technologies			X	X
4.	Commitment to looking after the environment		X		X
5.	Commitment to socio-cultural environment	X			X
6.	Improve and innovate administrative processes using information and communication technologies for the process which allow for its formulation and optimization			X	
7.	Awareness of responsibilities regarding the environment and the values of urban and architectural heritage as well as the capability of knowing and applying research methods to resolve creatively the demands of the human habitat, in different scales and complexities	X	X		X
8.	Ethical commitment regarding the discipline, manifesting social conscience of solidarity and justice, and respect for the environment	X	X	X	X
9.	Ethical commitment regarding the discipline, manifesting social conscience of solidarity and justice, and respect for the environment	X	X	X	X
10.	Ethical commitment regarding the discipline, manifesting social conscience of solidarity and justice, and respect for the environment		X	X	X
11.	Ethical commitment regarding the discipline, manifesting social conscience of solidarity and justice, and respect for the environment	X		X	X

Competencies		Courses			
		Energy and environ-mental policies and regulations	Energy and environ-mental economics	Solar energy	Hydro power
1.	Capacity for abstraction, analysis and synthesis	X			
2.	Social responsibility and commitment to citizenship		X		
3.	Ability to use of information and communication technologies		X	X	X
4.	Commitment to looking after the environment	X			
5.	Commitment to socio-cultural environment	X			
6.	Improve and innovate administrative processes using information and communication technologies for the process which allow for its formulation and optimization	X	X	X	X
7.	Awareness of responsibilities regarding the environment and the values of urban and architectural heritage as well as the capability of knowing and applying research methods to resolve creatively the demands of the human habitat, in different scales and complexities	X			
8.	Ethical commitment regarding the discipline, manifesting social conscience of solidarity and justice, and respect for the environment	X	X		
9.	Provide advice regarding the use of natural resources in the formulation of development policies, norms, plans and programmes, interacting in interdisciplinary and trans-disciplinary areas	X	X	X	X
10.	Development of the professional activity within a framework of responsibility, legality, security and sustainability, planning, executing, managing and supervising projects and services focused in knowledge, exploitation and use of renewable natural resources	X	X	X	X
11.	Propose solutions which contribute to sustainable development, planning, designing and executing research in the topic	X	X	X	X

Competencies		Courses				
		Biomass	Wind energy	Energy efficiency and renewable energy	Re energy& project management	Research methodologies focused on sustainability, environ-ment and re
1.	Capacity for abstraction, analysis and synthesis				X	X
2.	Social responsibility and commitment to citizenship					
3.	Ability to use of information and communication technologies	X	X	X		
4.	Commitment to looking after the environment			X		
5.	Commitment to socio-cultural environment					
6.	Improve and innovate administrative processes using information and communication technologies for the process which allow for its formulation and optimization	X	X		X	X
7.	Awareness of responsibilities regarding the environment and the values of urban and architectural heritage as well as the capability of knowing and applying research methods to resolve creatively the demands of the human habitat, in different scales and complexities			X		X
8.	Ethical commitment regarding the discipline, manifesting social conscience of solidarity and justice, and respect for the environment					
9.	Provide advice regarding the use of natural resources in the formulation of development policies, norms, plans and programmes, interacting in interdisciplinary and transdisciplinary areas	X	X	X	X	X
10.	Development of the professional activity within a framework of responsibility, legality, security and sustainability, planning, executing, managing and supervising projects and services focused in knowledge, exploitation and use of renewable natural resources	X	X	X	X	X
11.	Propose solutions which contribute to sustainable development, planning, designing and executing research in the topic	X	X	X	X	X

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