

Walter Leal Filho / Julia Gottwald
(eds.)

Educational and Technological Approaches to Renewable Energy



PETER LANG

Internationaler Verlag der Wissenschaften

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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 CO₂ 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 (IEA), 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

Part A

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

Nelson Amaro¹

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 its 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 Massachusetts 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