Understanding the Road Towards the Current Dominant Non-Renewable Energy Use Based Economy: Using An Inversegram to Point Out a Step by Step Strategy Towards an Efficient Dominant Renewable Energy Use Based Economy.

https://doi.org/10.5281/zenodo.15894835

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Abstract

There seems to be a plan to keep the non-renewable energy based economy going, which includes making it environmentally friendly. And governments, small and big, developed or underdeveloped, appear to have made this the official government policy. Economic development thinkers see renewable energy as a complement to non-renewable energy, not as a substitute, which explains why they do not see the need for a local and global transition plan for an orderly transition to a clean world as an urgent need.

Environmentalist, local and global, see current and worsening ecological issues as the key argument to call for a quick transition towards a full renewable energy based economy. They see renewable energy as a substitute to non-renewable energy, and therefore, they want to see all investment possible to be geared towards developing renewable energy producing technologies and to quickly phase out of all sources of non-renewable energy. So environmentalists see the need to transition from pollution based economies to clean economies as a pressing need.

So there we have the current main development discourse affecting the pace of the transition from dirty economies to clean economies, one group wanting the transition now, and the other group wishing it will never come. But the fact is that it is known that non-renewable resources will one day disappear and without appropriate levels of renewable energy production at hand then to make up for that expected short falls in total energy levels needed to run economies we may experience local and global economy black outs, with deep sustainability consequences.

And therefore, there is a need to look for ideas on how such a transition towards a cleaner world can be structured or contemplated or planned locally and globally to avoid extremely unsustainable economic, social, and environmental situations. One of the goals of this paper is to point out a possible step by step strategy that can be used to bring the current dominant non-renewable energy use model towards an efficient dominant renewable energy use based economy.

Introduction

a) The full pollution based economy

It can be said that maximizing production is the goal of the pure economic model with no or minimal social and environmental limits to growth. Here the view that more is better is essential. For example more and more growth is desirable as this leads to more and more jobs; and more jobs is poverty reducing development, an idea now being promoted by the World Bank (WB 2013). Even now a conference on growth for development is studying ways to define and implement the concept of "good growth" as inclusive, sustainable, transparent and transformative(CPA 2014). And since social and environmental externalities are not reflected in the pricing mechanism this development market model it is able to operate at the lowest price possible. The view above describes in general what has been called the more is better paradigm(Muñoz 2010).

The technological improvements in the discovery and production of non-renewable energy that have taken place have led not just to the ability to produce non-renewable energy at lower cost, but also to the creation of a wide renewable energy technology gap. A quick look at the publication "World Energy Outlook 2010 and renewables"(IEA 2010) gives a clear idea on the current superiority of non-renewable energy producing technologies over renewable ones. The renewable energy technology gaps and barriers to implementing renewable energy technologies are real. For example, those gaps and barriers are recognized and taken into account in looking forward towards a cleaner future in the UK Renewable Energy Road Map(DECC 2011)

When the social and environmental issues associated with pollution market based development could no longer be ignored the support for the economic growth only model started to decline. And now it is well accepted that development is more than just economic development(Soubbotina 2004).

b) The environmentally friendly pollution based economy

It can be said that the goal of the green economy is to minimize pollution, not a transition to a clean economy. None of the commitments reached in Rio +20 calls clearly for a speedy transition to a full clean economy(UNCSD 2012a). And this move from full pollution to less pollution is recognition by traditional economic thinkers that business as usual is no longer possible. And this thinking appears to be behind the endorsement of green economies in Rio + 20 "The future we want"(UNCSD 2012b). And now even country superpowers such as the United States and China have agreed on moving closer to a greener economy by setting targets to reduce CO2 emissions and by calling on other countries to do more too(Duggan 2014); and there is strong support now for having a climate change fund(Wintour 2014) to deal with climate change issues/risks.

Therefore, they see now the need to face environmental issues and the decarbonisation of the atmosphere head on, but within a dominant non-renewable energy fueled economy framework where now renewable sources of energy are more widely accepted but just as complements. It is known now that only about 20% of the global energy comes from renewable sources today(UN 2014) so that the ratio of non-renewable to renewable based energy supporting economies is 4 to 1. The need to find low carbon alternative to non-renewable resources is known now as the new argument in favor of renewables(Steenblik 2005). The use of renewable energy is expected to triple in size from 2008 to 2035 and government support is expected to more than triple(IEA 2010). And ideas on how to link carbonization and decarbonisation processes to environmentally friendly sustainable development and related programs have been recently put forward(Muñoz 2008).

However, for other environmentally concerned stakeholders who want to see clear steps taken right now towards a full renewable energy based economy and who wish to see the complete phase out of non-renewable sources of energy as quickly as possible, the current direction taken including at Rio +20 may not good enough or fast enough. For example, the pace and commitments agreed in Rio +20 do not appear to be consistent with the goal of envisioning a full renewable energy world by 2050 pointed out in the 2011 Energy Report of the World Wide Fund(WWW 2011) and with the vision that the Sierra Club has for transitioning the United States towards a cleaner world(TSC 2011). Moreover, concerns about the sincerity of some major economic players in taking the green flag led to the creation of a green wash detection kit(GPI 1997); and even events like the Rio +20 have been associated with global green washing(Hoedeman 2012).

Hence based on the above it can be said that supporters of the green economy want to deal with the environmental issues associated with economic development, but they do not want to go too far. For example, currently there seems to be only international support for taking a path to the renewable energy based economy through small, but scalable steps(UN 2014). Hence, the supporters of the green economy apparently think that time is on their side as they know that there is currently a renewable energy technology gap, and as long as this gap exists, they see a need for non-renewable energy for a long-time to come as prices are expected to continue to be attractive. And the supporters of the full clean economy such as the World Wide Fund(WWF 2011) appear to be wishing for a fast transition from dirty to clean markets and, on purpose or no, they appear to be ignoring or downplaying the fact that there is currently a renewable energy technology gap that would not allow us to produce the energy needed to meet the energy gap coming from phasing out all non-renewable sources today or quick or through banning their use; and therefore, doing this should be expected to lead to local and global economy black outs. For example, even the United States would not be able to meet its energy needs today or in the near future without non-renewable resources(Hoffman 2014); and therefore, its economy would collapse if non-renewable resource use was banned now or if they just suddenly disappear due to its current renewable energy technology gap.

We can see then that the lower the price of non-renewable energy the pace of the transition to a clean economy may be very slow as closing the renewable energy technology gap may not be then attractive to investors; and the higher the prices of non-renewable energy the transition pace should be expected to be faster as investors would capitalize on higher returns on their investments on renewable energy sources. It has been pointed out that lower oil prices may slow the development of renewable sources of energy(Miller 2014), and therefore, having local and global transition plans to ensure a smooth transition from dirty to clean economies is essential. In the case of the United States the renewable energy technology gap appears to persist as a renewable energy transition plan developed in 1978 by USA researchers and presented to the White House was never implemented(Hoffman 2014), which if it would have been implemented it would have placed the USA as the leader in clean development.

In other words, if suddenly there is no or not enough energy to run an economy, then this situation should be expected to lead to total or partial economy black outs or collapses. This is especially troubling as it is known that now we need energy to meet not just the energy needs of growing global populations, but also to meet the needs of geographic areas that have had no access to energy yet(UN 2014). See that economy black outs may be more difficult issues to deal with than for example financial collapses as without energy economies cannot be bailed out no matter how much money is available. It has been pointed out that if there is not enough

energy available to support our complex global market the system would collapse as energy supplies are the bedrock of the global economy(Korowicz 2011). Financial markets, on the other hand, can be bailed out with money as recent bail outs in America and Europe showed as there are no energy limitations blocking economic activity when they are being bailed out. Some countries are willing to embrace the development of renewables sources more than others at this moment. For example, the decision of Germany to moved away from nuclear energy has the goal of bringing the use of renewable energy in that country from 29% now to about 80% and therefore, about doubling its use by the year 2035(Mengewein 2014).

Therefore, if global warming issues are not enough reasons for green economy thinkers to speed up the transition from pollution economies to clean economies as it appears to be the case so far, then the threat of or the materialization of actual economy black outs should be expected to do the trick to induce a speedy transition to a clean economy as without energy there will be no markets to protect and governments would have to act quickly.

c) The need to take steps towards a dominant renewable energy based economy

So there we have the current main development discourse affecting the pace of the transition from dirty economies to clean economies, one group wanting the transition now, and the other group wishing it will never come. And attention is currently placed on managing the social, economic, and environmental risk associated with development(WB 2014), not on the social, economic, and environmental risks associated with a slow or fast transition from dirty to clean economies. Hence, the focus is on adapting to live in a harsh, but still oil based economy instead of planning for an orderly, local and global transition towards a clean world.

For example, see that none of the eight action areas championed in the 2014 United Nations Climate Summit is directly related to the development of a transition plan from non-renewable to renewables to ease climate change pressures; and even the energy action area of the summit sees as essential to develop renewable energy but just as complements of non-renewables, not as a needed permanent full substitute(UN 2014). But the fact is that it is known that non-renewable resources will one day disappear and without appropriate levels of renewable energy production at hand then to make up for that expected short falls in total energy levels needed to run economies efficiently we may experience local and global economy black outs, with deep sustainability consequences or risks. It has been pointed out that the best time to transition is before non-renewables resources reach the extreme part of the peak stage(Muñoz 2011).

And therefore, there is a need to look for ideas on how such a transition towards a cleaner world can be structured or contemplated or planned locally and globally to avoid extremely unsustainable economic, social, and environmental situations. One of the goals of this paper is to point out a possible step by step strategy that can be used to bring the current dominant non-renewable energy model towards an efficient dominant renewable energy based economy.

Goals

a) To point out analytically and graphically through an inversegram the road that has taken us to the current dominant non-renewable energy use based economy as well as to the creation of a wide renewable energy technology gap; b) To highlight analytically and graphically through an inversegram the road that can take us to a full renewable energy use based economy assuming that no renewable energy technology gap exist; c) To use the inversegram

above to indicate the structure of the efficient dominant renewable energy use based economy that we should envision given the fact that a renewable energy technology gap exists; and d) To use the inversegram above to show that if non-renewable resources disappear when there is a renewable energy technology gap we should expect to experience local and global economy black outs.

Methodology

First the terminology used in this paper is listed. Second, some relevant operational concepts are provided. Third, the structure of the general energy use inversegram is introduced to highlight the different energy use models that can be derived from it. Fourth, the inversegram describing the different development period on the road towards the current dominant non-renewable energy use based economy and their implications is presented. Fifth, the inversegram indicating the different steps within the strategy that can be taken to move the current economy towards a full renewable energy use based economy and its implications is given.

Sixth, the inversegram highlighting the conditions under which the goal of transitioning towards an efficient dominant renewable energy use based economy is the valid one, not the transition to a full renewable energy use based economy. Seventh, the inversegram stressing the requirements under which we should expect to see local and global economy black outs is shared. And finally, some relevant specific and general conclusions are listed.

Terminology

T = Total energy use N = Non-renewable energy use

R =Renewable energy use N*= Critical non-renewable energy use

E = Energy use ratio R*= Efficient renewable energy use

Operational concepts

i) Total energy use(T), the levels of non-renewable(N) and/or renewable(R) energy needed to run an economy efficiently, which can be stated as follows:

$T = N + R$

ii) Energy use ratio(E), the proportion of non-renewable(N) to renewable(R) energy use when running the economy efficiently, which can be indicated as shown below:

$E = N / R$

iii) Energy use ratio range, depending on how much non-renewable energy(N) and renewable energy(R) is used, the energy ratio varies from zero to infinite as shown below:

$0 \leq E \leq \infty$

iv) Total renewable energy use based economy, when only renewable energy(R) is used when running the economy efficiently. This means that N = 0 and R = 1; and therefore, the following is true:

$T = R = 1$ and $E = 0$

v) Total non-renewable energy use based economy, when only non-renewable energy(N) is used when running the economy efficiently. This means that N = 1 and R = 0; and therefore, the following is true:

$T = N = 1$ and $E = \infty$

vi) Dominant renewable energy used based economy, when most of the energy used to run the economy efficiently is renewable energy(R). This means that R > N so that $E \rightarrow 0$.

vii) Dominant non-renewable energy used based economy, when most of the energy used to run the economy efficiently is non-renewable energy(N). This means that N > R so that $E \rightarrow \infty$.

viii) Non-renewable energy technology edge, the clear current advantages that non-renewable energy technologies have over renewable ones in producing energy.

ix) Renewable energy technology gap, the technological improvements that need to take place in order to see renewable energy have the sole role or the dominant role in future clean markets.

x) Critical non-renewable assets, the non-renewable resources that will be either phased out last when moving to a pure renewable energy use based economy or that will be needed to make up for the total levels of energy needed to run an efficient dominant renewable energy based economy;
xi) Socially friendly renewable energy technology, one that does not compete with or crowds out social goals.

The general energy use inversegram

Figure 1 below displays the general energy use inversegram, where the total levels of non-renewable and/or renewable energy needed to run an economy efficiently can be appreciated. Here the box of the inversegram can be viewed as the whole body of that economy and the different types of energy that feeds it.

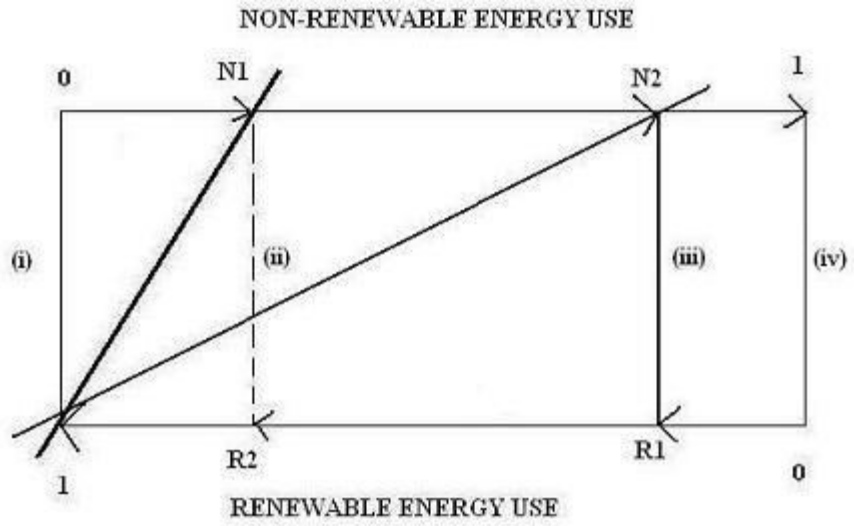

Figure 1 The energy use inversegram: a) renewable energy use can go from 0 to 1 as shown in bottom part; b) non-renewable energy use can go also from 0 to 1 as indicated in the top part; and c) economies can run in a mixed used system such as at point (ii) and at point (iii).

The following information can be extracted from the general inversegram above representing an efficiently run economy:

i) The full renewable energy use based economy

At point "i" in Figure 1 above there is a full renewable energy use based economy as only renewable energy is being used(R=1, N =0, and E =0).

ii) The full non-renewable energy use based economy

At point "iv" in Figure 1 above there is a full non-renewable energy use based economy as only non-renewable energy is being used(R=0, N =1, and E = ∞).

iii) The mixed use based economy

There are mixed uses at point "ii" and at point "iii" in Figure 1 above. At point "ii" there is a dominant renewable energy use based economy as more renewable energy than non-renewable energy is being used(R = R2 > N = N1 and E $\rightarrow$0). At point "iii" there is a dominant non-renewable energy use based economy as more non-renewable energy than renewable energy is being used(R = R1 < N = N2 and E $\rightarrow\infty$).

The road to the current dominant non-renewable energy use economy

To present the ideas in this paper it is assumed that the road to the current economy's situation can be divided into specific periods, as indicated in the inversegram in Figure 2 below:

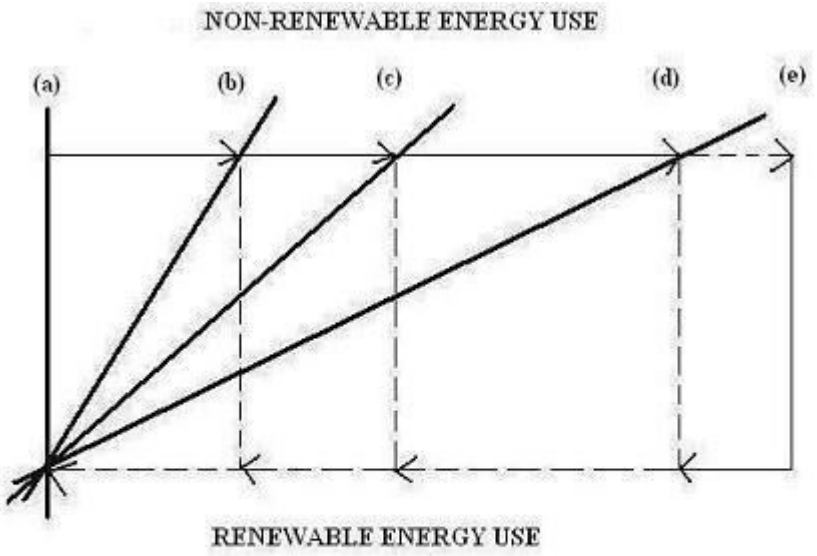

Figure 2 The road towards the non-renewable energy dominant economy: The subsistence period at point (a); the pre-industrial period at point (b); the industrial revolution period at point (c); and the modern period at point "d".

A summary of the main characteristics of each of the four periods in Figure 2 above is provided below:

i) The subsistence period

During the subsistence period in sedentary times to just before pre-industrial times, it can be said that all energy uses were based on the use of renewable sources of energy as shown at point "a" in Figure 2 above.

ii) The preindustrial period

The use of non-renewable energy as a complement of renewable sources of energy started in the pre-industrial period; and increased towards the coming of the industrial revolution as mechanization started to take hold as indicated in point "b" in Figure 2 above.

iii) The industrial revolution period

During the industrial revolution the use of non-renewable energy increased rapidly as man-made capital took a primary role in the process of local and regional industrialization. And as more and more man-made capital came into production as we approach globalization, more and more non-renewable energy was used, a situation represented at point "c" in Figure 2 above.

iv) The globalization period

It symbolizes the peak, the period where the use of non-renewable sources of energy has been maximized to be able to transform local and regional industrialization processes into global processes, which is indicated by point "d" in Figure 2 above.

Notice that Figure 2 above can also be used to point out that the current global economy model found at point "d" is not a full non-renewable energy use based model, but a dominant non-renewable energy use model(N>R) as some renewable energy is being used(R>0). This

situation is represented by showing the non-renewable energy use arrow at the top of the inversegram broken from point "d" and point "e" and by having a continuous renewable energy arrow from point "e" to point "d" at the bottom of the inversegram. In other words, since N<1 and R>0 at point "d" in Figure 2 above, then it indicates the structure of a dominant non-renewable energy use based economy(N > R and E $\rightarrow\infty$).

And finally we can use Figure 2 above to stress i) that the broken arrow at the bottom of the inversegram from point "d" to point "a" represents the current renewable energy technology gap; ii) that the continuous arrow at the top of the inversegram from point "a" to point "d" indicates the non-renewable energy technology edge; and iii) economies operating to the right of point "d" are dirtier and economies operating to the left of point "d" are cleaner.

In summary:

We went from no use of non-renewable sources of energy in the subsistence period to a situation of dominant non-renewable energy use in today's global development model, making social and environmental issues worse in the process.

The road towards a full renewable energy use economy

The inversegram in Figure 3 below describes the step by step strategy that can take us towards a full renewable energy use based model assuming that there are no renewable energy technology gaps:

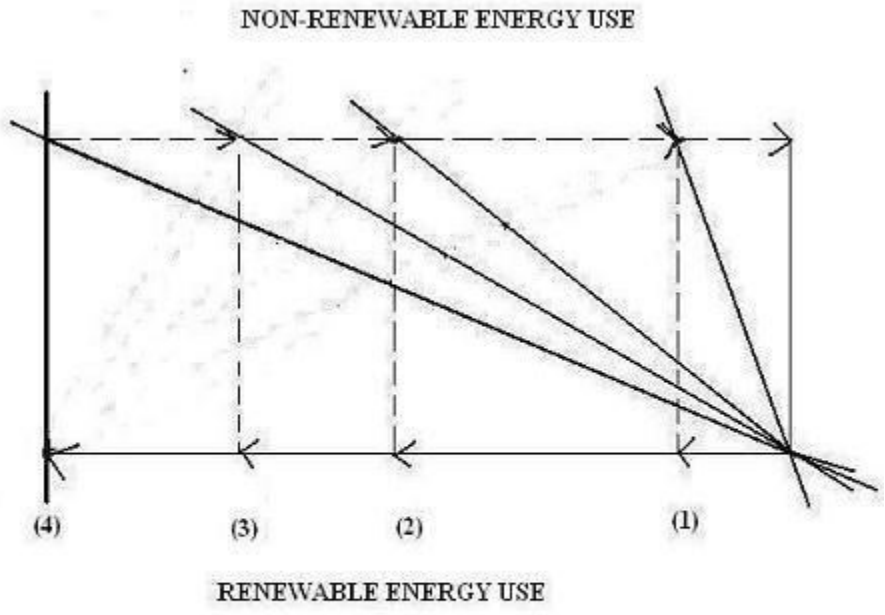

Figure 3 The road to the full renewable energy based economy: The short-term period at point (1); The medium term period at point (2); The long-term period at point (3); and the very long-term period at point (4).

Figure 3 above summarizes the strategy that begins with accepting that we live today in a dominant non-renewable energy use based economy as indicated by point "1' to a time when

there is only renewable energy fueling economies represented by point "4". Figure 3 depicts the need to think with the very long-term goal to ensure the smoother transition possible. Details of the step by step strategy goals are listed below:

i) Step 1: The short Term goals

Point "1" in Figure 3 above is the starting point towards the full renewable energy use based economy and the stage of the short term goals. We need to start by accepting the realities; we live in a dominant non-renewable energy use based economy today. And therefore, in the short term we need to advocate strongly for a more efficient mixed system locally and globally.

A system with truly binding, verifiable, and long-term regulatory frameworks to minimize the negative consequences of non-renewable energy use and aimed at maximizing the positive space for increase efficiencies and expansion of existing renewable energy producing technologies, especially those that are socially friendly and that can be replicated at different scales of production in places with similar renewable source endowments.

ii) Step 2: The medium Term goals

At point "2" in Figure 3 above we have the medium term point, where we need to advocate for eliminating first some of the most polluting sources of non-renewable energy as well as to promote the most efficient use of non-renewable energy sources still in use. This together with investing in the more efficient use of the existing renewable energy technologies at that moment and their expansion as well as investing in bringing into production new socially friendly sources of renewable energy with easy to replicate technologies.

iii) Step 3: The long Term goals

At point "3" in Figure 3 above there is the long-term stage, where we need to advocate for the elimination of non-critical sources of non-renewable energy and to continue to seek the most efficient use of critical sources of non-renewable energy still in use. At the same time, we need to continue to promote the efficient use and expansion of existing sources of renewable energy and technologies at that time as well as to continue investing in the introduction of newer socially friendly and replicable renewable energy technologies.

iv) Step 4: The Very Long Term goal

At point "4" in Figure 3 above we have the very long-term scenario, where we need to advocate for the elimination of all sources of non-renewable energy and the embracing of the full renewable energy use based economy.

Notice in the inversegram in Figure 3 above that there is no renewable energy technological gap as indicated by continues renewable energy line at the bottom of the inversegram from point "1" to point "4"; and therefore, any reduction in non-renewable energy production can be matched by an increase in renewable energy production keeping that way the total levels of energy needed to run the economy efficiently always available. As a result of this, there can not be here economic black outs as at all times the total levels of energy needed to run the economy efficiently are available; and therefore, the full renewable energy model is a fully efficient, economy black out free model.

Also we can see in Figure 3 above that the road towards the full renewable energy use based economy begings at point "1", where renewable energy use starts as a complement to non-

renewable energy use; and ends at point “4”, where renewable energy use is a full substitute of non-renewable energy use.

In summary:

Under the assumption that there is no renewable energy technology gap, then the goal of seeking a transition towards a full renewable energy use based economy is a valid one.

The efficient dominant renewable energy use based economy

Hence, only when renewable energy technology can meet all energy needs to run an economy efficiently; and therefore, only when there is no renewable energy technology gap, there can be a pure renewable energy based economy as indicated in point 4 in Figure 3 above. But it is a fact that there is today a renewable energy technology gap, which most likely will persist past the long term period at point “3” as shown in Figure 4 below.

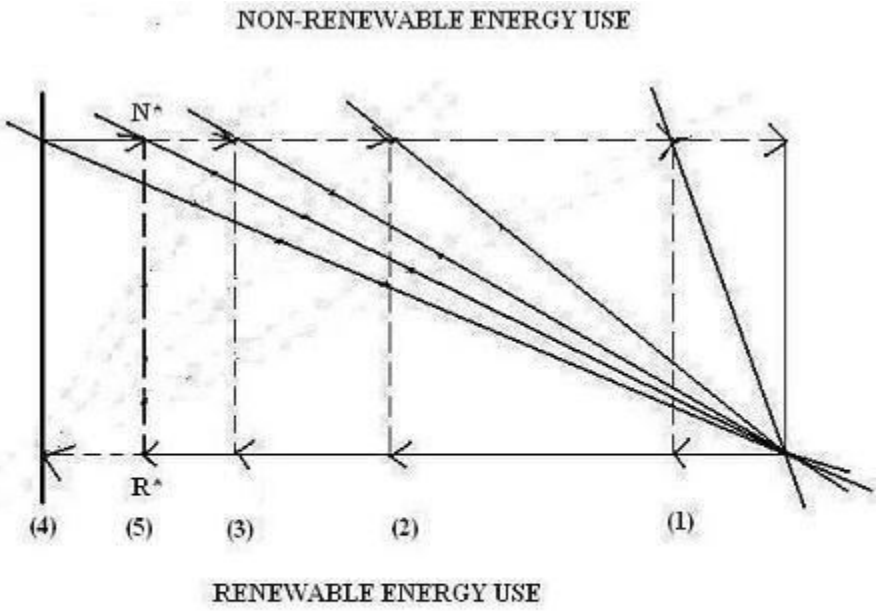

Figure 4 The efficient renewable energy dominant economy: It is an economy where levels of non-renewable energy use are reduced to minimal or critical levels and levels of renewable energy use are maximize as the renewable energy techology or capacity to meet all energy needs is not yet available.

In other words, we can see in Figure 4 above that if there is a renewable energy technology gap as indicated by the broken arrow to the left of R* at the bottom of the inversegram, then there is a need to use critical levels of non-renewable energy to keep the economy running efficiently as indicated by the continues arrow to the left of N* at the top of the inversegram. And this leads to an efficient dominant renewable energy use based economy found at point “5” in Figure 4 above, where we maximize the use of renewable energy to point R* and we minimize the use of non-renewable energy at point N* and keeping that way the economy running efficiently.

Finally, we can use point "5" in the inversegram in Figure 4 above to highlight the following: i) that to the left of R* the renewable energy use line is broken indicating the existence of a renewable energy technological gap; ii) that to the left of N* the non-renewable energy line is a continuous line indicating that critical non-renewable sources of energy are being used; iii) that since the mixture of renewable and non-renewable energy needed to keep the economy running efficiently is always available, then there is no room for economy black outs within this dominant renewable energy use based model; and iv) that economies operating to the right of point "5" are dirtier and economies operating to the left of point "5" are cleaner.

In summary:

In the presence of renewable energy technology gap, the goal of reaching a full renewable energy use based model is no longer a valid one as there would be a need to use some critical levels of non-renewable energy to meet total energy needs; and therefore the valid goal then becomes to seek a dominant renewable energy use based economy. If conditions are ripe and the renewable energy technology gap can be closed, then market forces alone will lead the dominant renewable energy use based economy towards a full renewable energy use based one.

The case of economic black outs

When there is a renewable energy technology gap at the same time that non-renewable sources of energy are no longer available or suddenly disappear, then we should expect to see economy black outs as indicated in Figure 5 below.

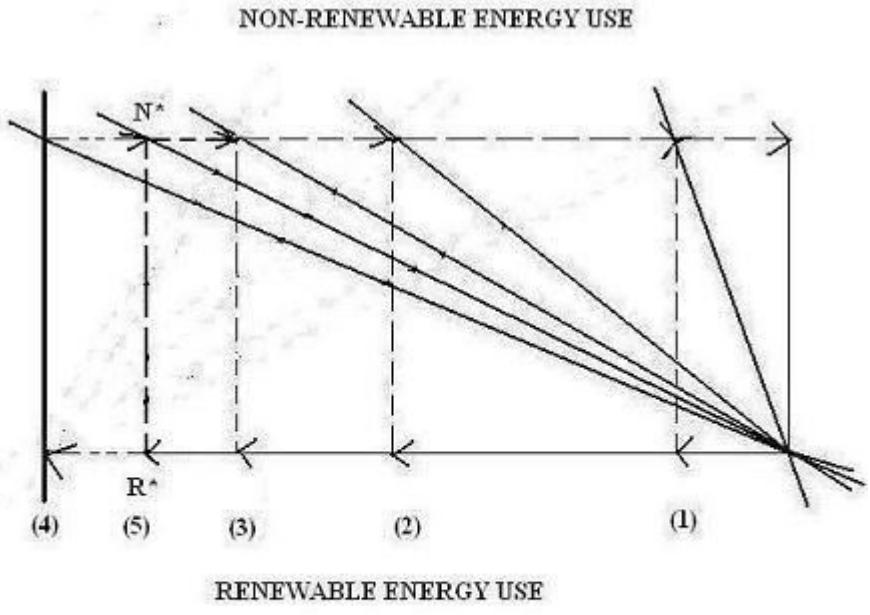

Figure 5 Economic black outs, total or partial, are events that happens when non-renewable energy resources run out at a point where the renewable energy technology available at that moment can not make up for the loss of non-renewable energy sources and keep the economy or parts of it running.

In other words, we can see in Figure 5 above that if there is a renewable energy technology gap as indicated by the broken arrow to the left of R* at the bottom of the inversegram; and there are neither critical levels of non-renewable energy sources to be used as indicated by the broken arrow to the left of N* at the top of the inversegram, then there will be not enough energy to keep economies running efficiently. And this energy gap should be expected to lead to local and global economy black outs, with deep economic, social, and environmental consequences.

Therefore, we can stress the following based on point "5" in Figure 5 above: i) that to the left of R* the arrow is broken showing a renewable energy technology gap; ii) that to the left of N* the arrow is also broken indicating that non-renewable energy sources are exhausted; iii) that under these conditions, we should expect to experience local and global economy black outs, with huge sustainability consequences; and iv) that economies operating to the right of point "5" have a wider renewable energy technology gap; and therefore, when non-renewable sources of energy disappear, they should be expected to experience more severe economy black outs.

In summary:

When there are no non-renewable sources of energy available and there are renewable energy technology gaps, then we have the necessary and sufficient conditions to expect local and global economic black outs. The wider the renewable energy technology gap when non-renewable resources disappear is, the more severe the economy black outs should be expected to be. And these economy black outs may provide the motivation to green development thinkers to transition fast towards a truly clean economy; a motivation that so far global warming issues have apparently not been able to provide.

Specific conclusions

It was shown that the energy use inversegram can be a good analytical tool to point out issues associated with inverse process such as the process of polluting and cleaning economies and its associated consequences. The inversegram was used to describe how we got from no using non-renewable energy at all to the dominant non-renewable energy use economy we have today. Next, the inversegram was applied to show how if there are no renewable energy technology gaps we can envision a step by step process to transition towards a full renewable energy use based economy.

Then ,the inversegram was adapted to indicate that when there are renewable energy technology gaps there is a need to use critical levels of non-renewable energy to keep the economy running efficiently and avoid economy black outs. Later, the inversegram was adapted again to highlight that when there are renewable energy technology gaps and non-renewable sources of energy are no longer available we should expect to see local and global economy black outs.

And finally, it can be said that without a clear local and global plan to transition from non-renewable energy based economies to renewable energy based ones the transition will be social, economic, and environmentally painful, especially for those economies having the larger renewable energy technology gap when non-renewable sources of energy disappear or become very scarce or even if their use were to be banned.

General conclusions

It was pointed out that today we live in a dominant non-renewable energy use based economy model. Next, it was stressed that the goal to transition towards a full renewable energy use based model is valid only if we assume that no renewable energy technology gaps exist. Then, it was highlighted that since renewable energy technology gaps are real, the transition goal should be first to reach a dominant renewable energy use based model, which when time is right and the renewable energy technology gap is closed can evolved towards a full model.

After that it was indicated that when we have renewable energy technology gaps together with non-renewable energy resource exhaustion we should expect to see economy black outs. And finally based on the above it can be said that with economic black outs in place and without a clear plan, local and global, to go from polluting economies to clean ones the future for mankind and the environment should be expected to be very painful.

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