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An Integral Perspective on Peak oil and an Energy Perspective on Integral Theory

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Abstract
In this study we will discuss the role of fossil fuels and energy in general for the development of our complex societies and ask how, or whether, our societies will be able to continue to develop after Peak Oil where we will experience limitations in our access to energy.

We will discuss why an energy and thermodynamics perspective seems to be overlooked in Integral Theory, but also give an integral perspective on the necessary tetra-transition away from fossil fuels, which needs to take all quadrants into consideration:

A lower right perspective focuses on the impact on food production, transportation, the economic crises in the US and EU, and solutions coming from new technologies or policies. An upper right perspective emphasizes the individuals' responsibility for their consumer lifestyles and behaviour patterns. We also need to address how Peak oil and related sustainability issues are perceived (or not) from different cultural worldviews and by the individual's understanding, maturity and motivation.

Introduction

This study focuses on the role energy, and fossil fuels in particular, play in our modern civilization, as well as the role energy has had as a driver of evolution. Today we live in a very special time called the fossil era, where humanity is rapidly consuming global resources of oil, gas and coal. The consumption and depletion of this storage of sunlight only happens once. The exploitation of fossil fuels made the agricultural Green Revolution possible, which facilitated a growth in the human population from 1 billion in 1800 to more than 7 billion today.

However, our modern civilization is based on a worldview that emerged with the Industrial Revolution, when the world was more sparsely populated by humans and their infrastructure (Costanza, 2008). In this relatively "empty" world, natural resources were abundant and people had limited access to infrastructure and consumer goods. (Costanza et al., 1997).

Today, our world is a "full" world, heavily populated by humans and our accompanying infrastructure.

Current technologies and institutions are extensions of a trend of adaptation to an empty world. Thus, our modern culture's worldviews, institutions and technologies are failing to meet our needs in a changing world. Global crises such as climate change, peak oil and a loss of ecosystem services have been caused by a failure to adapt our current socio-ecological systems to a full world (Beddoe et al., 2009). In particular, we seem to have overlooked that we have based this full world on finite fossil fuel resources.

If we go back billions of years to the origin of life on planet Earth, we will also see the importance of energy for evolution. Emergence of life and its continued evolution was only possible since Earth is situated in the energy gradient of our sun. Without energy, evolution and development are not possible. A world without an input of energy is a place governed by the second law of thermodynamics, where entropy tends to increase over time.

Thus, energy is the basis for life, evolution, culture and our modern civilization. However, our modern societies are dependent on finite resources of stored sunlight. We have global a resource challenge and it can be argued that this calls for an integral mindset to analyse the situation, as well as find solutions and a path forward.

On the other hand, an integral mindset might not be enough. At least, this is a reasonable conclusion based on the lack of attention and insight given to these issues in integral contexts. Despite the urgency and the centrality of this challenge – and despite the claim that integral theory is all embracing and all encompassing – it seems to almost completely omit the role of energy for evolution and for sustaining our modern industrialised societies.

In this study we will focus on the challenge that is probably most central and also most urgent to our societies, that of access to energy. (Heinberg, 2009) We will review our dependency on energy and how it has shaped our societies throughout history until today. Furthermore, we will analyse and discuss why the role of fossil fuels and energy in general seems to have been overlooked in integral settings.

Our current energy situation

Where do we get energy from? According to the latest figures from BP Statistical Review of World Energy 2013 (BP, 2013), fossil fuels (oil, coal and natural gas) account for a total of 84 percent of our global energy consumption, with the contribution from oil covering roughly one third of the total. The remaining 16 percent are derived from nuclear power and renewable energy sources such as hydroelectric, wind turbines, solar energy and biofuels. However, since fossil fuels are non-renewable resources, i.e. organic material decomposed and compressed during millions of years, they will eventually run out.

In the long-term our civilization has to be based on renewable energy sources, which means that the fossil energy sources will have to be phased out. It is highly unlikely that any renewable energy source (even in combination with present or coming generations of nuclear power) will be able to cover this decrease in energy extraction (Heinberg, 2009). Furthermore, such an energy transition would call for a change in our infrastructure on such a scale that one of the US's leading economists, Robert L. Hirsch, concluded that it would need to be started about 20 years before the global oil extraction reaches its peak (Hirsch et al., 2005). Due to its convenient liquid form and high energy density, oil is much more important for our society and economy than gas and coal. Most of our infrastructure and industry is completely dependent on cheap oil (both for energy and chemicals) and the transportation sector is run on close to 100 % liquid fuels. This, together with the fact that world oil production will peak before gas and coal production, is the reason that the main concerns related to the supply of fossil fuels are put on oil.

Peak oil refers to the point in time where the rate of petroleum extraction reaches a maximum, after which the extraction decreases permanently. The fact that fossil fuels are finite resources and that their extraction will someday peak, was pointed out as early as 1949 by the American geophysicist Marion King Hubbert (Hubbert, 1949). He later published what is now known as the Hubbert curve, a mathematical model of oil supply, which he used to accurately predict that the peak in US oil production would occur in 1970 (Hubbert, 1956). Today, it is clear that at least 60 of the world's 98 oil-producing nations have passed their peak production and are in decline (Hopkins, 2008).

There is some debate about when the global peak in oil production will occur, or if it already has occurred. Oil needs to be discovered before it can be produced. Most oil producing countries have followed a pattern where the peak in discovery occurred 30-40 years before the peak in production. The world as a whole peaked in discovery of oil in 1965, indicating that we may be at or close to the peak of production. We now actually consume about four barrels of oil for every one barrel we discover (Hopkins, 2008). Since mid-2004 world liquid fuels production has been relatively constant around 85 million barrels per day (IEA 2008; Höök et al., 2009), indicating that new production has only been able to offset the decline in existing production. As oil resources are getting scarcer, oil companies are forced to extract oil in less accessible and more environmentally hazardous locations, such as the Gulf of Mexico and the Arctic region. Other alternative fossil fuels that have gained in interest recently are unconventional oil tar sand and natural gas from fracking.

It is clear that modern civilization has a strong dependence on fossil fuels. However, energy and fossil fuels have not gathered much attention in integral settings, a rare exception being the discussion about Integral cities (Hamilton, 2008):

> "Dependence on carbon-based fuel has also made cities appear independent of their ecoregions. This fuel is sourced from generally remote regions for every city and enables modern city life as we know it on such a fundamental basis that

> we have only recently started to visualize its replacement. Cities are as dependent on carbon-based fuel as any addict is on heroin."

With such an urgency and importance of the issue at hand, one would expect that leading integral theorists, such as Ken Wilber or Sean Esbjörn Hargens (Esbjörn Hargens & Zimmerman, 2009), would emphasize the important role of energy to our societies and to our development. However, that has not been the case. In order to shed some light on the lack of an energy perspective in integral circles, we will review Ken Wilber's AQAL Integral Theory (Wilber, 2006a) – including its assumptions on the evolution of our species.

This will be followed by an energy perspective on evolution, where we emphasise some of the most significant revolutions in human societies: the fire domestication, the agrarian revolution and finally the fossil revolution. This will demonstrate the significant role that energy has played to these major transformations and to our evolutionary process.

Tetra-evolution according to Ken Wilber

Evolution and development are often described as a journey towards increased complexity in a process of differentiation and integration, and Wilber's view on evolution has also developed in line with this description. His point of departure was the spiritual and psychological aspects of human development, in the form of Wilber's "spectrum model" (Wilber, 1977; Wilber, 1979). But after reading Jean Piaget he incorporated the insight from developmental psychology that we are not moving away from paradise and trying to get back in, but rather growing out of it as a developmental journey towards goodness and unity (Visser, 2003; Wilber, 1981).

The developmental and evolutionary model was further refined by a differentiation into several lines of development, according to the different models from the field of adult development. An even further development was presented in *Sex, Ecology, Spirituality* (Wilber, 2000) where Wilber differentiated between the individual and the collective aspects of development, and incorporated a socio-cultural dimension to the description of the evolutionary process with the addition of the four quadrants. By means of the Wilber-Combs matrix, developmental stages were differentiated from mental and bodily states to form the AQAL model (Wilber, 2006a). With this model in place, the vertical evolution could be described as an interplay between the four quadrants, also denoted as a tetra-evolution.

The notion of a tetra-evolution is elaborated upon in *Excerpt A* (Wilber, 2006b). Here Wilber refers to Karl Marx's view of societal development, where the social system and its techno-economic base (the lower right (LR) quadrant in Wilber's AQAL model), is seen as governing and as a determinant of the psychological (UL), behavioural (UR) and cultural (LL) development. In contrast, Wilber argues that evolution is a four-quadrant affair – a tetra-evolution – where a successful transformation into a higher stage is an interplay between creative individuals and inventors, a shift in cultural values and paradigm, new behaviour patterns and techno-economic institutionalization. One example given is the industrial revolution in Great Britain in the 18th century (ibid):

> "With regard to the LR social system and its techno-economic base, what generally happens is that a technological innovation begins in the mind of some creative individual (UL)–James Watt and the steam engine, for example. This novel idea is communicated to others through the inventor's verbal and cognitive behavior (UR), until a small group of individuals eventually understands the idea (LL). If the idea is compelling enough, it is eventually translated into concrete forms (e.g. the building of actual steam engines), which now become part of the socio-economic base (LR)."

Hence, according to Wilber, evolution should be viewed as process of differentiation and integration taking place in and as an interplay between all four quadrants. Accordingly, one could ask what drives this evolution towards greater complexity.

Here Wilber refers to the great wisdom traditions' notion of involution and evolution, where involution refers to the process of manifestation from pure unity and Spirit to lower forms: to soul, to mind and to matter. Consequently, evolution is the reverse process of including more and more in the Great Nest of Being where matter is transcended to mind, which is transcended to soul, which is further transcended to Spirit. In "The Collected Works of Ken Wilber Volume 2"(1999) Wilber writes:

> "Now, of course, you are perfectly free to believe in evolution and reject the notion of involution. I find that an incoherent position; nonetheless, you can still embrace everything in the following pages about the evolution of culture and consciousness, and reject or remain agnostic on involution. But the notion of a prior involutionary force does much to help with the otherwise impenetrable puzzles of Darwinian evolution, which has tried, ever-so-unsuccessfully, to explain why dirt would get right up and eventually start writing poetry. But the notion of evolution as Eros, or Spirit-in-action, performing, as Whitehead put it, throughout the world by gentle persuasion toward love, goes a long way to explaining the inexorable unfolding from matter to bodies to minds to souls to Spirit's own Self-recognition. Eros, or Spirit-in-action, is a rubber band around your neck and mine, pulling us all back home. "

Wilber's notion of a tetra-evolution gives the impression of a bootstrap evolution, humanity raises itself up the evolutionary ladder, where the involutionary force, later referred to as the evolutionary impulse, is proposed or postulated to explain the observed movement from low to high complexity.

But is this view really consistent with what physics says, or what is given by an energy and thermodynamics perspective? The latter is a research area that Wilber only acknowledges by describing the two opposite movements of winding up (biological evolution) and winding down (according to thermodynamics) (Wilber, 2000). Here Wilber rests on insights into selforganizing systems made my theorists such as Prigogine and Varela, but does not seem to acknowledge the importance of energy access to drive these processes. In our case, the earth cannot be viewed as a closed system but one that gets a constant flow of energy from the sun.

We would like to close this knowledge gap and investigate the role that energy plays as a driver and engine to the evolution of our societies, our cultures and of our consciousness.

An energy perspective of evolution

In order to give a brief outline of evolution from an energy and thermodynamics perspective, some basic physical concepts need to be introduced. These insights of thermodynamics and statistical mechanics were derived in the late 19th century and the beginning of the 20th century.

Energy, which is the capacity to perform work, can be transformed into many forms, such as heat, electrical energy and chemical energy. According to the first law of thermodynamics energy cannot be created nor destroyed, only transformed to other forms of energy. For instance, chemical energy stored in oil can be transformed into mechanical work and heat when we drive a car. The mechanical work is transformed into kinetic energy of the car, which is finally dissipated into heat.

Entropy is a measure of a system's disorder, or more accurately, the number of micro-states a system can occupy. The more ordered (fewer numbers of possible micro-states) a system is, the lower the entropy. According to the second law of thermodynamics, a closed system (i.e. a system with no exchange of energy and matter with the surroundings) that is left to its own devices will always increase its entropy and move from a more ordered to a less ordered state. For instance, if we pour some hot water into a pool of otherwise cold water the temperature will move to a state of thermodynamical equilibrium, where the entire fluid has the same temperature. The opposite process, where an isolated pool of water moves from a state of equally distributed temperature to a state where it is cool in one end and warm in the other, is consistent with the first law but violates the second law of thermodynamics since the entropy decreases. Thus, according to thermodynamics the universe tends towards an equilibrium where all energy gradients are dissipated and maximum entropy is achieved. Rudolf Clausius, one of the founders of thermodynamics, summarised the two laws in this way:

> "The energy of the universe is constant. The entropy of the universe tends to a maximum".

But how can life on this planet not only be created but also evolve towards more and more complexity? Doesn't moving from dirt to writing poetry, winding up, violate the second law of thermodynamics that states that we always should be winding down? The answer is no, since our planet is not an isolated system, we have a constant energy flow to earth from the sun. Exergy can be introduced as the amount of energy that is available to produce work, or as a measure of the quality of the energy. Sunlight with its relatively short wavelengths is energy with high exergy while the long wavelength radiation leaving earth is of lower exergy.

A living complex structure can be seen as a highly organized one. How such structures can emerge and self-organize have been of increasing interest to many scientists, such as Ilya Prigogine who investigated thermodynamically non-equilibrium systems and others who have developed the science of complexity (Prigogine, 1989; Niele, 2005). In order for ordered and complex life to arise several conditions need to be met (Christian, 2014), but a constant influx of energy is a premise. From this perspective energy can be seen as not only as a necessary condition for evolution towards greater complexity, but also as a driving force to the process.

Even though there is no clear definition of what life is, or understanding of how it emerged, a necessary feature is that it sustains and reproduces itself, and that it demands metabolism of energy. Early life forms evolved from simple organic compounds into primitive cells containing DNA. One of these organisms, the cyanobacteria, has been of great importance for the biological development on earth since it is responsible for photosynthesis, the chemical process that uses energy input from sun radiation to enable the conversion of carbon dioxide and water into oxygen and carbohydrates. The process of photosynthesis can thus be seen as a process of energy conversion where sunlight, or electromagnetic radiation energy, is converted to organic material and thereby stored as chemical energy. Nowadays, photosynthesis is carried out by cyanobacteria, algae and plants.

This stored chemical energy can be exploited by animal herbivores through eating the plants and by carnivores through eating the herbivores. The chemical energy of food can be utilized for cellular regeneration and converted to mechanical work such as walking or running. The stored chemical energy can also be converted into heat by combustion or fire, something that can be initiated by lightning. About 400 000 years ago one of these carnivores, a bipedal hominoid, managed to domesticate fire (ibid). This, one the earliest technologies that were discovered by our species, was primarily used to provide the home with heat, light, protection against other predators and for heating food. However, keeping a fire alive, and later to create it, was a cognitively and socially demanding task in that it required tending to it, by sheltering it and gathering and feeding it with firewood. Fire literarily shaped the human culture. It is argued that the oldest organizational form, the circle, is shaped from gathering around the fire. The domestication of fire can be seen as a result of increasing cognitive complexity, but it can simultaneously be seen as a shaping force and an engine of future growth in human cognitive complexity.

About 12 000 years ago humanity made another significant developmental leap, which can be seen as a way of further harnessing the energy from the sun. At this point in time, we managed to domesticate the soil to grow crops, an event which is commonly referred to as the Neolithic or agrarian revolution. The transition from a hunter-gatherer society to an agrarian one, meant that less physical effort needed to be invested in food production. The energy output by growing crops was typically increased by a factor of 20 compared to hunter or gathering practices (Diamond, 1997; Niele, 2005). A further advantage was that agricultural societies could support more people per acre than hunter-gatherer societies. The agrarian revolution meant that a significant portion of the workforce could be released from food production, which enabled stratified societies with elites, armies and many specialized functions and inventions such as written language to facilitate the organisation of the society. As in the case of the previous revolution of fire domestication, the agrarian revolution was a result of a development in human cognitive complexity, but it also led us onto a trajectory that demanded even more complex thinking in that we started to build cities and large empires that needed to be governed and administrated.

The agrarian revolution mainly concerned the food production aspect of energy, but wood was still used as fuel for cooking, heating and for industrial applications such as iron production. This gradually lead to a shortage of wood in Europe in the 17th century and the interest in other energy sources grew, such as coal, which had been used in smaller volumes since the Middle Ages. The increased coal mining and consumption that ensued, is nowadays regarded as a necessary factor for the industrial revolution that started in 18th century Britain. One important outcome of this revolution was the invention of the steam engine, designed by James Watt, that originally was used in iron production. Ironworks was defining “the mechanical civilisation of nineteenth-century Europe” according to Vaclav Smil (Smil, 1991) and the fossil fuel coal was a necessary condition for achieving that, although it has been overlooked by more scholars than Wilber (Sieferle, 2001):

> “Considering the central importance of coal as the energy basis of the Industrial Revolution, it is quite astonishing that ... it has been almost completely ignored by economic history.”
>
> “Without coal, European societies of the 18th and 19th centuries would have remained agrarian societies, even if they had utilised the innovation potential fundamentally embodied in agrarian societies to a much greater extent.”

After the coal production, or rather extraction, oil and natural gas followed as important and fundamental energy sources for our societal metabolism and made it possible to grow in complexity. Oil was being drilled at large scale from the late 19th century in the US and enabled the rise of the industrial superpower with its world domination, at least until now when we can observe the consequences of the finite and non-renewable nature of the fossil fuels.

Although we have experienced a nuclear energy revolution during the 20th century, that hasn’t transformed our societies in the way that previous energy revolutions have. Presently, only 4 percent of global energy consumption comes from nuclear energy (BP, 2013) and it has hardly gained in popularity after the Fukushima disaster in 2011. Germany, for instance, has decided to shut down all national nuclear power plants.

When reviewing the decreasing prospects of fossil fuels and the difficulty associated with scaling up possible replacements, it is highly probable that our societies will have to manage on a decreased amount of energy in the near future (Heinberg, 2009).

Where are we heading?

The intimate connection and co-dependence between complexity and energy is a theme that has been investigated by e.g. Joseph Tainter, who states that increasing energy consumption will generally lead to a collapse of society (Tainter, 1988). Tainter defines a complex society as one with a high degree of differentiation in societal roles, with an accompanying integration and coordination of those roles, as seen in our modern societies. Collapse refers to a process where a society decreases its complexity, an example being the collapse of the Roman Empire. This view is shared by Frank Niele (2005):

> "Modern energy theory says that complexity never ever drives anything. Complexity emerges and the emergence of complexity is driven by a flow of energy, without exception."

The story of evolution can be viewed as the story of an increasing capacity for exploiting the sun. Historical examples being reviewed here are the domestication of fire for warmth and heating food, the Neolithic or agrarian revolution and finally the industrial revolution. Furthermore, the evolution of man is also a story of having beneficial environmental factors, such as grasslands spreading out allowing apes to hunt and walk upright, mutations in some sorts of grass that allowed for domestication of crops, domestication of animals, geographically large land areas that allowed ideas to spread (Diamond, 1997), fossil fuels and so forth. By incorporating and emphasizing these environmental factors into an integral framework, we might do better in addressing problems such as resource shortage. This could be done by emphasising that a map containing only the four quadrants does not sufficiently describe the evolution and sustainable maintenance of our complex societies. An adequate map should also include environmental entities such as geographical factors that shape our cultures and societies, the biosphere with its photosynthesis that provides us with oxygen and food, and the sun that provides us with energy.

According to Wilber, evolution is a four-quadrant affair, consisting of the interplay between – or co-arising in – psychological, cultural, behavioural and techno-economic dimensions. Furthermore, this tetra-evolution is driven by an involutionary force, later referred to as an evolutionary impulse, that drives individuals and societies towards greater complexity. However, as demonstrated in this paper we cannot ignore the fundamental significance of energy to our journey from less to more complex societies and individuals. From this perspective, increasing complexity comes with a cost; it needs an input of energy to be developed and maintained. And this we feel is a blind spot of the AQAL theory. Using an evolutionary impulse as a main explanation and driving force for evolution may prevent us from acknowledging several dangers ahead. With an added energy and resource perspective we may not even need to postulate an evolutionary impulse, and we can start to consider other possible directions for our societies, including acknowledging other perspectives, such as a collapse perspective, even though it may seem unthinkable to some (Wilber, 2000):

> "Evolution is irreversible. We may see amoebas eventually evolve into apes, but we never see apes turn into amoebas. That is, evolution proceeds irreversibly in the direction of increasing differentiation/integration, increasing structural organization, and increasing complexity."

At first glance, this statement from Wilber may intuitively feel right. However, there are several examples of cultures and ancient societies that collapse (Diamond, 2005) as a consequence of not being sustainable and degrading their respective environments. A similar reverse evolution from complex to more simple forms can be observed in organisms, such as growing wings and then losing them again (Maxmen, 2014).

With a collapse perspective we may interpret events differently than with an integral lens. One such example being the Arab spring that started in 2011, where people in northern Africa revolted against their leaders. From an integral perspective this crisis is a developmental one, where the people hunger for democracy and revolt against the dictatorship that stands in the way of cultural progress. An interpretation from a collapse perspective, on the other hand, emphasizes high oil and food prices at that time as the igniting spark as well as the long-term challenge (Lagi, et al., 2011). For example, in Egypt decreasing oil production leads to decreasing incomes which means that the government can't afford to subsidize gasoline and food so the people revolt, not primarily from hunger of democracy but from hunger of food.

From this perspective societies don't transform by leaving one stage for another. Just as described in integral theory, we do live in an information society, but we also still live in a fossil society, as well as in an agrarian society and we are still burning wood and biofuels as in the fire based hunter-gatherer society. Societies as well as individuals cannot transcend their fundamental needs for food and energy, but instead include the previous conditions. That has also been the story when it comes to energy production. All new energy sources such as nuclear, solar electric and wind turbines, haven't replaced any of the fossil fuels, but only added to an ever-increasing consumption.

A decrease in energy available to our societies will primarily affect the lower right quadrant and it is an open question whether the other quadrants should necessarily follow that quadrant down in complexity. Sometimes the notion of decoupling is discussed in the area of climate change, in that case referring to a decoupling of economic growth from carbon dioxide emissions. Perhaps a decoupling in this context could mean a decoupling between the lower right quadrant's structures and energy, or between the lower right quadrant and other quadrants.

Although complex, the connection between energy input to our societies and the lower right quadrant is manifested in our economic system, which is based on the premise of infinite growth (Martenson, 2014). It is also manifested in our infrastructure, in particular in the US, that has built its entire infrastructure around the car. It is likely that it was the high oil prices that triggered the subprime crisis, which was the start of the debt crisis that has spread to Europe. In Peeking at Peak oil (2012), Kjell Aleklett writes:

> ”In the United States before the financial crisis in 2008 it was noted that it was these poorer, fringe-dwelling households that were the first to be affected by high oil prices. The more than doubling of the oil price from 2005 to 2008 took a huge toll on the budgets of these households. One way for them to cope was to abandon their mortgage payments and give their house keys back to the banks. Thus, Peak Oil and the financial crisis were intimately linked.”

Transportation is the most affected energy consuming sector where 95 % of the energy comes from oil. The example above of the Arabic spring also illustrates the relation between energy and food production. In our industrialized agriculture we add 10 times more energy (mainly fossil) to the farming process than what is delivered to the consumers in calories (Pfeiffer, 2006). This energy is added by the use of fertilizers, irrigation, transports and machinery and so forth. The grim fact is that modern food production and distribution cannot be maintained at its current level without considerable input of fossil fuels. Thus, it is of greatest priority for our societies to phase out and decrease our dependence on fossil fuels.

Tetra-transition and energy limitations

The transition away from fossil fuels is a complex issue and a transdisciplinary approach is needed to grasp the whole picture. The integral framework has previously been suggested as a tool in this regard (Horn, 2013):

> “…the analysis shows how such a holistic framework may help us identify gaps in action and planning, and also gives leads on how different disciplines could work together to solve complex problems. Especially the integration of interiority (from individual interiors such as feelings, values and motivation to collective interiors such as worldviews) and knowledge disciplines like social sciences, psychology and cultural studies, is a valuable contribution of integral theory. The framework also presents a “view from above” where it is clearly seen that no single discipline can see the whole picture of a phenomenon.”

Thus, an AQAL analysis of such a transition is obviously very useful, but it needs to incorporate the role of energy and the possibility of reduced access to energy in the future. One possible way of addressing this is to place the quadrants in a surrounding environment, where resources, such as energy, can be placed to illustrate their fundamental importance for evolution. Without energy there will not be any tetra-evolution. Luckily, the Earth is an open system with accessible sun energy for many billions of years to come. Thus, we will have accessibility of energy also in the future.

The problem is that we have built a civilization of 7 billion people that is primarily based on a large input of finite fossil resources. In the foreseeable future it will not be possible to substitute this with renewable energy. Thus we will probably have to adapt to a situation with less energy available. For the LR quadrant this means less transportation and a more local world with less complex structures, as complexity comes with an energy cost. What will this mean for the other quadrants? Will it be possible to establish an integral culture (LL) quadrant in a more local and less complex society? In the field of adult development the notion of support is described as existing structures that can aid an individual's development (Commons & Goodheart, 2008). Such structures can be any form of cultural learning from schooling, language to books and internet, so that all individuals don't have to invent the wheel by themselves. Once a society has conquered a developmental stage the cultural support will make it easier for the next generation to acquire that level. The possible connection between energy and the psychological dimension seems to be complex and in need of further investigated.

Up until now it seems that development in all the quadrants has speeded up. In the short term this definitely has to slow down as such development seems to be based on an increased use of limited energy resources. A sustainable society based on renewable energy will allow a longer time perspective but probably a slower speed of development. Is it possible in any way to decouple development in the other quadrants from reduced complexity in the LR?

An ability to reason and identify in a complex way does not guarantee that these issues are properly addressed. At least we should emphasise that with the problems we are facing there are no guarantees that we will continue on this path towards higher complexity.

The direction of the universe

Our civilizations have been shaped by a number of factors; one of the most central ones has been access to energy, which locally has let us disobey the second law of thermodynamics on Earth. What conclusions can we draw from this regarding where we are heading? According to integral theory we are heading towards increased complexity and higher consciousness. We are on the path to higher complexity and unity driven by an evolutionary impulse, this inner spiritual principle that drives the development of the universe and its beings. According to AQAL Integral theory there are no limitations to this process.

According to thermodynamics, however, the faith of the Universe is a heat death guided by the principle of entropy. This is formulated by the second law of thermodynamics: The entropy of an isolated system, such as our Universe, will inevitably increase over time. This means that all energy gradients will disappear and the energy will be evenly distributed, and the Universe will reach a thermal equilibrium with maximum entropy. In such a Universe life cannot exist. Thus thermodynamics and integral theory have a very different view of the direction of development and the ultimate faith of our Universe.

But how can complex life and humans exist in a universe governed by ever increasing entropy? The answer is that the total entropy of the universe is indeed increasing, but locally entropy can decrease if the entropy increases in a different place. For entropy to decrease in one location it needs an input of energy, i.e. it must be an open system. The Earth is such an open system, situated in the energy flux from the sun. Such a continuous input of energy allows for a local increase of complexity (and decrease in entropy) on Earth, i.e. the development of life and culture. The burning of hydrogen in the sun leads to far more increase in entropy than the entropy reduction caused by the development of life and ecosystems on earth. Thus thermodynamics allows for local development of complexity if the system has an input of energy. Turn off the sun and all ecosystems, life, culture and complexity would disappear. The drive of an evolutionary impulse would not be of any help. Thus, from an energy and thermodynamics perspective, integral theory's view of the evolutionary impulse can only be valid for an open system with an influx of energy. And the evolutionary impulse is only valid for a certain time since the energy source, which is limited, will eventually be consumed. This direction is even more apparent when studying a civilization based on the consumption of fossil fuels.

Conclusions

In the present analysis we have reviewed the role and importance of energy in general and fossil energy in particular for the development and sustenance of our complex societies. Our evolution has been fuelled by the constant energy flow from the sun, which we have gradually used in an increased degree through a number of energy revolutions: the domestication of fire, the agrarian and the industrial revolutions. Now we find ourselves in a difficult situation where we are heavily dependent on fossil fuels that we need to break free from. Here a transdisciplinary approach, such as applying the AQAL integral framework, can be useful to describe the transition that needs to take place in all four quadrants: in transforming our infrastructures, our economic systems and our food production systems (LR), in finding new collective ways of making meaning of our relation to energy, to nature and to each other (LL), in finding new behaviour pattern and ways of adapting to a world without material and energy abundance (UR), and finally, in transforming to a new mindset that is better suited to address these for many new circumstances, by means of an inner transition (UL).

A question that arises in this integral context is if people that are integrally informed and integrally aware has an advantage in recognising and addressing this issue. Our analysis show that this is not necessarily the case, it might even be the opposite. Peak Oil and collapse perspectives are not commonly discussed in integral circles, and further, we show that an energy and thermodynamics perspective is inconsistent with the AQAL theory as described by Ken Wilber. Firstly, it's inconsistent in that energy is omitted as a fundamental driving force or necessary condition for evolution and that it doesn't fit into any quadrant according to Wilber's description of a tetra-evolution. Secondly, the second law of thermodynamics, that tells us that entropy will increase in a closed system, is inconsistent with Wilbers notion of an involutionary force, or evolutionary impulse, since they state that we are moving in opposite directions, towards a decrease and towards an increase in complexity, respectively.

In order to better address these fundamental energy challenges we suggest that these inconsistencies are addressed by means of emphasising the importance of the surrounding environment to the societal, cultural and personal aspects of our development that is described by the four quadrants. Further, we argue that the notion of an evolutionary impulse or telos towards higher levels of consciousness and complexity or to some omega point should be questioned, or at least discussed in order to open up for a perspective and possible future where we are heading in the opposite direction, i.e. open up for the possibility of a collapse – not for the first time in history, but for the first time on a global scale.

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