Activities and working life in the coming great transition

Staffan Laestadius

Abstract

This chapter is about that coming process of transformation with focus on human activities and our working life. It is structured as follows: Section two contains some methodological remarks followed by a third section which summarizes "the state of the climate". Section four provides a short analysis of *the great acceleration*, i.e. the rapid global growth process after WW2 and which basically has created the present climate crisis. In section five we analyze the conditions for the great transformation ahead. In section six we leave the general analysis in favor of the specific: we focus on the climate impact of the balance between activities within and outside the formal economy. Section seven is focused on productivity presently and in the post fossil society followed by a section (eight) on the role of coal. After a general discussion on the coming transformation of working life in the ninth section we focus on the role of AI in section ten followed by a competence-related approach in section eleven. Section twelve, which also concludes with the paper, discusses the necessary and probably most important issue in the path ahead towards a post fossil society: the transformation of our minds, i.e. the paradigm shifts in our understanding of the planetary conditions for human activity and work

Keywords:

AI power consumption, artisan small-scale mining, carbon budget, climate and working hours, coal and work, the Great Acceleration, planetary boundaries, productivity decline, working conditions,

Introduction

A great transformation of human activities – and thus of working life - is inevitable for planetary reasons. The climate crisis is now so severe that a continuation of business, and life, as usual (BLAU) is not a realistic alternative on a global scale. Within a few decades, certainly within this century, BLAU will cause living conditions for mankind to deteriorate significantly, accompanied by extreme heat waves, large migration, shortage of food and water and not the least, large scale conflicts due to the increased competition on land and food.

The necessary alternative to BLAU is a primarily proactive transformation of our societies away from their present addiction to fossil carbon. This structural change has to be rapid and far reaching and will, as a part of it, include a large-scale transformation of how human activities are organized: in formal working life as well as in the hours spent in our "free" time.

Methodological remarks

There is a strong scientific consensus as regards the severity of the present climate crisis. We now have a solid knowledge of the history of our planetary climate as well as of its present state. This includes knowledge on relationships and causalities between a significant amount of natural as well as anthropogenic variables related to planetary change. We will return to that in section three below.[1]

The development of the climate crisis hitherto – and the mechanisms behind - is thus well known. The future of the crisis – and of the Planet - is more problematic to assess. For sure there are several modelling activities which forecast potential and more or less *probable* development paths for the global climate based on various assumptions of aggregate human behavior. The present trend of emissions is often used as a basic scenario to which potential alternatives are related. Basically, the present trend is what we here label business and life as usual (BLAU).

BLAU is, however, not probable. That development path will very soon result in dramatic consequences for mankind and necessitate *reactive* policies with significant impact globally as well as on national level. Alternatively, nations and the international community may act *proactively*, i.e. somewhat before the worst-case scenarios are realized. For the moment, also this *proactive window of opportunity* is closing rapidly.

[1] For comprehensive and authoritative reports, see e.g. *IPCC, 2023; WMO, 2023; WMO, 2024a & b; WMO et al, 2024.*

Several climate policy analyses on the global level have published *conditional scenarios* – sometimes of a *backcasting* character - on how the transformation ahead towards a zero-carbon economy can take place. (See e.g. IEA, 2024c; SEI, et.al., 2023 & UNEP, 2024).

This paper is too short for that kind of analysis. We do not predict how mankind will manage the present severe climate crisis. We discuss how human activities, including those performed within the formal economy, i.e. working life, under certain conditions, may be affected by, and contribute to, a proactive transformation strategy towards a low carbon/fossil free society. As there is a strong connection – and trade off - regarding the climate impact of activities within and outside the formal economy, we here choose to apply a broader activity perspective in our analysis.

One implication of our conditional approach is that we have reduced the usage of empirical data. We do not deliver historical trends or forecasts based on those (i.e. BLAU), we analyze the conditions for deviating from the present, the magnitude of which we discuss in section five below.

It is not obvious whether the transformation ahead should be labelled *re-active* or *pro-active*: On the one hand a rapid decarbonization policy is basically caused by the consequences of greenhouse gas (GHG)-emissions (and thus reactive), on the other, the activities may be directed to reduce those emissions rather than adapting to their consequences and thus labelled proactive. Delaying mitigation activities today will inevitably increase the magnitude of extreme weather and thus necessitate tougher climate policies in the future.

State of the climate

The level of GHG: s in general, and CO_2 in particular, in the atmosphere is significantly higher than it has been for at least 800 000 years (Keeling, 2024). The rate of increase in intensity of these gases is higher than ever (NOAA/GML, 2024). As a consequence, the planet absorbs more heat than it reflects. 90% of this heat is absorbed in the oceans. That energy imbalance causes global temperatures, in the atmosphere as well as in the oceans, to increase. This heating process is primarily the result of anthropogenic GHG emissions which have increased over almost two centuries and resulted in an all-time high in 2023 and early 2024 in both the atmosphere and in the sea (Copernicus, 2024; Friedlingstein, et.al., 2024). The consequences of these still growing human emissions have been more rapid and severe than forecasted just a few years ago (Deng, 2024; Schmidt, 2024). The well-known Paris target from 2015 to keep temperature increase below 1.5°C below preindustrial level during this century is probably already passé. We may persistently pass that level by 2050, probably within a decade already.[2]

[2] The 1.5°C limit was passed already in the 13 months period Aug. 2023 to Aug. 2024 (Copernicus, 2024).

As a consequence of temperature increase the cryosphere is melting all over the planet with a long-term impact on global sea level as well as on sea currents. The warming atmosphere can accommodate more humidity which in turn can – and will - result in extreme rainfall and storms. Heat waves as well as snowstorms will become more frequent and extreme (WMO, 2024a&b).

The great acceleration towards a global society addicted to (fossil) carbon

Although human planetary impact is as old as mankind we may identify two historical milestones in our growing addiction to carbon. *First*, the origin of the industrial revolution and the introduction of the steam engine around the early 19th century. Primarily in the middle of that century the steam engine became widely used in connection to a rapid increase of coal consumption. In the late 19th century oil was added to coal and soon became the main fuel for the growing transport systems.

Secondly, the period after WW2 has been characterized by a rapid growth of industry, of all kinds of communications, of consumption – not the least of durables - and of new technologies related to that. This *great acceleration* has been fueled by a constantly growing consumption of fossil fuels. The energy input from coal, oil and gas has grown by 3 percent annually since 1945. Fossil fuels still, in spite of the rapidly growing role of renewables, make up to 82 percent of global energy transformation. In fact, the global use of fossil fuels still increased by 1.5 percent in 2023 (EI, 2024).

Almost eight decades of exponential growth of natural resource extraction and burning of fossil fuels have now moved mankind close to what earth scientists label our *Planetary Boundaries*. Recent research indicates that our planet is close to, or has even passed, several tipping points as regards geophysical and climate change (Steffen et al, 2015; Richardson et al, 2023: Rockström et al., 2023). Among the most important anthropogenic threats are the GHG emissions – of which CO_2 is the most important - and our impact on biodiversity.

Both threats necessitate a rapid and far-reaching transformation of human activity, parts of which must take place in the formal economy, and thus in working life. In the rest of the paper, I evaluate the conditions for and potential impacts of that transformation.

The necessary transformation[3]

The necessary speed and magnitude of the transformation ahead is conditioned by the planetary boundaries, i.e. the limits of the (almost) finite planet. The exemption to finiteness is the constant inflow of solar energy. This is an important exemption and the main source of

[3] More in depth analyses of the magnitude and necessary speed of this transformation are available in my recent monopgraphs, written in Swedish (Laestadius 2018, 2021 & 2023).

hope in the coming transformation. Mankind has used the solar inflow directly and indirectly in all her history as the main source of energy. During the recent two centuries, however, that source has been increasingly marginalized by the combustion of fossil carbon stored underground. The still growing emissions from that combustion are accumulated in the atmosphere with consequences on the radiative force of the planet.4

The basic, and doubtless the most important, parameter to consider as regards climate policy in the years ahead is the Remaining Carbon Budget (RCB). The concept, which was introduced in the IPCC vocabulary already in 2013, is an estimate on how much CO2 which (given certain conditions) can be emitted globally in the atmosphere if we have the ambition to keep the increase of global atmospheric temperature below a certain level, say 1.5°C above pre-industrial level.

According to the most accurate calculation (from Nov. 2024) on the RCB for a 50% probability to keep global temperature increase below 1.5°C above the preindustrial level is 235 GtCO2 starting from January 2025. That is equal to approx. six years with the present level of CO2 emissions. Accepting a higher temperature increase, like e.g. 1.7°C (585 Gt) or even 2°C (1110 Gt), will of course give more time for climate policy, 14- & 27-years resp. But the consequences for the planet – and for mankind – of such a retreat of climate mitigation ambitions are enormous (IPCC, 2018; IPCC, 2023; Forster et al, 2024)5. Following a recent UNEP report there is now in reality no hope to keep global temperature increase below 1.5°C and very small hope to stay below 2°C (UNEP, 2024).

The policy implications of the present state of the climate are that society, globally as well as nationally, has to reduce all emissions from human activities by 7 – 10% annually in the rest of this decade (Laestadius, 2021 & 2023). This includes emissions from production as well as from consumption, i.e. from our working life as well as from activities during our "free" time. Whether companies, like e.g. steel plants or aviation companies, are the direct emitters or individuals, like e.g. automobile and boat drivers, is of no importance from a climate perspective.

To approach that activity-related problem further we commence the following analysis with some reflections on the working time question.

Working time

It has been argued that a reduction in working hours will contribute to the transformation towards a low carbon economy. In this section I will focus on that argument. This also means

[4] The present (Oct. 2024, de-seasonalized) CO_2 intensity in the atmosphere is approx. 426 ppm which is approx. 52 percent above the preindustrial level (280 ppm).

[5] The uncertainties in these calculations are large. Here we follow Friedlingstein (2024) whose calculations landed somewhere between those of IPCC (2023) and Forster et al., (2024).

that I will neglect all other – and in my opinion basically reasonable – arguments for shorter working hours. They belong to another discourse.

European countries differ as regards the activity level of their populations as well as the working hours of those employed. There are differences between the various national labour markets as well as differences in culture and lifestyles. Sweden, e.g., has an activity rate – i.e. part of the population available to the labour market - of 88 per cent in the age 15 – 64 years which is highest in the EU. The average working hours of those employed is 1440 hours annually, which is lower than the EU average (1607 hours). National differences in retirement age add to the complexity. The mechanisms behind these phenomena are not important to analyze in detail here. Enough is to conclude that Swedes, thanks to social/welfare policy and labour market activities, *on the average* for those employed, have reduced their activities in the formal economy to approx. 31h/week, assuming a 46-week working year.

Time not spent as working hours in the formal economy is spent in the informal. For those Swedes who are employed that is approx. 7300 hours annually. For those not employed, the whole year, 8760 hours, is spent in the informal "free" time.

The character of that time spent (of which approx. 3000 hours are used for sleep) may differ between countries, between gender, social classes and professions. Those who have finished their working hours, may spend more time together with their children or build on their second homes, take care of their kitchen gardens, go fishing or hunting, perform music, read books or write their own´s – just to illustrate a few aspects of human life. Retired people may take care of their grandchildren in some countries where preschools are less common. Early retirement and shorter working hours will also make it possible for some to join other working positions and start a second working life.

There is often a correspondence between activities performed by an individual in their working life and in the domain of" freedom". The character of your profession and working conditions may have an impact on how you value your work as well as how you spend your free time. In her classification into *Labour*, *Work* and *Action* Hannah Arendt did draw attention to the different characters of human activities (Arendt, 1958). In short: *labour* is what you have to do, whether in the labour market or in the private sphere. *Work* is skilled and professional tasks which keep you engaged and proud when you build your own house as well as when you do it for a customer or an employer. And *activity*, in the Arendt vocabulary, is when what you do becomes part of your lifestyle, when the distinction between the realm of necessity and freedom disappears.

Although it may be assumed that most people want to reduce their dirty or boring "labour" irrespective of whether they face it in the working condition or their domain of "freedom" this is far from obvious for those who perform "work" or "activities". The engaged farmer will make sure that all important tasks are fulfilled before he/she closes for the day. And so will the professional carpenter. The engaged academic or author may not even make a clear distinction between the realms. Shorter working hours may also facilitate for some to develop dual activity strategies:" labour for cash and creative work or action for freedom"!

That takes us back to the climate dimension. The climate impact of a general reduction of working hours in the labour market will depend on the marginal difference between the human footprint of the time reduced in working life and the footprint of the increased time spent outside the formal economy. In short: if the increased availability of free time ends up in more GHG-emitting global as well as local travel, more fossil-based material consumption and polluting activities, a reduction of working time is the wrong way to go.

Economic policies and the transformation of the wage structure connected to the working time reduction are important here. Those who argue for shorter working hours often also argue against wage reductions. This is probably neither a good climate strategy nor a possible path to follow.

As regards the climate impact it may be argued that *ceteris paribus*, if aggregate labour income is the same after the reduction in working time, consumption will be the same, and so also the climate impact. More time in the realm of freedom also means more time for fossil-based lifestyle. To pay for that larger consumption potential some people may use a part of their new freedom to earn more money which also may increase their expenditure on GHG-emitting consumption. We may call that phenomenon the *working time rebound effect.*

It is frequently argued that a reduction of working time can be paid for by increased labour productivity, which often is assumed to increase in the future along its historical post WW2-path, i.e. by 2-3 percent annually. A variety of this argument is that wage increases during recent decades have been significantly lower than the increase of labour productivity (see e.g. Bivens & Mishel, 2015; OECD, 2024). Whether historical productivity increases can be relied upon in the transformation to come is the topic of the next section.

Productivity increases historically – and in the future transition to a post-fossil economy

Industrial transformation is – and has always been - connected to either new forms of organization of activities and/or the introduction of new technologies, some of which end up in new outputs or new inputs – energy and material - in the economy. In short, this is what innovations are about.

Good illustrations of the organizational change connected to working life are provided to us from the origin of the industrial revolution. The simple reorganization of tasks, division of labour, as described by Adam Smith among others, contributed to a significant productivity increase. The movement of items in work as well as the movements of the workers were rationalized. More important, however, was the fact that the introduction of a strict sequential and divided production line favored mechanization and new technologies, i.e. (process) innovations (Laestadius, 1992).

This also opened the door to the introduction of external – nonhuman – power in the production process (Landes, 1969/77; Laestadius, 2018). Although sun, wind and water had been used for centuries, the introduction of coal-based steam power contributed to rapid industrial expansion, mechanization and significant productivity increases during the 19th century already. Around the turn of the century 1900 oil added to the primary sources of external energy. And, as discussed in section 4 above, the Great Acceleration after WW2 has been based on a rapid increase in the use of energy in general and fossil fuels in particular.

This dependence motivates a deeper discussion on our understanding of productivity; in particular on the role of energy input for productivity increase – and thus for growth. Productivity in general is a concept for the relation between output from the processes in a system and the inputs we identify (alt. are interested in) for that process. Historically economists have identified (the quantity of) capital and labour as the significant inputs. After WW2 knowledge and technical change were identified. We may label them brain power. Although Landes, as mentioned above, long ago noticed the importance of external power (i.e. energy) as an important mechanism behind the industrial revolution, economists have been reluctant to identify energy as a separate factor of production rather than an input among others. Energy is normally not included as an input factor in total factor productivity (TFP) analyses.

An analytical problem when analyzing the role of external power (energy), behind productivity increase and economic growth is that it is deeply related to – and can be hidden behind - our brain power, i.e. our innovative ability: we have learnt to excavate fossil fuels deeper and cheaper. We have developed new machines, the capacities of which are dependent on a large and increasing energy input. A significant part of our creativity has thus been directed to deepen our addiction to fossil fuels, which now must be rapidly abandoned. It is not probable that our historical productivity increase – and thus economic growth - can be upheld if we from now on must use most of our human creativity to reduce the dominant form of energy.

It is, in addition, far from obvious how to measure productivity change. For our purpose, the labour productivity concept is highly relevant. That is simply the output of an economy or an industry per working hour or per employee. Other inputs from external power and brain power (like process innovations) are simply statistically allocated to labour. But also, the GDP/capita is a relevant measure. It simply allocates the total production in the formal economy to everyone irrespective of whether they have their activities in the formal or informal economy.6 In addition GDP/capita data is easier to compile.

[6] In short: house wives, doing unpaid homework in the informal economy to make it possible for the men to be productive in the formal economy, become "included" in the GDP/capita data.

Table 1 below reveals that the Great Acceleration was the golden post WW2 era. During the period 1950 – 1973 labour productivity growth within the OECD area was in the magnitude of 4.5 percent annually and GDP growth per capita in the magnitude of 4 percent annually. This was also a period with rapid growth of fossil fuels input, here approximated with global CO2 emissions: 4.7 percent annually. Since then, labour productivity has declined to half of the golden level. This is illustrated in graph 1 below.

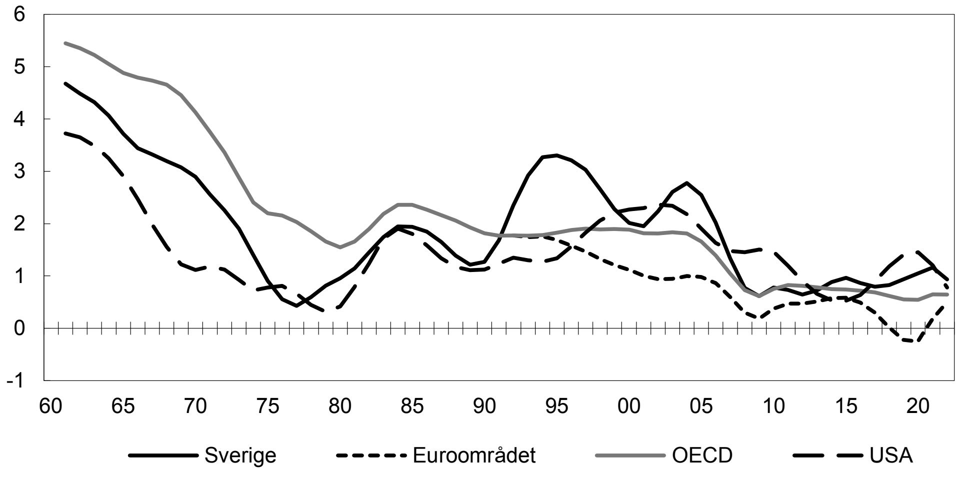
Table 1: Productivity growth measured as GDP/hour worked and GDP/capita and global carbon emissions 1870 – 2019.[7]

Annual growth rates rounded to one digit accuracy

		1870-1913	1913-1950	1950-1973	1973-2003	1973-2019
GDP/hour	orig.OECD	1.6	1.8	4.5		
	UK	1.2	1.7	3.6	2.2	
	USA	1.9	2.5	2.8	1.7	
GDP/cap	orig.OECD	1.4	1.2	3.8	1.85	
	W.Europe	1.3	0.8	4.0	1.9	1.7
	USA	1.8	1.6	2.5	1.9	1.8
	World		0.9	2.9	1.5	1.6
CO2 em.		4.5[8]	1.4	4.7	1.6	1.8

Sources: GCB (2023); Krantz (2000); Maddison (1991 & 2007); OECD (1985 & 2003); WDI (2024)

Graph 1: Long term productivity decline in advanced economies, 1960 – 2022.



Source: BP 2023/24 and Milicevic (2023)

[7] The table combines aggregate statistics from various (partly related) sources and over a long period. Our task here is not to get stuck in data details but to provide a historical overview of the productivity/growth phenomenon in the transition to come.
[8] This figure reflects the early phase of the fossil economy. The level of emissions in this period is approx..1% of the level in the last period which by definition creates high growth rates. In addition: during this period coal – which causes higher emissions than other fossil fuels - was dominant.

The reasons behind the significant decline in productivity increase in the old industrial world since the early 70s is an object for intensive discussions among economists and policy makers (Milicevic, 2023). Here is enough to note that this decline has been connected to the stagnation in the growth of fossil fuel inputs. But we are still waiting for a decline in real terms in the use of fossil fuels.

That takes us back to the task ahead, i.e. to reduce global CO_2 emissions – and thus the use of fossil fuels – to the magnitude of 7–10 percent annually. Following our discussion above we may – *ceteris paribus* - assume that the labour productivity increase may be still lower in the coming transition to a fossil free economy than its recent declining trend. To be clear: it is not enough to stabilize the use of fossils, it must be reduced significantly!

A rapid successful transformation may even temporarily cause an absolute decline in (revealed) labour productivity. This may be the case if less productive non-fossil-based solutions substitute for fossil-based ones. An electric truck may e.g. have a lower payload capacity than one fueled by oil.[9] In addition, the post fossil economy may include more of reparations and handling of spare parts in various circular systems than the present wear and tear habits. This may reduce the speed and productivity in the production system. The consequences for working life of this transformation are not obvious and are, of course, open for innovative activities.

The "ceteris paribus condition" stated above is important here. The reduction of fossil fuels will be parallel with other transformations in the economy, the probably most important of which is the rapid introduction of artificial intelligence (AI). We will return to that phenomenon in section 10 below.

Coal and work

An analysis of the impact on working life of the transition to a post fossil economy must necessarily consider the old, tight and cruel relation between coal and work. The excavation of coal - during several centuries primarily for direct heating, from the 19th century increasingly also for transport and prime movers in industry and during the 20th century successively more used for electricity generation – is historically by far the most hazardous and deadly labour activity (Freese, 2003; Malm, 2016). The high frequency of accidents in coal mining is, however, not only history. Globally coal is probably still the most dangerous industrial activity (GEM, 2021).[10] To the accidents in the mining sequence of the value chain for coal we may add accidents in the further handling – historically e.g. for stokers on ships – but also indirect consequences of emissions from fossil-based activities. The smog

[9] A fair analysis of this problem has methodological difficulties. If the price of fossil-based activities does not reflect the real climate costs (a gigantic *external effect* which is difficult to agree upon) the costs of the fossil economy will be underestimated. This is probably presently the case.
[10] More details are also found in a Wikipedia (2024) text on Mining Accidents from 18th century and onwards. Most accidents relate to coal mining.

phenomenon – nowadays e.g. in Delhi and for centuries in London culminating in the Great Smog 1952 – has primarily its origin in the burning of coal.

There is, however, a cruel symbiosis between coal and work. The introduction of steam engines, and still more electricity generated by coal powered plants, contributed to reducing many heavy burdens in the working process and thus to *improving* working conditions. Still today the clean conditions in high-tech manufacturing sites all over the world depend on electricity produced in plants fueled by coal from dirty and hazardous sites. Not the least is this the case in China and India where 61 and 75 percent respectively of electricity generation (2023) is based on coal. Globally coal´s share in electricity generation (2023) is 35 percent. The country which hitherto has been most successful in transforming away from its heavy dependence on coal is, ironically, the United Kingdom: only one percent of its electricity comes from coal. That does not make it carbon free however: fossil gas still makes up 34 percent. Oil is almost phased out in the UK (EI, 2024).

Electricity is the most efficient and labour friendly form of direct energy in the post fossil working process. However, in 2023, still 60 percent of global electricity generation is based on fossil fuels (EI, 2024). To get free from this addiction to carbon, economizing with electricity in all sectors of the formal as well as the informal economy is a necessary complement to the substitution of renewables for fossils in its generation.

The transformation of working conditions

The transformation ahead to a post-fossil economy will – and has to – be faster and more far reaching than any earlier transformation in the history of mankind. It is not obvious to what extent working conditions will be dramatically different from what we have today. A prima vista it may be assumed that the decline of the still dirty activities in the giant global coal sector may contribute to better working conditions if those presently employed are successfully transformed to new post carbon employments.[11] This is, however, not necessarily the case.

Downscaling policies in several countries for the coal mines often lack good incentives for coal miners who face few alternatives to continue to work informally even in closed mines and under bad conditions. Not the least China faces problems to reduce its coal production and manage a just transition away from coal (Gong & Lewis, 2024). In fact, coal production is still increasing in the non-OECD area.

[11] A World Bank (2021) report estimates that global employment (2021) in coal and lignite extraction is 4.7 million of which approx. 3.2 million in China (2018). Gong & Lewis (2024) report a Chinese employment level of 3 million forecasted to decline to 1 million before 2030 due to climate transformation. This excludes those employed in the "coal value chain" from equipment to electricity.

As regards the post-fossil solutions "of the future" we already know the technologies and processes of transforming the energy system away from our present addiction to carbon and how to enter upon a path towards sustainability.

Wind power is a rapidly developing technology which already is cheaper than coal and rapidly expanding: a global growth rate of installed capacity of 13 per cent in 2023. The situation is similar for solar energy/photovoltaics which added its global capacity 2023 with 32 percent (EI, 2024). These are mature technologies with well-established routines in production, knowledge formation, professional skills and working conditions. The challenge is the large and necessary upscaling of these electricity generating systems, an upscaling which may create new necessities and opportunities for process innovations as well as in the technologies themselves.

The situation is similar as regards transportation. Also, in this sector we already know more than enough for the take-off in the transport revolution. The IEA strategy *Avoid, Shift, Improve* is a good starting point (IEA, 2013). The solutions, technologies and systems to which we have to shift rapidly are well-known industries, distribution, production processes and human competencies have to transform on a large scale. But basically, we are not transforming to something new under the sun.

Systems for freight and personal transport will transform. Electricity creates new opportunities and conditions for mobility. The great challenge is aviation which – for decades ahead at least - is locked in into non sustainable fuels. Activities related to that sector have to decline rapidly in favor of other solutions for communication.

The hands-on knowledge needed in the transformation to come is thus not new to the world but rather locally new to individuals, to companies and to regions. Several of the necessary tasks are performed already but, in many countries, still in a too small scale compared to the magnitude of the challenge. China, of course is the outlier. Although the largest emitter of CO_2, China is also by far world leading in production as well as installations of post-fossil systems and solutions. In particular this is the case in wind power, solar power, electric vehicles and high-speed trains.[12] These rapidly growing Chinese sectors are setting the standard of the working conditions of the transformation.

There is another side of the coin, however. All solutions we introduce and/or expand in order to develop "low carbon activities" must also be strictly sustainable, ecologically as well as socially. Presently this is often far from the case. The rapidly growing electricity based "industries of the future" are heavily dependent on a large set of "critical" and sometimes "rare" minerals. All of them are not necessarily rare in the Earth´s crust but "wrongly" located from political and economic perspectives.

[12] In 2023 China added its wind power (solar power) capacity with 21 % (55%). This was 66% (62%) of total global new capacity increase (IRENA, 2024).

The rapidly expanding excavation and production of these critical minerals often take place in developing countries and with *artisan small-scale mining* (ASM) technologies. In theory ASM technologies must not be a bad solution for the environment or for the health of the workers. There is a potential for significant technological improvements. In reality, however, this is a large and rapidly growing global problem. During the period 2009 to 2017 employment in the global ASM industry increased with 170 percent and was 2017 already an order of magnitude higher than the employment in coal mining.[13] The very bad labour conditions in the critical mineral supply chains is more or less an elephant in the room in the discourse on the green transition.[14] The necessary large scale transformation ahead runs the risk of contributing to deteriorating working conditions in many places of the world.

AI and the transformation to a post fossil working life

The impact of AI on human activities in general and on working life in particular motivates an anthology of its own. Here we restrain ourselves to some reflections of the impact of AI on the transformation towards a post fossil society.

AI may be looked upon as another – final? - step in the digitalization of human activities. It adds to, or deepens, the cognitive abilities of the digital devices we have introduced in our life and production for more than half a century. Some of our activities may be taken over by our AI-equipment, others will change in character and/or will be performed faster or better.

Similarly to what was the case when mechanization did enter the production floor in mid-19th century (Giedion, 1948; Landes, 1969), today's digitalization comes together with an increase in energy demand. AI induced improvements in working conditions and increased labour productivity necessitates more electricity, 60 per cent of which still on global level is generated by fossil fuels.

This is not a negligible phenomenon due to the fact that the rapidly expanding AI technology is extremely energy demanding. The energy consumption of the Graphic Processing Units, which have become the platforms for AI operations, has almost doubled within a few years. The new generation GPU from NVIDIA has a 300 per cent increase in power consumption compared with the present. Still, they report that their new chips are 25 times more energy efficient than the older generation (IEA, 2024b). In addition to this higher power consumption per chip, AI increases the demand of GPU: s and in the extension also necessitates more capacity in the data centers. Morgan Stanley e.g. forecasts that annual AI power demand will increase fivefold to 2027 compared to the 2023 level, i.e. to the interval 200 - 250 TWh (Kindig, 2024).

[13] DELVE, 2024.
[14] See e.g. ILAB (2024) which has identified 12 mineral chains with child labor and forced labor and also performed in depth studies on several of them. See Rouhana et al., 2024 which has a strong focus on the EV sector. For a global health perspective see Schwarz, et.al., 2021.

In an aggregate forecast, including data centers, AI and cryptocurrencies, the IEA forecasts that electricity demand from those activities will double from approx. 460 TWh in 2022 to approx. 800 TWh +/- 200 TWh in 2026.[15] The AI induced increase in electricity demand in AI data centers may, following IEA forecasts, be tenfold between 2022 and 2026, i.e. from 7.3 TWh to > 70 TWh (IEA, 2024a). In an updated forecast IEA concludes that electricity demand from data centers will expand from 1- 1.3 per cent to 1.5 – 3 percent of global electricity. This is a more rapid growth rate forecast as well as a larger share than is the case for electric vehicles (IEA, 2024b).

In summary: unless the AI-revolution will contribute to significant energy/electricity savings in their applications in human activities – a large-scale *energy trade off* – and become much more energy efficient per operation - its rapidly growing energy demand will work against our activities to reduce human addiction to carbon.

The transformation of our competencies

The large-scale transformation ahead will – similar to earlier transformations – necessitate, as well as provide opportunities to, new forms of competencies and skills parallel to the reduction and elimination of others. These processes take place on/in many different levels/dimensions, e.g.:

- *The quantitative dimension:* less people with fossil related competencies is needed in favor of more with knowledge and competencies related to renewable and sustainable solutions. This necessitates large-scale re-education activities but also in many sectors a *downscaling* of the need for service activities. An EV e.g. has approximately one tenth of the moving parts compared to an ICEV, thus significantly reducing the need for maintenance staff.
- *The qualitative dimension:* my conjecture here is that there is a difference in what we may label the qualification profile as regards complexity between the fossil related and post fossil activities and industries. Relatively more skilled people with high theoretical knowledge are needed in the post fossil society. We face not only *re-skilling* but *upgrading* which sometimes may be challenging. In short: abundant coal miners may not easily qualify as wind power technicians.
- *The time dimension.* The necessary high speed in the transition ahead reduces the potential of combining competence shifts with smooth retirement of old staff and the recruitment of new staff. Individuals have to change.
- *The geographical dimension.* The core activities in the carbon economy are still related to the extraction of coal, its transport to coal power plants, and its transformation to electricity. Approx. 35 percent of all electricity is, as mentioned, generated from coal and around 70 per cent of all coal is used for electricity (IEA, 2023a). The coal economy is highly concentrated in specific areas and regions where it often totally dominates

[15] Just to illustrate the magnitude of this: total electricity generation in France during 2022 was 466 TWh.

the economy, its employment and activities. In short: it is improbable that these regions will manage the enormous shift in competencies and activities and close down of the coal economy in a smooth way. Strong regional policies are needed to get acceptance for a transition.

- *The material dimension.* The mirror image of the steady and rapid growth of fossil energy input in the economic metabolism is its continuously growing material character. The world economy has never been so heavy as the present (Laestadius, 2023). The global reshuffling of material is in the magnitude of six times as heavy as the total weight of all CO_2 emissions. Activities like these must transform radically if we will succeed in getting away from fossil fuels. This necessitates new ways of solving the human welfare problem, economizing with planetary resources rather than expanding the use of them. In short: there is a need for *a new mindset* in how to work and cooperate with the planet.

The transformation of our minds

The fundamental, and most difficult, challenge as regards the transformation of activities and working life along a development path towards a post-fossil society is probably the adaptation of a new mindset: replacing *a linear perspective* on our relation to the planet - connected to a conviction of mankind as master of nature - with a *circular*, and more humble posture. The linear "man as master of nature" world view is normally connected to the post-renaissance intellectual discourse emerging in the early 17th century and personalized with the science-philosopher Francis Bacon and also to the strong *idea of progress* dominating Western philosophy.[16] The revealed treatment, in theory and practice, by mankind of nature as a *cornucopia* was possible as long as human societies were small in relation to their habitats. This is, as discussed in section four above, no longer the case: the habitat for mankind is now global and our exploitation of resources challenges several important *planetary boundaries* (references in section four above). Nature strikes back.

This necessitates the transformation from a mindset implicitly or explicitly based on *exploitation* of nature to a mindset dominated by *bounded circularity*. This will – and must - become a *paradigm shift* – a shift in our fundamental convictions on planetary processes and on the conditions for mankind (Kuhn, 1962/70). In short, this is more than just taming capitalism and reducing the power of profit seeking companies. If the Planetary Boundaries for more than a century was a non-issue for the Fossil Capital in its exploitation of workers (Malm, 2016) this is no longer the case. Today´s investments in and producing fossil fuels, as well as promoting such activities may be understood as ethically non-defendable. But it may also be interpreted as an indicator of the depth of our *hybris* of identifying ourselves as masters of Nature.

[16] For a summary on this, see Laestadius (2018, chpt 6). Although the chapter is in Swedish most of the references are in English.

We are still in the struggle between paradigms. In many sectors in society – and among all of us - adaption and mitigation activities are presently more of a *green chic* character than fundamental. The new paradigm has to penetrate activities and working life on all levels and in all details. It has to penetrate employers as well as workers and transform the formal economy as well as life in the domain of freedom.

We still have a long way to go. Our shortcomings are everywhere, not only on the aggregate level as we have discussed above, but also in the details shaping our daily (working)life:

- We throw it away instead of repair because it is "cheaper" (but is it?).
- We transport using fossil-based systems because it is more efficient (but isn´t this a question of how we calculate?). And our transport chains are longer than ever – in production as well as in consumption.
- We travel with fossil-based systems because we "have" to (and have organized our lives and activities so we "must".).
- We still use "comfortable" fossil-based solutions – easy, practical and CO_2 emitting.
- We still add more energy input to our activities instead of reducing it.
- Human activities – inside as well as outside our working life - is more material intensive than ever, and with an impact on energy transformation and climate. Material transformation and transportation always use energy.

All this has to change. To have a real impact on everyday solutions in the activity and working life sphere the bounded circularity paradigm must be integrated in human mindsets and culture to a large scale. This is far from the present situation. In fact, I argue that much of present activities as regards climate policy, energy efficiency and reduction of fossil fuels take place "within the old paradigm" rather than transforming along new paths. This policy is rapidly approaching its limits. And probably not enough to lay a sustainable ground for human activities – and working life - in the future.

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About the Author

Staffan Laestadius, is a Swedish economist and professor emeritus of industrial transformation, Royal School of Technology, KTH, Sweden. slae@kth.se