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THE ENERGY CRISIS IN THE WORLD TODAY

Analysis of the World Energy Outlook 2021²

Antonio Turiel

Last October 2021, the annual report of the International Energy Agency (IEA), known as the World Energy Outlook (WEO),³ was published. As with every year, it is important to analyze its key highlights. However, before going into detail, it is essential to understand both the context and intent of the WEO.

We are in the midst of an unprecedented global energy crisis. The seemingly unlimited availability of fossil fuels has come to an end, and without them, **renewable energies (plus nuclear energy) will not be sufficient to fulfill our current energy demands.**

Hence, **the energy transition⁴ is an imperative**, not only from a climate perspective, but also from a systemic and economic perspective, given that our current economic system is underpinned by the idea of infinite growth based on intensive energy consumption. **If we are unable to maintain (and increase) our capacity to generate energy, our current global systems are threatened with collapse.** Therein lies the real interest of the economic and financial powers in the “green” transition, and to which **we must also look for the root cause of the ever-increasing scarcity and price of energy**, no matter how much the pandemic, logistical problems, increase in digital demand, just-in-time production and other contextual factors are used to justify **a problem that is, in fact, structural.**

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² Adapted from the article: “World Energy Outlook 2021: Aquí tienen su coartada” published on October 15, 2021 on The Oil Crash blog (<https://crashoil.blogspot.com/>).

³ IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

⁴ The energy transition is the transformation of the global energy sector from fossil-based energy production and consumption, such as oil, natural gas and coal, to “green”, zero-carbon and/or renewable energy sources such as wind, solar and tidal.

It is within this context that we should situate the reports of the IEA—which is an intergovernmental organization in which practically all Organisation for Economic Co-operation and Development (OECD) states participate—and its efforts to construct a favourable hegemonic narrative in the face of the current energy challenge.

In this document I analyze the recent WEO 2021 in light of the energy price crisis, and address the possibility of a “blackout” in Europe. I also analyze in detail the WEO’s forecast for some of the main energy sources (oil, gas, coal and uranium), and critical materials (essential materials for the installation of renewable energy systems, for example). Finally, I argue the need to recognize the severity of the problem we are facing, and outline several concrete actions that should be taken to achieve the most orderly and painless transition possible.

The current price crisis and the risk of “blackout”.

One of the most serious problems we are facing in Europe right now is related to the shortage of natural gas. **The European power grid system is crucially dependent on natural gas, which is a critical issue as it could trigger long-term blackouts.** Let me explain.

We tend to think of electricity as a fluid, as if it were water, but in fact electricity does not behave in that way. In our electric sockets we have an alternating current, a wave that oscillates fifty times per second. This is done so that less energy is lost when transported long distances. When putting different systems in a network to produce electricity (for example power plants of all kinds, renewable systems and such), it is necessary that they are all perfectly synchronized, meaning that they rotate at the same speed and at the same time, otherwise, a lag occurs. With the current number of systems distributed over a very large area and with very different characteristics, it is extremely difficult to synchronize them all perfectly, and this can lead to serious incidents. If a lag is not controlled, it can produce very large voltage surges and dips, up to 10 or 20 times higher than usual, and can literally destroy a high-voltage line or a

transformer station. When a lot of this type of instability occurs, the power grid has to be shut down immediately. For example, on January 8th 2021, in Croatia, an underfrequency was generated (not reaching the usual 50 cycles per second), while in Germany there is invariably superfrequency (more frequency than adequate due to their many wind turbines). As a result of this lag, the European regulator was forced to cut the European grid in two, separating the East from the West.

To avoid these lags, we can use power plants that have a rapid response capacity that can compensate for instabilities wherever they occur. There are only two technologies that allow us to introduce high power at specific locations quickly: hydroelectric power plants and combined cycle gas plants. However, with the water reservoirs depleted during this summer of high prices, large amounts of gas are required for combined cycle gas plants in order to keep instabilities at bay. This is one of the difficulties with the way in which the mass installation of renewable systems has occurred without the expensive but necessary additional stabilization systems having been added. Now, **when gas becomes scarce and its price rises, the electricity grid is left at the mercy of renewables, as and when they are installed, without the necessary additional systems. This increases the risk of instability and long-range power outages that can take up to weeks to resolve.** This is why civil protection authorities in Austria and Germany have made recommendations in the face of a possible power blackout this winter. **Although Spain is much less vulnerable to such risks, mainly due to its reduced interconnection with the European grid, it is not exempt from problems. They exist to a lesser degree, but are still important,** and this is not being explained.

The symptoms of a structural crisis

These days, many companies in many different sectors are experiencing shortage problems. Although there is always a multifactorial problem when considering the case of each raw material, processed material or final product, with many factors affecting the shortages observed, the short-

age of diesel is one of the most important. **It was known that sooner or later the diesel shortage would occur, and now it has arrived in full force, yet still no action is being taken.**

The highest quality oil, the so-called conventional crude oil, needed to make diesel, reached its peak between 2005 and 2006.⁵ Many of the new liquid hydrocarbons that have been introduced in recent years to substitute conventional crude oil (the so-called “unconventional oils”), are oil substitutes with many limitations and are not suitable for making diesel. **Due to this lack of quality oil, we reached the peak of global diesel production in 2015 and after a few years of standstill, its production has begun to fall sharply** (Figure 1).⁶

This global diesel shortage is behind the rising cost of both land and sea transport.

The cost of transporting containers by sea has increased tenfold in the last year. Not only that, some mines have been closed and certain projects have been scrapped as operating costs have become more and more expensive due to the widespread use of diesel for mining equipment. Combined with the already existing difficulties in increasing

coal production since 2014 (primary peak coal production), such issues are causing a severe shortage of coal in China and India (countries whose electricity relies 65% and 70% on coal respectively), but are also causing shortages in the availability of aluminium, copper, iron, lithium, silicon metal, and ultimately, virtually any raw material.

The rise in costs of diesel has also caused problems with road transport. The emphasis for these problems has been placed on the fact that there are no truck drivers, **but what is not being made clear is that the wages and working conditions of these truck drivers have been greatly degraded as transport companies try to save on diesel costs.** Currently in Spain, for example, the price of diesel is only slightly below the highs reached in 2008 when oil rose to \$147 a barrel. Now, even with cheaper oil (in the \$80 to \$90 range), diesel is almost at the same price. This is because the high-quality oil that was best for making diesel has decreased sharply.

However, **approaching this problem as something that is structural, permanent and getting more and more complicated, is often avoided.** Except for small upturns

Figure 1. Evolution of world diesel/diesel production between 2003 and 2021 in millions of barrels per day

Source: Fernández, R. (2021). El pico del diésel: edición 2021 [The peak of diesel: 2021 edition]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2021/11/el-pico-del-diesel-edicion-de-2021.html>

⁵ IEA (2010). *World Energy Outlook*. Available at: <https://www.iea.org/reports/world-energy-outlook-2010>

⁶ Turiel, A. (2010). La Agencia Internacional de la Energía reconoce la llegada del Peak Oil [The International Energy Agency recognises the arrival of Peak Oil]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2010/11/la-agencia-internacional-de-la-energia.html>

triggered by the collapse of many companies, the trend in terms of energy availability will be downward. It is essential to recognize that structural measures must be taken to deal with these problems. To summarise in one sentence: **the current economic model is finished**, the party's over. **We have to be honest and tell the truth, we are entering an era in which the abundance of cheap energy is ending.** This does not mean that all energies will finish abruptly, but instead that we have reached a maximum and **from this point on, no matter how much we invest, we cannot avoid the fact that we have less and less energy.** It is hard to accept that the party's over, but the sooner we recognise it, the better we can act.

With this contextualisation, let's now delve into the WEO 2021.

World Energy Outlook 2021: An edition against the clock

Similarly to the previous year, the WEO 2021 was published one month earlier than usual. The stated reason for the change on this occasion was to put a **special emphasis on the important United Nations summit on Climate Change, the COP26, which took place in Glasgow between 31st October and 12th November 2021.** While it is positive that the IEA places such importance on climate issues, these types of summits take place every year and until now, there has never been any apparent consideration to synchronize the release of the WEO with such events. Perhaps, in some way that we do not yet know, this summit was special.

Another thing that stands out about the WEO 2021 is its relative brevity. Instead of the 700 pages that the IEA had us used to, this year's WEO is "only" 386 pages. There is a good reason behind this brevity. As a general rule, the bulk of the work of compiling the data, running the models that make the projections and drafting a WEO ends around May or June of each year, and the three

or four months prior to publication are devoted to polishing details and layout. This year, however, it is clear that they have had to work against the clock to reach the anticipated publication date. Just three months before, the IEA projected that the price of gas in Europe would not exceed 60€/MWh⁷, and that in spring 2022 it would drop to 30€/MWh⁸. Reality has belied this forecast however, and **the new situation with the coal shortage in Asia is making it clear that something in the energy market is getting very out of control.** The WEO 2021 has had to be in large part improvised in record time, re-running models and redoing the analysis, to avoid looking ridiculous by ignoring the disaster that we are currently in.

The fallacy of peak demand

As I do every year, the first thing I did was to search for the expression "peak oil" in the report. As is almost always the case, these words are not presented together on a single occasion. However, the expression **"peak in oil demand" (the old fallacy)**⁹ is repeated on multiple occasions, which is the way that the stubborn defenders of the free market prefer to think that our shift away from oil will occur. In fact, "peak" is mentioned 35 times, and in every case it is either associated with a reduction in the demand or supply of some energy source, or talking about CO₂ emissions. Even more significantly, the word "security" (**"energy security" being the euphemism used by the IEA to refer to supply problems**) is written 95 times, each time discussing possible supply shortages. In fact, we are already told in the introduction to the report that they will analyze the energy security risks associated with the necessary energy transition. It also states that **in all scenarios the demand for coal and oil decreases**, but at the same time it is necessary to greatly increase investment in new renewable systems to avoid the risks of the transition. **How is it that the demand for these energy sources is decreasing, but there is not enough renewable capacity to**

⁷ The megawatt (equivalent to one million watts) is a unit of power that, associated with time (megawatt-hour or MWh) is often used to measure the consumption of industrial plants or urban conglomerates.

⁸ IEA (2021). Global Energy Review 2021. Available at: <https://www.iea.org/reports/global-energy-review-2021>

⁹ Turiel, A. (2011). Cenit de oferta vs cenit de demanda [Peak Oil vs Peak Demand]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2011/02/cenit-de-oferta-vs-cenit-de-demanda.html>

replace it (due to a lack of investment, according to the IEA)? There is no economic logic here whatsoever: **how can there be a decrease in demanding something as essential as energy if there is no substitute available? Are we supposed to believe that the world is so sensitised to the problem of climate change that everyone will stop consuming fossil fuels even if that entails economic ruin due to lack of energy?** It is impossible to start from a more absurd premise, especially given that Europe is desperately demanding coal (which is not available either) now that it lacks natural gas. Such a starting point is totally contradictory to the factual reality.

The vast majority of the report focuses on decarbonization commitments, emission targets, and how to meet them with appropriate substitution with renewable technologies. I will only deal with these issues tangentially, just to trace what is actually happening with energy supply. That is not to say that environmental problems, and particularly climate change, are not important. Of course, they are and very much so, but this is not the main purpose of this analysis; the interested reader will no doubt find other detailed analyses of these very relevant issues. Since the structure of the report focuses on these previously mentioned aspects, the discussion of such aspects that refer to the current energy crisis are somewhat scattered throughout the report. In this *analysis*, I group them together to try to get a coherent picture of what is going on and what the IEA is actually telling us which, in principle, should be its central mission.

The different scenarios

As in every annual WEO, **different scenarios are established for each of the forecasts.** The main scenarios presented in this year's edition are summarised in Box 1.

Aside from these, there is **another minor scenario**, a continuation from WEO 2020, which is the **Sustainable Development Scenario (SDS)**, something that would be halfway between a NZE and this year's APS. Interestingly, **the**

Current Policies Scenario, the BAU (Business as Usual), does not appear this year.

Box 1. Main scenarios of the World Energy Outlook 2021

Zero Net Emissions Scenario in 2050

(NZE): This scenario assumes that emissions from the burning of fossil fuels are offset by appropriate measures that ensure that the amount of atmospheric CO₂ does not increase after 2050.

Announced Commitments Scenario

(APS): This scenario assumes that the commitments already announced by governments to fight against climate change will be put into effect.

Stated Policies Scenario (STEPS): This scenario assumes that the policies already in place and those in the approval phase go ahead. In previous years, this was the reference scenario, but in this WEO the IEA decided not to get involved and does not explicitly state any reference scenario.

All these scenarios are produced using a demand-driven numerical model (derived from the OECD economic models). Such models are suitable when there are no supply constraints, simply meaning if there is more demand for oil, or other resources, a supply quickly appears to meet it. **However, such models fail spectacularly as we approach the material limits of our planet.** In recent years, the IEA has made an effort to integrate some supply constraint issues into these models, especially for oil, as year after year their predictions were far from reality. **Despite this, they have not yet taken the step of modelling reality with supply-based models, such as MEDEAS ("Modeling Energy Development under Environmental And Socioeconomic constraints").**¹⁰ As we will see at the end of the analysis, **this anomaly leads them to have problems reconciling what the model demonstrates and reality,** which they solve in a rather puzzling way.

¹⁰ Turiel, A. (2016). Arranca el proyecto MEDEAS [The MEDEAS project gets started]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2016/02/arranca-el-proyecto-medecas.html>

Another consequence of these models being demand-driven is that it is assumed that some alternative source will provide the necessary energy. In recent years, and in the presence of increasingly evident physical limits on raw materials, that source is logically renewable energy. However, **the aforementioned models are not in any way integrating the possible limitations that renewables may have.** Therefore, the analysis of the evolution of these sources within the WEO is, in my opinion, of little interest, since it merely discusses what is needed to reach their intended objective. Even so, the IEA is beginning to understand that certain limits may affect them, particularly that of the critical materials that they need for construction.

To present the scenarios, they show us a graph (Figure 2) comparing how the forecasts in the STEPS scenario have evolved over the last five years. I think it is quite significant and eloquent. In this WEO 2021, **we see for the first time that all fossil fuels reach their limit (although in the case of gas, since it has not yet reached its peak, they artificially delay it until 2050).** What is **particularly striking**

is the sharp drop in coal, which is perhaps not entirely realistic (especially if slave labour is used, as will probably end up happening)¹¹, and the overly gentle drop in oil.

To justify this debacle (still excessively sweetened, because oil and gas will fall faster than predicted here), **we are told that everything is going to make a rapid transition towards electrification, of course with renewable origins.** However, **even in the most drastic scenario, the NZE, electricity only accounts for 50% of all final energy consumption in 2050** (and only 30% in APS). This explains why a moderate view of the decline in fossil fuel consumption has yet to be given. The IEA emphasizes that much more money has to be invested in renewable energy and, above all, in “clean technology”, which is what it calls technologies destined for the harnessing of renewable electricity. As we know, **the world is stagnating at around 20% of final energy consumption coming from electricity**, and it is proving difficult to increase that percentage. **Although a certain increase is feasible, it is highly debatable that it will ever be possible not only to reach 100%**

Figure 2. Demand of petrol, natural gas and coal in the Stated Policy (STEPS) scenario in the World Energy Outlook 2021, 2020 and 2016

Note: Oil peaks for the first time in the WEO-2021 STEPS scenario; natural gas has been revised down from the WEO-2020; coal use is much lower than was projected five years ago. WEO-2016 numbers are the New Policies Scenario extrapolated to 2050.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

¹¹ Turiel, A. (2011). Tasa de Retorno Energética y progreso tecnológico [Rate of energy return and technological progress]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2011/10/tasa-de-retorno-energetica-y-progreso.html>

renewable electricity, but even to exceed 50%. In this sense, the IEA recognizes the difficulty of implementing “clean technologies” in long-distance transport and heavy industry, and therefore indicates the need for more innovation in these areas, as if more research would necessarily provide us with the solutions we need.

Figure 3 (extracted from page 165 of the report) summarizes the expected evolution of the total primary energy consumed according to the various scenarios.

As one can see, **even in the STEPS scenario** (which in other years would be considered as a reference), **energy production from non-renewable sources would have already peaked**, although it is assumed to fall gently until 2050; and all the energy that is needed in order to continue growing is provided by renewables. The other two scenarios are much more interesting: **in the APS we see a scenario of a moderately rapid decline in non-renewable sources**, while **in the NZE the decline is very abrupt**. That is very convenient, because **if in the end the latter is what happens** (due to investment problems that are discussed below), **it will be said that the**

world is following the NZE scenario, only with the necessary investment in renewables lacking, and that therefore it is necessary to invest more money in them: this is precisely the tune that the IEA has been playing for the last few months. It is also worth noting that **the NZE scenario is clearly a degrowth one**, and that, **even though the volume of renewable energy grows in an absolutely implausible way, there is still a decrease in the amount of total energy**. The report justifies this by saying that the improvements in efficiency and the better performance of electricity mean that with this volume there will be more than enough (an improvement in energy intensity of at least 2.5% per year throughout this decade is assumed - as a reference, Spain's energy intensity has improved less than 1% per year in the last 20 years), but **by now we are aware that energy decline implies, in the medium and long term, economic decline**.¹²

Let us now summarize the main findings regarding the issue of energy security, non-renewable fuels and critical materials.

Figure 3. Total primary energy supply by fuel and scenario

Note: Closing the implementation gap between STEPS and APS requires achieving current pledges; new pledges are needed to close the “ambition gap” from the APS to NZE.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

12 Le Monde (2014). Gaël Giraud, du CNRS: “Le vrai rôle de l’énergie va obliger les économistes à changer de dogme” [Gaël Giraud, from CNRS: “The real role of energy will force economists to change their dogma”]. Available in French at: <https://www.lemonde.fr/blog/petrole/2014/04/19/gael-giraud-du-cnrs-le-vrai-role-de-lenergie-va-obliger-les-economistes-a-changer-de-dogme/>

Energy security

On page 64, the WEO echoes the recent price race for all non-renewable energy commodities (Figure 4).

The IEA recognises that this price increase is due to the fact that the supply is not able to fulfill the demand. Even more surprisingly, **they recognise that investment in exploration and development of oil and gas fields in recent years has been declining**, as some of us have been warning for years.¹³ Contradictorily, they tell us, more and more is being invested in vehicles with internal combustion engines and the gas distribution infrastructure is expanding. On top of that, COVID-19 has aggravated the disinvestment trend in oil and gas, which we had also indicated previously.¹⁴ **The rise in the price of fossil fuels generates contradictory impulses for the transition:** on the one hand, it makes renewables more economically competitive (which in reality, is doubtful, because

all raw materials are becoming more expensive, as well as those used to manufacture panels and wind turbines), but on the other hand it encourages governments to provide subsidies to alleviate energy bills, and theoretically favours investment in fossils (which we know has not happened since 2014 because it would be investment in a lost cause).¹⁵

Aware as they are that there is a serious problem with raw materials for energy, the IEA has carried out a sensitivity analysis of how a price shock in 2030 would affect household economies. The problem is that they stay within very modest price ranges and estimate that the impact on household bills would be an increase in energy costs of 25% in advanced economies and 35% in emerging economies in the case of the STEPS scenario; in the NZE scenario it is very small because, as they say, renewables have marginal costs tending towards zero (they are apparently immaterial). **Unfortunately, as they do not use an integrated model such as MEDEAS, they are unable to see that an increase in energy prices, even**

Figure 4. Oil, natural gas and coal prices by region (2010-2021)

Note: Natural gas and coal prices were significantly reduced during the pandemic, but have recently risen sharply. USD/MBtu = US dollar per million British thermal units. Gas prices for the European Union and Japan are weighted average import costs. The United States gas price reflects the wholesale price on the domestic market. Coal prices are an average of steam coal import prices in the European Union and Japan and domestic sales and imports in coastal China.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

13 Turiel, A. (2016). Pasándose de frenada. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2016/02/pasandose-de-frenada.html>

14 Turiel, A. (2020). La tormenta negra [The Black Storm]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2020/04/la-tormenta-negra.html>

15 Turiel, A. (2014). La ilógica financiera [The Financial Illogic]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2014/09/la-ilogica-financiera.html>

a moderate one such as they project, ends up impacting the prices of everything else, further deteriorating the family economy. Therefore, the laudable effort to analyze this problem ends up being a clearly unsuccessful exercise.

However, at the IEA they are not unfamiliar with a reality that is becoming harsher and more elusive. Therefore, on page 68 there is a very interesting discussion in which **they recognise that their model, by construction, can only represent smooth changes, while the transition could be drastic and volatile, with high risks associated with what they call “investment misalignments”, meaning that investments are not made where they should be.** Of course, there is still a growing investment in renewables and a decreasing investment in fossils (which has fallen 60% from the 2014 highs, but is still large), yet it would take much more investment to avoid problems. What the IEA does not understand is that, in reality, **the huge additional investment required to avoid these problems is not being made anywhere, neither in fossils nor in renewables, due to lack of profitability.**

The graph shown by the WEO 2021 (Figure 5) on the recent evolution of investment in oil and gas exploration and development on the one hand,

and in “clean energy” systems on the other hand, is very illustrative. This is especially because it shows a **clear intention to deceive and confuse, which from my point of view is almost criminal.**

Looking at these graphs, **one might get the impression that investment in oil and gas had remained fairly stable in recent years** until the arrival of COVID-19, while investment in “clean energy” is very constant. **The reality is quite different.**

The key is to only show what happens as of 2016. If we widen the focus (as in Figure 6, from Rystad Energy) we see that **until 2014 investment in oil and gas grew at a good rate, and then plummeted between 2014 and 2016.** If we looked at the graph going back until 1998, it would show that **from 1998 to 2014 the investment had multiplied by three.**

In fact, this graph from Rystad Energy provides us with more interesting information: **after 2016, a process of slower decline begins all over the world except in the United States (US), where there is a vigorous rise (the ruinous fracking) that compensates the fall of the rest.** Then, with the arrival of

Figure 5. Investment in oil and gas production and clean energy in the STEPS and NZE by 2050 scenarios

Note: Currently, investment in oil and gas production is closer to the NZE than the STEPS, even while today's spending on clean energy is well below levels reached in both scenarios. 2021e = estimated values for 2021.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

COVID-19, fracking begins to sink. It should also be noted that a **substantial part of the non-fracking investment is for the maintenance of existing fields, not to search for new ones, meaning that the drop in the investment specifically dedicated to exploration is probably greater than 60%.**

Returning now to the WEO 2021 graph (Figure 5), what the IEA tells us is that in the STEPS scenario, a good part of the investment that was made in 2014 would be recovered (around 80%). This is not only unlikely; it is **impossible, because companies have understood that investing more in oil means losing money.**¹⁶ Even the investment of the NZE scenario is highly unlikely, because the trend is to decrease investment even more, although in principle more gradually. **The IEA skews the information to convey a completely misleading message.** Also, if the presentation is skewed in the case of investment in oil and gas, what about the graph on the right? Suffice to say that **two thirds of what they call “clean energy” are biofuels**, which by the way are far from clean, due to being obtained by industrial agricultural means with an enormous

consumption of fossil energy, generating a double accounting effect. Moreover, they recognise that it is not as simple as limiting investment in new fields, because demand can remain high which causes a price shock (a situation we are in right now with gas and coal, with visible consequences for the entire world, and in which we may soon be with oil). **So political measures must be taken to reduce consumption (IEA, 2021: 69).**¹⁷ **What are these measures?** It will be interesting to see.

Before finishing this section, I would like to reproduce here a paragraph that I recommend for those who interpret the IEA models to read carefully, as a kind of comprehensive prediction given a set of starting conditions:

“By design, the scenarios in this World Energy Outlook describe smooth, orderly processes of change. Energy markets, technologies and policies adapt to one another and evolve in a mutually consistent direction. Prices follow a smooth trajectory, international energy trade is assumed to be free of geopolitical friction, and the scaling up of clean energy technologies occurs in parallel with a gradual decline in investment in unabated fossil fuels. In practice, energy transitions can be volatile and disjointed affairs, characterised by competing interests, market imbalances and stop-go policies. The

Figura 6. Investments en exploration and production by source, in billion USD

Source: Rystad Energy UCube (2020). Global E&P capex will reach at least a 13-year low in 2020 as COVID-19 and price war persist. Available at: <https://www.rystadenergy.com/newsevents/news/press-releases/global-ep-capex-will-reach-at-least-a-13-year-low-in-2020-as-covid-19-and-price-war-persist/>

¹⁶ Turiel, A. (2021). El Gran Despilfarro [The Great Splurge]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2021/03/el-gran-despilfarro.html>

¹⁷ IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

uneven distribution of gains and losses from transitions could deepen existing fault lines in the global political economy, or create new ones. Change could have sharp edges, and bring energy security risks with it." (IEA, 2021: 249)¹⁸

In other words, **the IEA itself is perfectly aware that its demand-driven models are completely incapable of describing the complexity of the abrupt changes that are coming our way, and the description can be particularly bad if non-linear phenomena occur** (which is most likely at this point of incipient energy crisis).

Oil

As mentioned at the beginning, the various scenarios for oil production show large differences between the estimates of its future evolution, although they all share the fact that by now **we would have passed or are about to pass the peak of production, described here as "peak demand"** (as is logical, although incor-

rect, since their models are *demand-driven*) (Figure 7).

An interesting discussion about the future of oil production begins on page 221 of the WEO 2021. We are told that, according to the NZE scenario, investments in new oil fields have not been required since 2021, which is fortunate considering the radical drop in investment that was mentioned a moment ago. We are also reminded that **without any additional investment, oil production from existing fields would fall at a rate of 8-9% per year**, which would mean an excessively rapid decline even in the NZE scenario, and that investment measures are proposed in the existing fields to slow down the fall. This is quite worrying: **11 years ago, the drop in production in the existing fields was around 5% per year. By 2015, the annual rate of decline stood at 6%, and in 2018 it was already close to 8%.**¹⁹ That it is now reaching 9% indicates the degree of aging of the fields currently in operation: **at a rate of 9% per year, production without new investment could fall by around 40% after five years.** In any

Figure 7. Oil demand over time and low emissions fuel demand in 2030

Note: a 31 mboe/d difference in oil demand emerges between the STEPS and NZE by 2030. Biofuels remain the largest low emissions fuel but hydrogen-based fuels increase in the NZE scenario. mboe/d = millions of barrels of oil equivalent per day.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

¹⁸ IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

¹⁹ IEA (2018). World Energy Outlook 2018. Available at: <https://www.iea.org/reports/world-energy-outlook-2018>

case, investing in existing fields to slow down the fall is common and, of course, it has been done for years, so there is nothing abnormal here, except to note that indeed the existing fields are aging fast.

It is also significant that, when discussing oil, biofuels are included. Not because they are included in this category, as they are usually considered “unconventional oils”, but because they are made to count in the category of “clean energy” when convenient. **The IEA notes a significant increase in biofuel production in all scenarios** (Figure 8).

This increase is very worrying, because **currently 6.5% of cereal grain and 8% of vegetable oil that is harvested in the world is destined to the production of biofuels**,²⁰ and this has been maintained for more than 10 years at a meager 2 million barrels per day (2 Mb/d), compared to the 95.5 Mb/d that was produced in total for all petroleum liquids in 2019.²¹ The growth rates proposed by the IEA are very high in all scenarios, and **the risk of this having an**

impact on greater competition of these fuels for food is enormous. It is of little use for the IEA to clarify that most of the increase comes from “advanced” biofuels: the increase until 2030 of traditional biofuels (that is, those that come from food) is considerable. In addition, **there is no technology today that commercially provides “advanced biofuels”**, which theoretically are those obtained by processing the inedible parts of plants. Therefore, the risk of the missing biofuels being taken from food is considerable, and it is totally reckless for it to be considered here, especially considering all of the food crises of recent years and the current fertilizer crisis.²²

Gas

According to the IEA scenarios, **natural gas is expected to be close to reaching its productive peak in all scenarios except that of STEPS**, although even in this scenario it shows a trend towards stagnation (Figure 9). **In APS and**

Figure 8. Liquid biofuel demand by type and scenario

Note: Production routes and end-uses differ, but biofuels increase strongly in all scenarios until 2030. Advanced biofuels are key to meeting net zero targets, especially for trucks and aviation. mboe/d = million barrels of oil equivalent per day.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

20 Washington Post (2011). How biofuels contribute to the food crisis. Available at: <https://www.washingtonpost.com/wp-dyn/content/article/2011/02/10/AR2011021006323.html>

21 IEA (2021). Oil Market Report. Available at: <https://www.iea.org/topics/oil-market-report>

22 Bloomberg (2021). Food Prices Poised to Surge With Fertilizer at Highest in Years. Available at: <https://www.bloomberg.com/news/articles/2021-09-20/surging-fertilizer-costs-risk-making-food-even-pricier-next-year>

Figure 9. Natural gas use over time and low emissions gas supply in 2030

Note: Natural gas use increases in each scenario to 2025 with sharp divergences thereafter. Biogas use grows rapidly in each scenario. There is a large role for hydrogen in the NZE. “Hydrogen gases” include low-carbon gaseous hydrogen and synthetic methane. 1 EJ = 29 bcm.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

NZE, the decline in natural gas production is very marked.

It is interesting to see, according to these scenarios, how this decrease in production and therefore consumption will be achieved. The IEA explains that for the APS scenario, **the large drop in consumption would be produced by the reduced use of gas in buildings in Europe and the US, and in the electricity production sector in the US.** The idea is obviously that these two sectors are going to resort en masse to the use of renewable electricity. **Unfortunately, the primary use of gas in buildings is to produce heat, and electricity is not generally (heat pumps apart) the most efficient to produce heat.**

Coal

The **outlook for coal in the WEO 2021 is terrible**, with it falling in any scenario (Figure 10).

According to the IEA, one of the reasons that would explain the drop in demand is

the rapid withdrawal of coal-fired power plants. However, as shown in the graph below, the average age of plants in China and India (the two largest coal consumers in the world) is around 11 years, when these facilities have a use life of 30 years, which can easily be extended by another decade or two. And as the WEO 2021 tells us, **two-thirds of the installed power in coal-fired power plants is in Asia, so China’s and India’s actions are key.** In the midst of the current coal crisis,²³ **It is difficult to believe that the Chinese or Indians will choose to retire their plants. Rather, their problem is that they will not have coal to fuel the plants.**

Uranium

Breaking with the tradition of previous WEOs, in WEO 2021 **a great expansion of new nuclear power plants is contemplated in all scenarios, reaching its maximum expression in the case of the NZE scenario**, which posits double the current installed capacity by 2050 (Figure 11).

23 Turiel, A. (2021). La Crisis del Carbón [The Coal Crisis]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2021/10/la-crisis-del-carbon.html>

Several issues in this graph should be highlighted. The first is that **the new power grows in an absolutely dizzying way in all scenarios**: bear in mind that the power of the new plants is the sum of the two bands of lighter color; the dark green and dark blue stripes correspond to current plants, which will be decommissioned at

an increasing rate in the coming years. Another interesting question is that, **looking at the graph of total energy that we saw earlier in Figure 3, we do not see in the scenario an expansion of nuclear energy like the one that Figure 11 would suggest**. The key is that **this last figure speaks of in-**

Figure 10. Coal and solid bioenergy demand by scenario

Note: Coal demand declines by 55% until 3030 in the NZE, far below levels in the other scenarios. Modern bioenergy increases in each scenario; traditional uses are phased out in the NZE.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

Figure 11. Nuclear power capacity by scenario (2020-2050)

Note: Nuclear power can help clean energy transitions through lifetime extensions for existing reactors where safe, and the acceleration of new construction where acceptable.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

stalled power, but not of energy produced.

And that brings us to the key question: **what uranium is supposed to be used in those nuclear power plants? It is clearly being assumed that the plants are not going to be used to their maximum capacity.** If you look up the word “uranium” in the WEO 2021, you will be surprised to find that there are zero results. For some reason, the IEA does not consider it important to talk about the production of fuel consumed by nuclear power plants, even though the rate of their installation is expected to accelerate in the coming years. **In 2014, the last year in which the IEA decided to include a graph on uranium production, it presented a very dispiriting outlook: a continuous decline in uranium mine extraction, only offset by the use of secondary reserves** (the excess uranium extracted in previous decades, mostly stored in the form of nuclear bombs that are now being dismantled) **and by the start-up of some miraculous “identified mines”** (but not in operation). Despite these reserves, **by**

2025 uranium would begin to be lacking if its consumption continued to rise as predicted (Figure 12).

Data for the years since 2014 show us that we are actually worse off than these figures predict. In fact, **if one looks at the most up-to-date data on mine uranium production, we see that production only managed to exceed the 60,000-ton mark in 2016, and since then we have entered a continuous production decline that, obviously, has not allowed the demand to increase.**²⁴

It so happens that, **just as with oil, coal and gas, investment in uranium mines has also been falling for years - and more so lately, as the WEO 2021 itself recognises - so it is not clear how production could increase. Indeed, it will not: uranium peaked in 2016** (Figure 13), and as a consequence the production of nuclear energy will never exceed that historical maximum and will progressively move away from it.

Figure 12. Uranium demand in the New Policies Scenario of WEO 2014 compared with existing and planned production

Note: Identified mines incorporate prospective and planned mines and those under development. Some of those mines are already under construction; others are projects likely to proceed only if adequate price signals are sent by the market. New Policies Scenario was the central scenario in WEO 2014. It described a pathway for energy markets based on the continuation of existing policies and measures as well as the implementation, even if they were not yet formally adopted (WEO 2014: 6).

Source: IEA (2014), World Energy Outlook 2014. Available at: <https://www.iea.org/reports/world-energy-outlook-2014>

²⁴ World Nuclear Association (2021). World Uranium Mining Production. Available at: <https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx>

Knowing this, we can understand how to reconcile Figures 3 and 11: the IEA is assuming that this decline in uranium production is going to be slow enough to maintain a fairly constant nuclear power production even though installed power is going to increase (that is, some panels will be idle for a part of the time). It is the usual way for the IEA to indicate one thing while saying another.

Critical materials

The need for critical materials, the price of which is skyrocketing, is an issue discussed in this WEO. One figure that has caused quite a stir is Figure 14.

What the figure on the right shows is the factor by which the demand for certain materials used to manufacture electric cars in the NZE scenario will multiply under two hypotheses: that the most efficient chemistry will be used for batteries, or that chemistries will be chosen that are less efficient but do not require as many critical materials. As we can see, **by 2050 the demand for**

lithium could multiply by 130 with respect to the current demand. In addition, the IEA clarifies that **the demand for lithium for all uses would multiply by 100, and that for nickel and cobalt would multiply by 40.** These are completely unbelievable values: **it is absolutely impossible that production could reach such disproportionately high values, due to - among other things - the lack of oil needed for its extraction, but also because there are not enough reserves of these materials, nor can production be sustained in such high values.** For this reason alone they should understand that **the NZE scenario does not have any trace of credibility.** In any case, the rest of the scenarios also have serious problems in this part of the report, without reaching the extremes of the NZE. The report also mentions the cost-related problems associated with the use of silver in photovoltaic panels, or rare earths in wind turbines (such as neodymium and dysprosium), but without dis-

Figure 13. World uranium production between 2009 and 2020, in metric tonnes

Source: own elaboration based on data from the World Nuclear Association. Available at: <https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx>

Figure 14. Battery chemistries and EV-related mineral demand growth in the Net Zero Emissions by 2050 Scenario in the base and constrained mineral supply cases

Note: A switch away from high nickel chemistries towards LFP and LNMO chemistries in the constrained case shows complex trade-offs between mineral demand and prices. LDV = light-duty vehicles, including passenger light-duty vehicles, light commercial vehicles and two/three wheelers; LFP = lithium iron phosphate; LNMO = lithium nickel manganese oxide. NCA = nickel, cobalt and aluminum oxide; NCA+ = nickel-rich (and low-cobalt) variant of nickel-cobalt-aluminum oxide (NCA); NMC811 = nickel manganese cobalt oxide with 80% nickel, 10% manganese and 10% cobalt.

Source: IEA (2021), World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

discussing the possible supply problems that also affect these materials. The WEO 2021 is limited to making a comparison of the total costs of photovoltaic panels, wind turbines, batteries, etc. before and after the current price increase in 2021, and concludes that these are moderate increases (the highest would be a modest 16% for photovoltaic panels). **However, the report does not even include a minimal analysis of the risk of interruptions to the supply of these critical materials, despite the fact that these considerations are found in the section that discusses energy security.**

Hydrogen

Demonstrating the degree of desperation that we are reaching, the WEO 2021 gives a degree of prominence to hydrogen that it had not given in

previous WEOs. I will not go into **the thermodynamic absurdity of hydrogen²⁵ and the risk that its exploitation will lead to a colonial impoverishment of most of the world, except a small metropolis.²⁶ Still, even in NZE, the most extreme scenario, it is assumed that hydrogen production and consumption in 2030 will be quite modest: less than 20 EJ**, compared to the 570 EJ of total primary energy consumption in the world today. However, **the most curious thing is that about half of that hydrogen would be produced through natural gas with capture, sequestration and use of carbon - more thermodynamic nonsense** (Figure 15).

25 Turiel, A. (2020). La Fiebre del Hidrógeno 2.0 (I) [The Hydrogen Fever 2.0 (I)]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2020/11/la-fiebre-del-hidrogeno-20-i.html>

26 Turiel, A. (2020). Colonialismo vs Nacionalismo Energéticos [Energy Colonialism vs. Energy Nationalism]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2020/11/colonialismo-vs-nacionalismo-energeticos.html>

The coming disaster

However, undoubtedly the most important graph of the WEO 2021 is Figure 16, because of its multiple implications. Firstly, it is necessary to give the context in which this graph appears. It is in the last chapter of the WEO 2021, where the problem of energy security is discussed. The paragraphs in which it is inserted discuss **the need to continue investing in at least the maintenance of the existing oil and gas fields in order to verify the NZE scenario, and consider the risk that there will not even be this investment**, in line with what has been experienced in recent years. Let's recall that **since 2013 the IEA has been warning that there could be problems with lack of investment.**²⁷

The WEO 2018 introduced a very extensive discussion on how much oil could be lacking due to divestment in the search and commissioning of new fields. In this edition, the **IEA warned that**

in 2025 up to 34% of oil consumption could be left unsatisfied, which would produce several price spikes.²⁸ **In the WEO 2020, this possible shortage was increased to almost 50%**, and it presented the problem the same way as in this year's WEO, showing what the supply should be according to two scenarios and comparing it with what the decline would be if there is investment or not in maintaining the current fields.²⁹ The difference between the 2018 graph and the 2020 and 2021 graphs is that in the two most recent graphs the space between the supply and the demand has been filled in colour so it gives a better impression, without emphasising the size of the missing supply.

The first thing to note is that Figure 16 presents three scenarios, and not two as in the previous WEOs. In 2018 and 2020, the second strip corresponded to how the production of the existing wells will actually fall, assuming that there will be investment in their maintenance. In the WEO

Figure 15. Low-carbon hydrogen and hydrogen-based fuel demand and supply by scenario in 2030

Note: Hydrogen demand increases across the board and is produced by both electrolysis and natural gas with Carbon Capture, Usage and Storage (CCUS). The transformation includes electricity and heat, production of hydrogen-based fuels and refineries.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

27 Turiel, A. (2013). WEO 2013: El límite de la mentira [WEO 2013: The Limit of the Lie]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2013/12/weo-2013-el-limite-de-la-mentira.html>

28 Turiel, A. (2018). World Energy Outlook 2018: Alguien gritó "peak oil" [World Energy Outlook 2018: Someone screamed "peak oil"]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2018/11/world-energy-outlook-2018-alguien-grito.html>

29 Turiel, A. (2020). World Energy Outlook 2020: La dificultad de seguir engañándose [World Energy Outlook 2020: The difficulty with continuing to trick ourselves]. *The Oil Crash*. Available in Spanish at: <https://crashoil.blogspot.com/2020/10/world-energy-outlook-2020-la-dificultad.html>

2021, the green strip (NZE scenario) also includes, besides the existing wells (as the 2018 and 2020 editions indicated), the commissioning of some new fields. There are not many, but it dampens the fall a bit - especially in the first years - and in any case it helps to conceal the anomaly of this type of graph.

Yet these graphs do not make sense in a comparative discussion of scenarios, because there is no scenario called “No investment in oil/gas fields” or “Only with investment in the maintenance of oil/gas fields”. Nevertheless, the associated stripes appear on those graphs. Why? Because they are implicit scenarios. **The IEA has already detected that investment in the search for and commissioning of new fields is not correctly described by its *demand-driven* model.** For this reason, their oil production growth forecasts have been revised downwards year after year (from the 120 Mb/d that they predicted for 2035 in WEO 2007 to just over 100 Mb/d in 2050), and only in the STEPS scenario (the other scenarios showing a drop). The IEA model cannot integrate the lack of investment, and includes those extra stripes in the graphs to be able to give a reference; to know where we are.

Last year, the drop from the peak of oil production to the 2025 value was almost 50%; this year it stands at 42%, more in line with the announced value of a production decline of 9% per year for existing fields. A bigger drop would mean that fields currently in production are being abandoned, and that must have seemed too radical. The IEA shows us, therefore, what is the worst that could happen (if all investment in the production of oil and gas was eliminated) and compares it to what happens if the bare minimum is invested. **This justifies the introduction of the NZE scenario, despite its dire implications in terms of materials that we discussed above, as it allows for camouflaging the possible course of oil production, in which investment is only made to conserve existing fields with a minimum in new exploitation.** That also explains why there is no baseline scenario: if things evolve as in the NZE scenario, it will be said that the world’s climate ambition is very great and that investment in oil and gas corresponds to this scenario, and that it would only be necessary to make the corresponding investment in renewables, which, as we know, will not be able to meet the unattainable levels required. **However, the IEA already has its alibi: no one can blame them for not having warned**

Figure 16. Global oil and natural gas demand and declines in supply by scenario

Note: In climate-driven scenarios, a large part of upstream oil and gas investment is spent on maintaining production at existing fields. mb/d = million barrels per day; bcm = billion cubic metres.

Source: IEA (2021). World Energy Outlook 2021. Available at: <https://www.iea.org/reports/world-energy-outlook-2021>

us. The worst part is that we will probably stay below the band attributed here to the NZE scenario, given the climate of widespread divestment and growing problems in global supply chains.

The other worrying aspect of this graph is that it shows, for the first time, a negative course for natural gas production. **The NZE strip shows a gas peak occurring before 2030, in line with expectations. It is the first time that the IEA has taken a step towards recognizing that there is going to be a peak in natural gas production, although they call it a “demand peak”.**

The last curious thing about this graph is that they have not considered it relevant to show this same breakdown with coal, which is strange because all three fossil fuels have been referred to in an analogous way throughout the report. **The fundamental reason for this inexplicable omission is, in my opinion, that what happens to coal is primarily of interest to China and India, which are not OECD countries.** Essentially, in my view, this report provides excuses for OECD governments to use, who the IEA ultimately works for.

In conclusion, this strange WEO has only served to present the story with which the energy crisis, already underway, will be explained from now on. **When the production of oil, gas and coal goes down, it will be said that the predicted “peak demand” has taken place, necessary to meet the objectives set in the fight against climate change, and it will be insisted that it is necessary to increase investment in renewables, although this will never arrive in the required volume.** All of this is without taking into account that in order to extract the materials necessary for this colossal renewable deployment, those same fossil fuels are needed, yet their production is going to decrease, regardless of our ambitions to tackle climate change. **The narrative is already prepared.** It now remains to be seen whether Western public opinion buys it or not.

The path to be taken

From the point of view of science and technology, we have enough knowledge and capacities to be able to guarantee a quality of life as good as the current one, but consuming much less, and with a different lifestyle.

The first thing to be done is to recognise the problem in order to be able to start designing policies on as local a scale as possible, taking advantage of renewable energy while improving its performance and consuming less scarce materials (that are also produced in other countries). Everything is becoming more scarce, which is logical because everyone wants to adapt at the same time. **More local and more redistributive systems should be proposed, so that energy is used in the same place it comes from.** We must forget about building enormous global networks and have more local consumption, combined with a more direct usage of renewable energy. For example, using factories that function with the hydraulic energy of rivers, or making use of organic material to produce chemical reagents, medicine, plastic, etc. All of this is possible at a much **more moderate scale of consumption.**

If we do not change we could reach a situation of collapse. Human history shows us that there have been many collapses before now. Societies collapse **because they are led by a mistaken idea** for religious, political or economic reasons, such as is currently happening by maintaining capitalism and its perpetual growth at all costs. If this continues, we are undoubtedly going to collapse. On the other hand, **there are historical examples of societies that recognised the signs of collapse, and managed to stop it from happening and improved their situation.**

Capitalism is not only the system that regulates economic - and even social - exchanges in our society. Beyond that, it has a large cultural weight: it possesses the hegemony of the public discourses. This means that, for example, **many people have a very defeatist attitude of “we can’t change anything”.** This is false. **We can change many things, but in order to do so we must be aware that it is necessary to**

make a series of changes that ultimately bring us to a more **healthy, more self-sufficient, more resilient** society that is better adapted to face climate change and the energy crisis. People must understand that they have much more power than they think. When everyone acts together, they can change things, and there is hope. The **first step is to understand the situation** in order to confront it. **Where do we start?**

The first problem to be resolved is that of food. There is a scarcity of nitrogenous fertilisers, phosphorus and potassium, which is the combination that is commonly used to fertilise the land. **The second is water.** When the Austrian or German civil protection spoke recently about the water problem derived from the potential “blackout”, this was because the water supply in cities comes from deposits that pump water using electricity. If there is no electricity, there is enough water in the deposits for two or three days. **Third is the distribution networks of everything.** These must be reduced, and local resources must be used. We have many sources of primary materi-

als, such as landfills and junkyards. They contain a lot of high quality material that can be used.

There are many things to do: create local employment, guarantee communications, avoid dispersed urbanisation with remote housing far away from supplies, maintain the health, education and - above all - dignity of the population. All of this cannot be improvised; it requires us to take appropriate and duly planned measures. Energy alone is just an instrument, a tool, yet it is necessary for these basic necessities, and right now we are squandering it. **In the face of the looming energy crisis, we must urgently concentrate our efforts on guaranteeing these essential elements of society. ■**

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