New Alter Project for Brittany

Version 2022

Towards resilience or chaos?

A sustainable future for Brittany
Living better oil-free and nuclear-free

Photo credit : SABELLA

Preamble

A new Alter Breton project

The drafting of the new alter breton project was undertaken following a proposal made to UDB in 2018. Today the document is available to all, individuals or organisations, with the aim of increasing and improving its content.

For a project remains a set of proposals whose different components are articulated according to their own internal logic.

It is by no means a bible or a programme that should be applied as is without consultation.

All the subjects presented are obviously open to amendment and will require argued contributions that will enrich, increase, clarify, improve or even correct the initial document.

All new proposals may therefore be studied by a committee yet to be formed.

The stated objective is to achieve energy autonomy for Brittany by 2050.

Only one provision is non-negotiable:

*T**he project's scope of action concerns the real Brittany.***

The neighbouring Transligeria, a technocratic creation, which shares many characteristics with Transnistria, including the lack of international recognition, must be dissolved and its "departments" distributed among the neighbouring regions.

DELENDI SUNT PAGI LIGERIS

The content of this document is based, while remaining coherent, on seven of the twenty themes presented in the UDB programme book published in 2018.

In particular, the following chapters: spatial planning, housing, transport, energy, agriculture, sea and economy.

It should be noted that these seven themes are also part of the areas of competence devolved to the Senedd: the Welsh Assembly. which has the necessary budgets to exercise them.

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Pending the setting up of a structure dedicated to the discussion, comments can be addressed in PM on the following page

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Yes Brittany

You can download the file in pdf format by clicking on this link:

https://www.yes-brittany.eu/pellgargan/RANB2022/New-Alter-Project_4_Brittany_2022_YB.pdf

Better living in Brittany

Without oil and without nuclear power

For a new Alter Breton project

*This year marks the fiftieth anniversary of the publication of the report **"The Limits to Growth"**, whose conclusions are now proving relentlessly accurate with regard to the evolution of the five basic factors that determine and, in their interactions, ultimately limit growth on this planet.*
By choosing to study the energy data alone, among the five factors in the above-mentioned report, thirteen years ago the UDB updated the data of the first alter Breton project dating from 1979.

During these thirteen years, the perception of the ecological impasse towards which our civilisation is rushing has progressed among the population, but it must be noted that consumer behaviour has not changed significantly.

It is true that the ultra-liberal and short-termist nature of our societies makes it impossible to integrate such perspectives quickly.

The energy consumption curve has not undergone the spectacular and necessary reversal expected to correct the trend.

This report will attempt to highlight the societal brakes that are blocking the change in our behaviour.

It will then attempt to quantify the rare progress made over the last thirteen years and will review the terms of the Breton alter project in the light of technological advances and new paths taken since its last draft.

Most of the second part will be presented in the same way as the 2009 report based on 2005 energy data. The latest available data from 2019 will be used for this update.

Unfortunately, we can only recall here the conclusion of the introduction written in 2009

Today, a radical change of course is becoming urgent.

But the only difference is that we will no longer have another thirty years to postpone the societal changes that are needed now.

And compared to that time, there are even thirteen years less.

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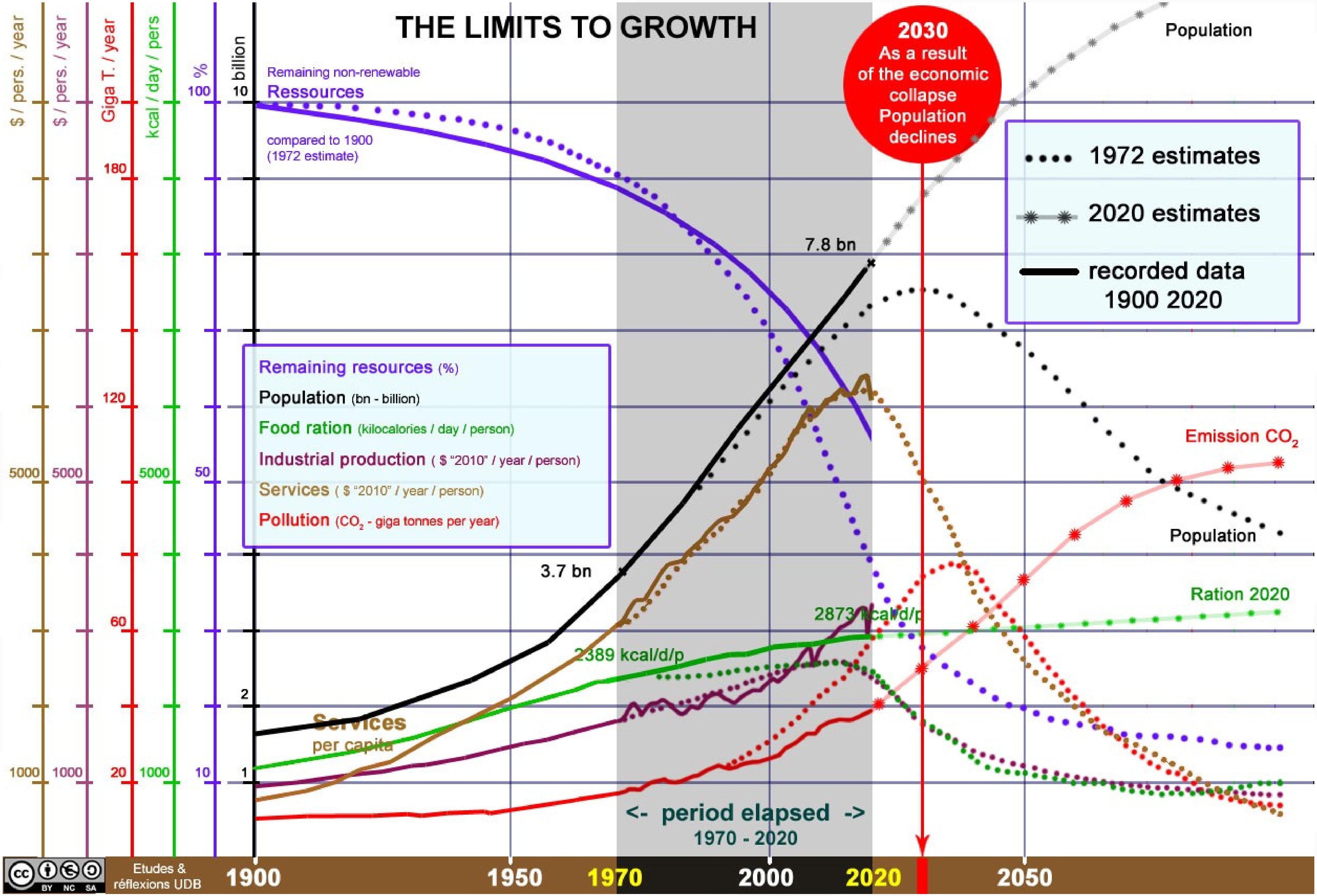


Sources : www.yes-brittany.eu/pellgargan/RANB2022/data/p01_data_2020_Limits-2-Growth.xls

Introductory note

The year 2019 marked the fortieth anniversary of the publication of the first Breton alter project. During the 1970s, the question of whether growth could continue at the same pace as during the "thirty glorious years" timidly entered the political debate. The surge of the hippie protest wave on our old continent coincided with the emergence of the environmentalist discourse, which was rather inaudible at the time.

In 1970, the Club of Rome, an international think tank, commissioned a report from young American researchers at MIT on the limits to growth. In 1972, a resounding report was published: "the limits to growth", also known as the "Meadows" report. This report called the community to account for the impasse that unlimited development represented.

Despite this, towards the end of the decade the 'necessarily' responsible British and American conservative governments succeeded in imposing on the international community the primacy of the market, privatisation, deregulation and unrestrained international trade.

As a result of this policy, and despite disastrous economic results, particularly in Great Britain after the Thatcher era, the ultra-liberal option is still the one that prevails today.

Although it would have been wise to take it into account in the conduct of world affairs, the Meadows report has been ignored by most political leaders.

A - The lessons of the Meadows report

This report, published at the initiative of the Club of Rome in 1972, is often summarised by a simple graph (see opposite) comprising six predictive curves corresponding to the estimated evolution of six systemic parameters over a period of some sixty years (1972 - 2032)

These six parameters are: population; the three types of production: food, industry and services (expressed in "2010 $" per capita); the stocks of available non-renewable resources and finally the level of pollution (limited here to CO_2 emissions only, as this curve was not explicitly described in 1972, see page 69 of the report). At the time, these six parameters were compiled up to 1970 and then forecast for the following 60 years.

Today, 50 years later, we have the actual evolution of these data over a large part of the period considered in 1972 and we can therefore compare them with the forecasts made at the time.

What is immediately obvious from this diagram is that over the last 50 years, the 1972 forecasts (the so-called BAU scenario) are correlated with the actual data collected over this period. It does not matter today whether the forecasts for the next 40 years will be as accurate or shifted by another 10, 20 or 50 years. The limits to growth are no longer a figment of the imagination and they will constitute a cluster of problems that will one day impact the foundations of our civilisation. We must anticipate these problems in order to try to limit their destabilising effects on our societies. We cannot rely on possible technological breakthroughs, unpredictable by definition, to hope to find solutions to these difficulties.

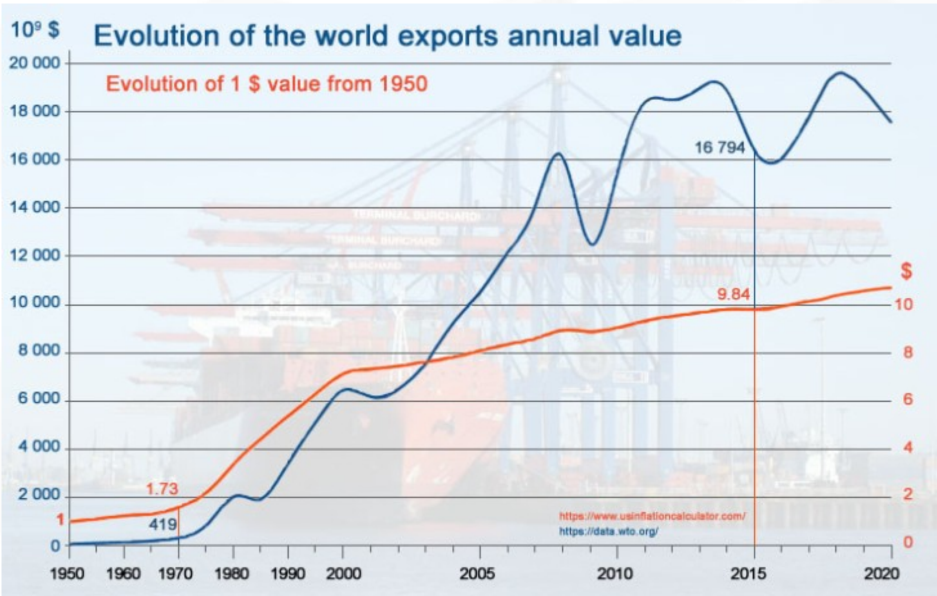
Anticipate these next systemic crises!

Capitalism, especially in its ultra-liberal phase at the beginning of the 21st century, does not confer great stability on the now globalised economic order. Today it is certain that a new systemic crisis will occur within a time frame that is unfortunately not easy to specify. But the warning signs are already there. The price of oil has been rising for more than two years now, evolving between $18 and $83.54 **(1)** per barrel in October 2021 (BRENT), it has evolved during 2019 around $60, but it could rise very quickly to $100. Private debt is growing in China without any real collateral. The American car loan (of the "subprime" type) was developed in order to allow low-income customers to acquire a vehicle, in the same way as in the real estate sector before the 2007 crisis.

Today, these defaults are becoming more and more important. The total amount of these loans reached a new record of $1302 billion **(2)** in the third quarter of 2021, compared to $809 billion in the third quarter of 2007, which marked the beginning of the US crisis. As well as at the time, they were securitised to dilute the risk among numerous financial derivatives.

The financial markets seem to be overheating. Two bubbles are developing in these markets: a stock market bubble and a bond market bubble. Asset prices have become too high for a global economy that is expected to peak soon.

OECD economists point to insufficient business investment, whether to offset the depreciation of existing assets or to expand and fuel hypothetical growth. The OECD is also concerned about the high level of indebtedness of economic actors in several countries against a backdrop of cheap money, which exposes them to the foreseeable tightening of monetary policies by central banks. **(3)**



But our political leaders are keeping their voters in the dark and are trying to reassure the population by publicising the limited take-off of the economy while exaggerating certain positive signs: start-up nation, rising bosses' morale, "drop" in unemployment ....etc.

They claim that measures to reduce financial systemic risk are sufficient, as are measures to ensure that banks truly serve the real economy and do not pose a threat to it. **(4)**

However, the facts are stubborn: ultra-liberal globalisation, combined with technical progress (computerisation, robotisation, uberisation, etc.), imposes an increasingly unbalanced distribution of profits to the benefit of capital and to the detriment of labour. It leads to a continuous increase in unemployment and a stagnation of income and wages for those who still have a job.

To maintain an illusory standard of living, maintained by advertising, even the most modest wage earners have no other solution than to resort to massive debt. In the end, due to the progressive insolvency of the most vulnerable, because of the cyclical rise in fuel prices which will occur one day or another, the situation will logically evolve towards a major debt crisis.

The fight against this new crisis will require the intervention of central banks. They will then lower the cost of credit (interest rates) to revive the economic machine, creating... even more new debt! This will generate new shocks. These multiple crises will logically end up in a final systemic crisis of the ultra-liberal economy.

What is the alternative after the next financial crisis?

TINA: the ultra-liberals only have this acronym on their lips. Since the Thatcher-Reagan tandem came to power 40 years ago, the same ideological potion has been administered relentlessly by self-proclaimed experts via the media at their masters' orders. Ultra-liberal ideology is the unrivalled political doctrine in most of our underdeveloped countries.

Under the leadership of Friedrich August von Hayek, the members of the Mont Pelerin Society **(5)** have since advised many heads of state and their influence remains strong. Their thinking still dominates university teaching today and inspires the work of many advisory and think tanks.

But if economics were really a science, it could only take into account the limits of the planet. Instead, it completes itself in the magical thinking of infinite growth in a finite world.

If there is still no credible opposition to this society of spectacle, communication and unbridled consumption, its ultra-liberal thurifers will have a lot to worry about when they have to explain, let alone justify, the next crisis.

Business as usual: it's no longer a credible option!

This does not absolve the opponents from seeking solutions to ensure the least violent transition possible.

But will humanity finally be ready to hear what it has refused to consider since the Club of Rome's 1972 report "The Limits to Growth"? Most of the population is in fact in deep denial of the scale of the environmental challenges and resource constraints it faces. A political party that exposes these problems and the radical measures needed to change the trend will be defeated in the elections it claims to be contesting. **(6)**

Despite a growing scientific consensus on environmental threats and the risks of resource depletion, our societies continue to do business as usual, or tinker on the sidelines.

An economy based on the continued expansion of raw material consumption is not sustainable, but neither is degrowth the best option. The growth dilemma can only be solved by a radical transformation of the economic system.

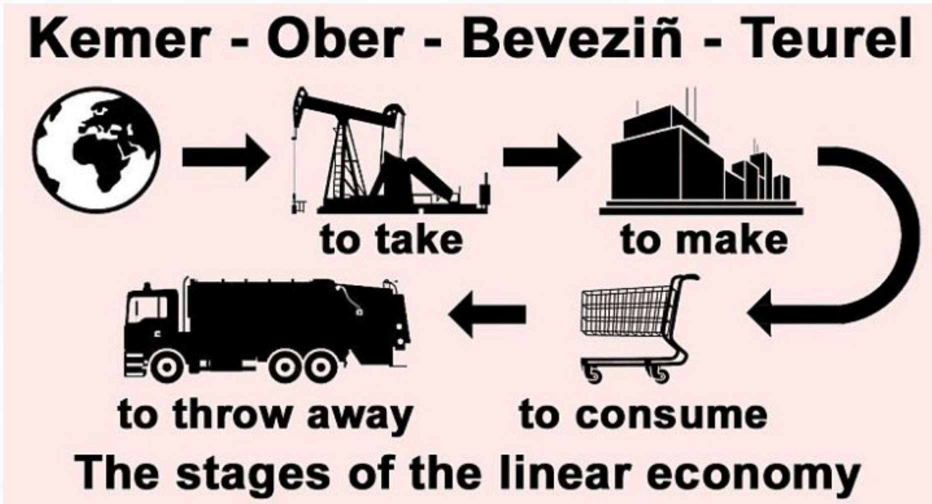
There should be an end to GDP growth as the key objective of development. Instead, the focus should be on a limited number of welfare indicators. Today, alternative economic models must be built, such as a massive shift to the circular economy based on reuse, reconditioning and recycling, all of which are essential for sustainable development.

This will require phenomenal progress in resource efficiency and a growing public focus on human well-being rather than per capita income growth. But this change may not happen as we envisage.

Population growth, for example, is likely to be drastically challenged by unsustainable limitations in access to basic goods, by declining productivity as a result of social unrest or conflict, and by the continuing poverty of the world's 2 billion poorest people. And global warming, now certain, will disrupt the few plans that have been made.

Is systemic economic change possible before our societies collapse?

Climate change, widespread pollution, rising inequality and the 2008 financial crisis show how urgently we need a more sustainable social, ecological, economic and cultural development model. But is it really possible to change the current system without creating even more social and economic problems?

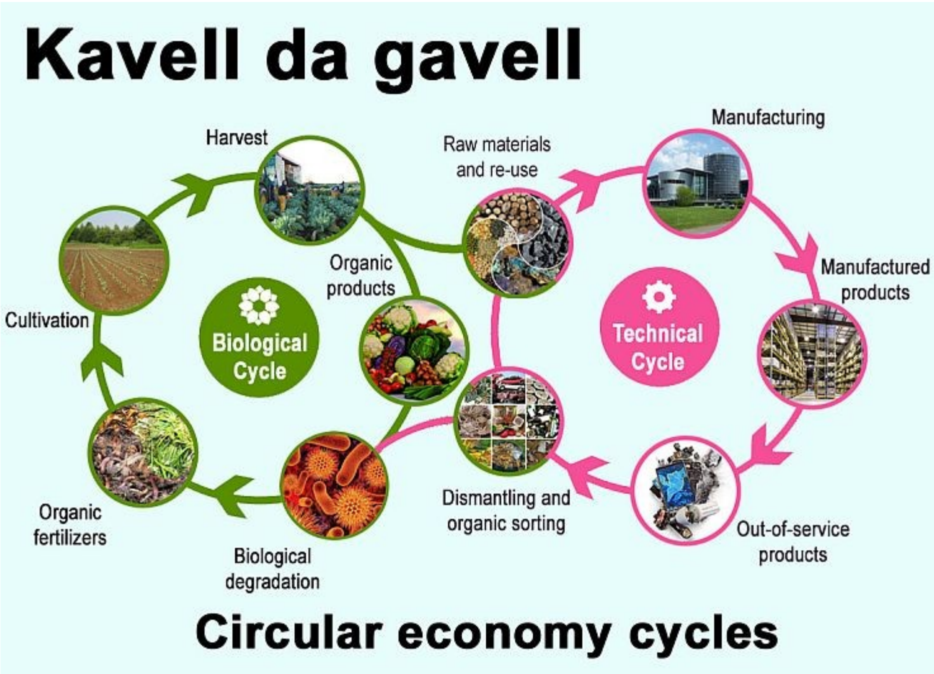


Our societies need to buy time. They can get it by gradually transforming the economic system, restructuring finance and business, shifting to renewable energy, reforming food production and redefining the nature of work, in order to create jobs and thus secure livelihoods for all. The technology and understanding to make these changes already exist. It is a question of social and political will.

How will we be able to guarantee a good life for future generations after the upheavals of the next forty years?

How will humans adapt to the physical limits of the planet? Can the solutions be implemented locally and gradually, or is global action required from the outset?

It will be necessary to transform production and consumption systems by migrating from the linear model of "take, make, consume, throw away" to a circular model favouring services, where products are designed for recycling, maintenance and repair. **(7)**



It is a concept that is gaining ground across Europe as policy makers and business leaders realise that our linear system of resource use is putting societies and businesses at serious risk. Numerous studies have already shown the case for a circular economy.

But how would a circular economy benefit society as a whole?

The situation has evolved in some minds, the intelligibility of the ineptitude of continuing growth as presented to us by the elites, the relevance of the need for drastic societal changes no longer yields to mockery, more and more people have even come out of the period of denial of reality. Today it is anger and apprehension that dominate, which is why those in favour of the current system still manage to prevaricate by exploiting the fears of the most fragile. It remains for us to seek and create the conditions for the acceptance of the real world by the greatest number of people so that society can engage in sustainable development.

But the greed of a privileged few, eager to increase their wealth without restraint or questioning in order to maintain their status and extravagant lifestyle at the expense of the basic subsistence of the many, risks provoking real riots in the already disadvantaged territories.

The traditional sociability of the Breton countryside is gradually disappearing and it is not the current metro-politan counter-model that will compensate for this loss. However, only initiative, decentralised solidarity action and direct democracy at all levels of competence will succeed in creating the conditions for resilience and the maintenance of an evolved society that will guarantee everyone, via different and innovative economic processes, access to a healthy environment, housing, training, employment, culture and health.

Our task is to persuade (to begin with) the people of Brittany that it is urgent to confront the problems created by the ultra-liberal mode of operation of the economy, this will certainly not be enough, but let us already do our share of the work of reflection and try to convince.

The positive impacts of the circular economy on employment, carbon emissions and the balance of trade for European economies will need to be assessed and explained relentlessly. **(8)**

Either we manage to open new relief channels without delay, to reduce the pressure and lower the levels of constraint, or the walls of the dyke will eventually break, leading to a surge of unforeseeable consequences.

For the year 2021, France is in 23rd position (stable) in the latest world ranking of states, which since 2006 has ranked 165 countries on the planet **(9)** according to the quality of their democracy. Out of fourteen reports carried out since the beginning, France has been excluded ten times from the top group of the twenty accomplished democracies to appear among the defective democracies. For the self-proclaimed country of human rights, they should do better before admonishing the rest of the world.

And it should be noted that among the top ten countries, five of which have been in the top five for the past seven years, apart from two states: Australia and Taiwan, the other eight have fewer than 11 million inhabitants and six fewer than 6 million. (Sweden and Switzerland on the one hand, Norway, Iceland, New Zealand, Denmark, Ireland and Finland on the other). (small is beautiful, but above all, effective)

As for the ranking according to the Human Development Index (HDI) created by the United Nations Development Programme (UNDP)**(10)**, the same 10 countries remain at the top of the table, while France rose from 23rd to 37th place between 2016 and 2018.

This shows that the economic and societal transition, which will require a high degree of local democracy and development, cannot take place in a hyper-centralised state of 67 million inhabitants that takes all the advantages for its capital region. The future will be played out closer to the ground, in those territories where there is still local brainpower oriented towards a culture of resilience and solidarity.

We have a choice: democratic resilience with a normative power devolved to an assembly of Brittany or catabolic collapse with the Jacobin nuclear power of the Parisian ultra-liberal bourgeoisie.

The objective of this study is not to give an exact picture of the energy problem in 2050, as there are too many unknown parameters that will influence the future situation; but rather to present:
1 - the current state of energy supply and consumption
(for 2019, as in 2020 consumption has dropped)
2 - a project based on the best renewable energy production technologies

The comparison of these two situations will make it possible to measure the gap that we will have to fill in order to hope to cope. It is no longer possible to procrastinate. Constraints will arise and they will have to be overcome.

The question of access to energy for the greatest number of people will quickly arise in terms that are difficult to manage, and this question will of course have repercussions on food production at the global level.

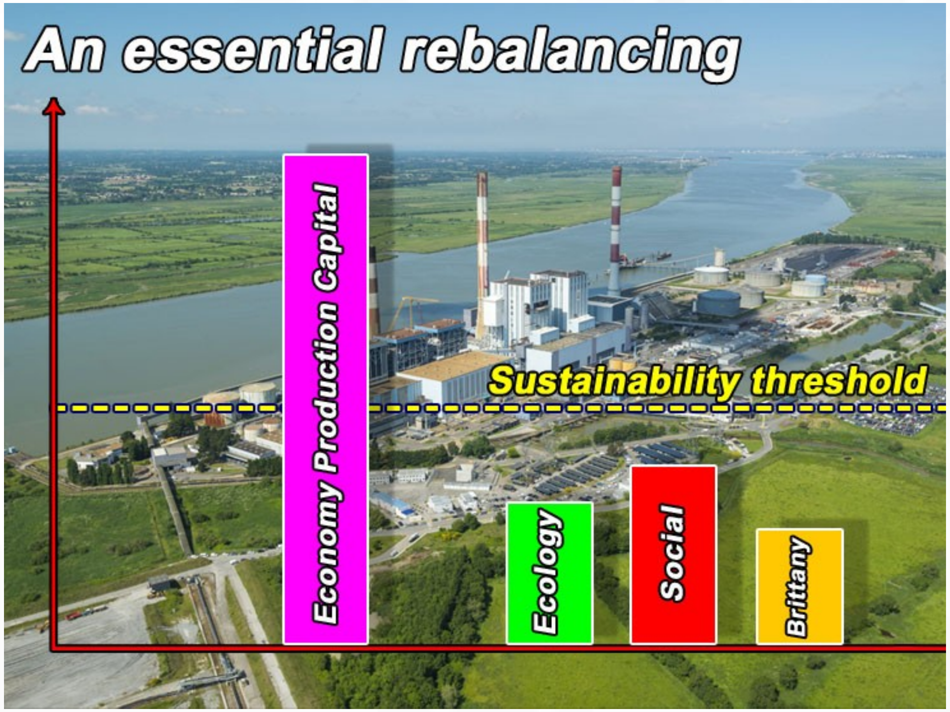
We have therefore chosen to prioritise energy autonomy and to update the Alter Breton Project once again, 43 years after its first publication and 13 years after its first update.

The project for food autonomy in Brittany could then be addressed in another dedicated study.

No oil, no nuclear

An Alter project for the planet is necessary

Even more than in 2009, liberal globalisation has exceeded the limits of what is desirable, and its unsustainable nature is now undeniable. Confronted with a global crisis of many forms: ecological, social, economic, cultural and, for some countries, food, our societies must now carry out a profound revolution and give a central place to diversity, sustainability and solidarity if they want to limit the effects of this major crisis.



The globalised economy is now coming up against the physical limits of the planet in ways that are very reminiscent of the Club of Rome's predictions in the early 1970s. It is true that oil production has been increasing since 2012, but the origin of this increase is the exploitation of North American shale oil at an appalling environmental cost. Everything indicates that we have reached peak oil for traditional deposits (maximum possible oil extraction) and the amount of oil available worldwide can only be reduced in the future at increasing cost.

The 'green revolution' model developed in the 1970s is running out of steam. Increased production is struggling to keep up with population growth and is causing tensions on the grain markets. The situation will continue to worsen due to climate change and the development of agrofuels.

In the long term, the collapse of food stocks will lead to a considerable increase in prices and serious social unrest in the urban populations of the Third World.

The consequences of these developments are still difficult to assess. It is likely, however, that they will result in a cycle of major food, energy, socio-economic, political and cultural crises interspersed with periods of varying degrees of respite.

This phenomenon of self-sustaining crises will only come to an end when we can base our entire economy on renewable resources, which seems hardly compatible with the continuation of the consumer society.

At least two developments in the global context are now becoming increasingly clear to a large proportion of the European population:

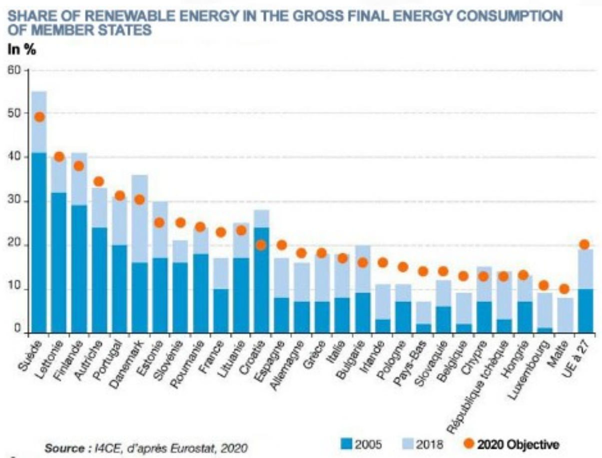
- Global warming:
Since 1988, six reports by the Intergovernmental Panel on Climate Change (IPCC) have validated the reality of climate change, which is reflected in global warming. This warming is leading to an increase in extreme climatic events: fires and floods, rising sea levels, the advance of deserts, in unprecedented proportions and with the cohort of human dramas and the explosion of costs that these phenomena generate.

- The depletion of fossil fuel deposits:
For 150 years, our societies have been based on the ever-increasing exploitation of fossil fuels that were previously abundant and cheap. Soon our societies will be faced with a shortage of these fuels. It is becoming urgent to change the energy system and to anticipate very important investments. .

In Europe and in Brittany :
a different institutional context but
still inadequate and ineffective in the Hexagon!

A few institutional developments have occurred since the previous version of the NPAB in 2009. First of all, at the European level, the Lisbon Treaty came into force in December of the same year, following a ratification process by the 27 member states that took two years. Europe has accentuated its ultra-liberal turn without leaving any checks and balances to its citizens.

On energy policy, at the end of 2008, the European Union (EU) committed itself, among other things, to increasing the share of renewable energy sources in total energy consumption to 20% by 2020.



According to a 21/11/2021 publication on the EEA website, greenhouse gas emissions in the EU-27 decreased by 31% between 1990 and 2020, exceeding the target of a 20% reduction from 1990 levels by 2020. By 2030, projections based on current and planned EU-27 measures point to a 36% reduction in emissions, which is a rather conservative outlook in the absence of new measures.

Thus, the 2030 climate and energy framework sets three main objectives

- to reduce CO_2 emissions by at least 40% (compared to 1990 levels)
- to increase the share of renewable energy to at least 27%;
- improving energy efficiency by at least 27%.

And according to its roadmap to a low-carbon economy :
- the EU should reduce its GHG emissions by 80% by 2050 compared to 1990 levels, rising to 40% by 2030 and 60% by 2040;
- all sectors must contribute to achieving these targets;
- the transition to a low-carbon economy is affordable and achievable.

The framework was adopted by EU leaders in October 2014. It follows on from the 2020 climate and energy package.

For the implementation of this policy it is interesting to note that during a debate on the Energy Union at the plenary session of the **European Committee of the Regions** at the beginning of July 2015, President Markkula welcomed the statement of European Commissioner Šefčovič who called the role of regions and cities **"indispensable"** in the EU energy transition. Šefčovič pointed out that **"the energy transition does not happen without decentralisation of production. To achieve this transition, it is imperative to cooperate with local authorities".**

For Brittany

For its part, Brittany, within the framework of a so-called Act III of decentralisation, has had to endure the catastrophic regional reform of the hexagon. The State, far from devolving the necessary regulatory competences to the regional council, has set in motion a media-political grand-mess introducing a period of institutional confusion without removing any administrative level, and even adding one: the metropolises! Moreover, he has once again maintained the partition of Brittany, against the population's commitment to reunification.

Concerning the energy question, the Bretons have always been particularly sensitive to it. Because the French state systematically imposes its nuclear options in its centralist vision of a pseudo energy independence based on the atom. And this State has been careful not to devolve energy competence (with the budget that goes with it) to the regional institution in order to block any reorientation of the objectives.

However, the regional council of Brittany now has some European subsidies which encouraged it to set up the very limited Brittany energy plan in 2007. The European level should be a privileged interlocutor for Brittany's local authorities.

The citizens of Brittany should be able to have a say in the energy choices that concern them. To do this, they must be kept informed of the alternatives available.

This is precisely the purpose of this updated alter breton project.

The old society has definitely given way

At the end of the 1970s, Brittany was beginning to see the concrete results of the economic transformation it had begun after the Second World War. Those involved in this transformation, most of whom were born shortly before the Second World War, still had the previous living conditions in mind and could measure the progress made in terms of material comfort. Their children, born in the 1960s, still remember meeting **some** elderly people born in the 19th century who still lived in small houses with dirt floors, no running water, and a fireplace for heating and cooking equipment.

Technological progress seemed marvellous and lifted a large part of the population out of poverty, especially in rural areas. Optimism was the order of the day.

Today, the bad omens of the past are firmly established in reality and can be observed by all. Global warming, widespread pollution, the depletion of natural resources and the loss of bio-diversity, the premises of which were still widely disputed only twenty years ago, are creating serious uncertainties about the sustainability of our consumerist civilisation.

Neo-liberal globalisation is precipitating the disaster and, particularly since the 2008 financial crisis, large sections of rural society are continuing to decline. In France, the response of the **Parisian state** is **centralisation**, **metropolisation** and **business as usual**. In short, apart from a few green washing actions: the promotion of urban agriculture, the electric car (with the associated nuclear power plants), practically no radical questioning emerges in the political offer, except perhaps from the " zadists " (ZAD = zone à défendre = area to defend).

" Brittany is poor... " that is what they were told.
" It has no energy, it has no industry. "
" Brittany had to accept nuclear power ".

It was its last chance to collect some crumbs of "croissance", before its final marginalisation in the then Europe.

Both of these assertions of the official ideology were absurd at the time and are even more absurd today especially as we now have energy efficient technologies.

If we consider the only energy that can be recovered from agriculture, from agricultural biomass, the available potential is equal to our current needs. Our wind potential is considerable, the sea is a reservoir within our reach.

In truth, Brittany is full of energy, energy that is indefinitely renewable! But their exploitation is linked to another model of development, to another type of society, which is concerned with living differently, with developing our natural resources, a society which puts an end to the ideology of dependence.

Like our predecessors, this is the perspective from which we are still working today:

- We reject the nuclear solution, not only because of the risks it poses to humanity, but also because it reinforces a centralised economic and political system and is not sustainable (uranium resources are limited).

- We propose an ALTERNATIVE solution based on indefinitely renewable energies, compatible with another development model, with a self-managing and ecological society.

1979 predictions confirmed...

It is always topical to kill myths that have a hard life and in particular that of the "industrial development model" which would bring progress and happiness to humanity. This "ultra-liberal" model of society transforms all sectors of the economy to achieve one objective: growth through the massive production of industrial goods. Anything is produced and sold as long as it brings in a profit. The perversion of the system led to the emergence of the financial products market, whose collapse in 2008 plunged the planet into an unprecedented crisis. It doesn't matter if the materials are running out, if certain regions are really being rolled out by this steamroller...

In Brittany, too, this myth has its followers, and yet its fruits are bitter.

A century of "industrial development" has left our country bereft. Far from creating jobs in proportion to the increase in population, this production system has simply transferred them. The primary sector (agriculture, fishing) has become a minority in favour of the tertiary sector, the secondary sector (industry) has stagnated; the balance sheet is negative: the active population has just risen since 2001 (1,690,189 individuals) to the level it had reached in 1906 (1,673,000 people) (fig. 1) after the lows due to the First World War and the wave of migration in the 1950s and 1960s.

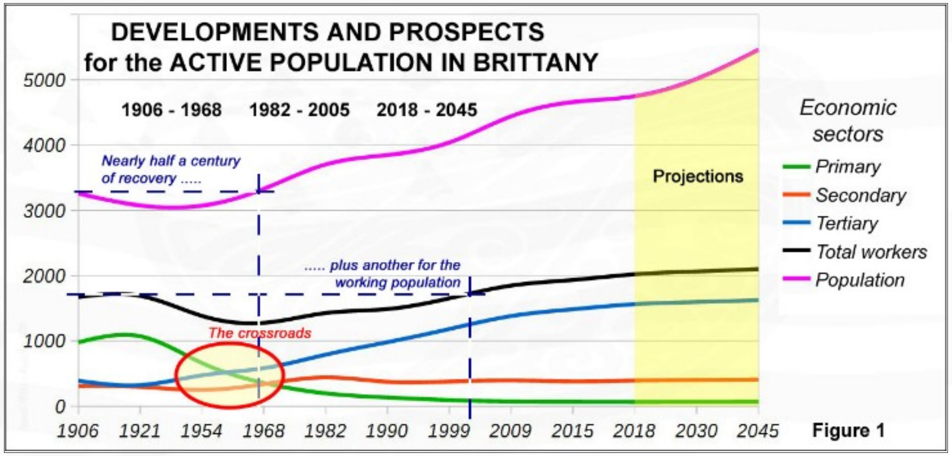
Far from creating "development poles", this mode of production accentuated the transfer of populations. The rural communes were emptied. The Bretons moved to the outskirts of the country, to Brest, Rennes or Nantes. The official "decentralisation" no longer dares to take itself seriously. What is left of the Gaullist or Mitterrandian speeches on regionalisation?

To keep hope alive, new vocations are being discovered for Brittany: after having lost its faith... here it is devoted to tourism, a temporary and marginal activity, limited to our shores and sometimes to the parks of our interior desert. The 1960s and 1970s were in many ways a decisive period for our future. **"A crossroads"**.Sources: Published on: 19/08/2009

BRITTANY: EVOLUTION OF THE WORKFORCE 1906 – 2040												
	Recovery from NPAB 2009					INSEE data*					Projections	
SECTORS	**1906**	**1921**	**1954**	**1968**	**1982**	**1990**	**1999**	**2009**	**2015**	**2018**	**2030**	**2040**
Primary	978	1071	661	356	197	133	93	78	74	72	68	69
Secondary	306	296	249	338	441	377	377	394	380	392	404	407
Tertiary	389	323	473	583	789	981	1 182	1 381	1 485	1 563	1 607	1 622
Workforce	1 673	1 690	1 383	1 277	1 427	1 491	1 653	1 853	1 939	2 028	2 078	2 098
Population	3 258	3 075	3 072	3 330	3 703	3 848	4 040	4 441	4 659	4 748	5 013	5 460
Percentage	0,513	0,550	0,450	0,383	0,385	0,387	0,409	0,417	0,416	0,427	0,415	0,384

Retrieved from NPAB2009
Sources: Published on: 29/12/2020 Legal municipal populations since 1968
https://www.insee.fr/fr/statistiques/fichier/2522602/fichier_poplegale_6818.xlsx

Sources : Released on : 03/12/2021 T201 : End of year employment in Brittany
https://www.insee.fr/fr/statistiques/fichier/4255466/T201.xls



(1) PSU-Bzh Documentation, n° 6,

What's new today ....

Projections to 2040 are not much better. The number of working people has certainly increased since 1979, but so has the total population. INSEE projections show that thirteen employment zones (ZE2010) should see their active population increase until 2040. The total population of Brittany will increase due to the return of the generations affected by the rural exodus of the 1960s and 1970s, while the exodus of young people continues and the active population grows mainly due to residential migration, particularly in the east and south of Brittany.

Today, service jobs are the most numerous, while industrial employment is maintained and agricultural employment continues to decline.

The population is increasing in Brittany and the coastline, in particular, is becoming more attractive to tourists due to global warming. In this context, how can ecological objectives such as stopping the concreting of agricultural or natural land, reducing car traffic and protecting water quality be met?

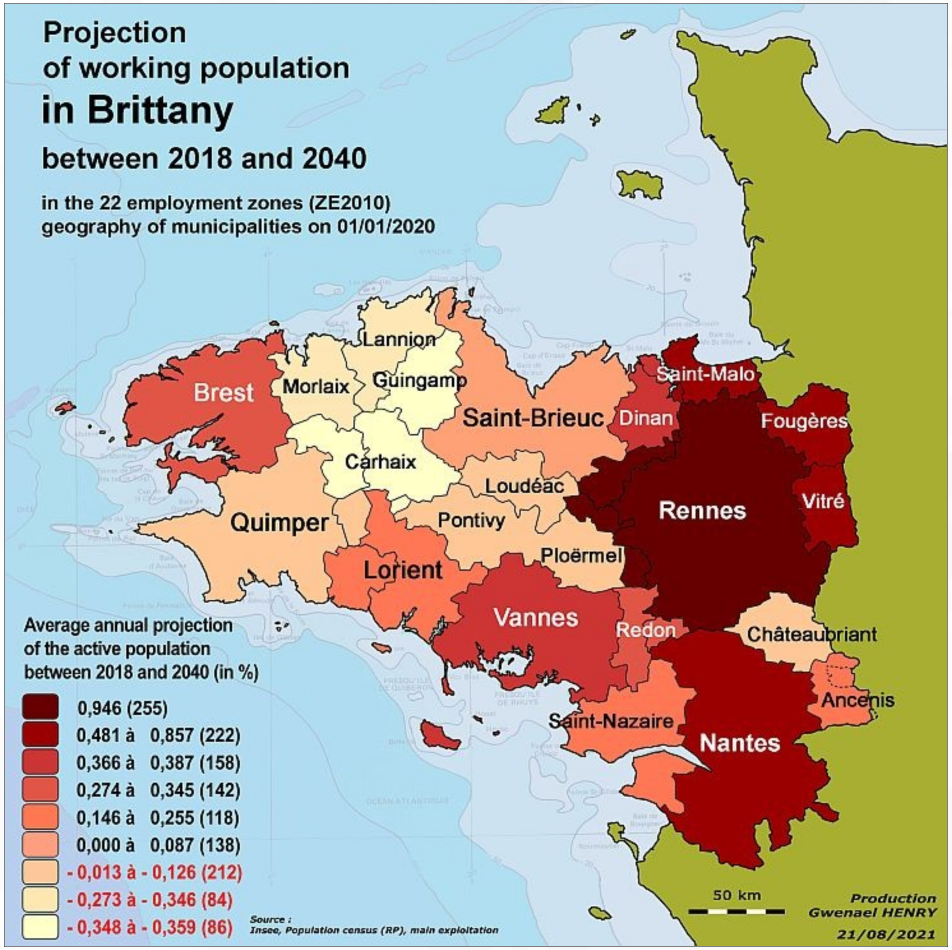
At the same time, hundreds of thousands of homes remain empty for three quarters of the year, because they are used as second homes. Without making anyone feel guilty, it is high time to ask ourselves a fundamental question: is it fair and reasonable to freeze a large part of the housing stock (12.5% for Brittany as a whole) for temporary leisure? Properly housing the entire population while stopping wasting our resources seems a more important issue!

If nothing is done, local youth populations will continue to migrate to the metropolises, with the inherent problems of housing, travel and pollution.

An appropriate residence status should be put in place. This is a recurring problem in Europe in all regions relatively untouched by excessive industrialisation. Rural areas should also be reoccupied and "business as usual" investments, already planned in the metropolises, should be redirected towards real sustainable development projects, thus preserving rare resources.

Assumptions ....

These projections are not definitive forecasts. The upheavals that our societies are experiencing today will require adaptations that will reshuffle the deck.



Code / Ranking of the variation of AP between 2018 and 2040	Number of employment areas by development category	Wording / Employment zone 2010	Average annual change (in %) Between 2018 and 2040	Number of municipalities in the employment zone (EZ)	Population evolution in the 22 employment zones in Brittany (EZ 2010) according to the INSEE central scenario: Active population with a job in 2018	Projection of employed AP in 2040	Δ 2040-2018	% evolution
1	1	Rennes	0,946	255	363 411	436 244	72 833	20,04
2	4	Saint-Malo	0,857	33	41 173	48 589	7 416	18,01
3		Fougères	0,642	34	27 716	31 381	3 665	13,22
4		Vitré	0,640	28	23 739	26 869	3 129	13,18
5		Nantes	0,481	127	455 757	500 224	44 467	9,76
6	2	Dinan	0,387	47	36 421	39 256	2 835	7,78
7		Vannes	0,366	111	135 913	145 886	9 973	7,34
8	2	Redon	0,345	22	17 960	19 202	1 242	6,91
9		Brest	0,274	120	184 576	194 623	10 048	5,44
10	3	Saint-Nazaire	0,255	48	117 740	123 692	5 952	5,05
11		Ancenis	0,151	10	17 080	17 587	507	2,97
12		Lorient	0,146	60	113 862	117 126	3 264	2,87
13	1	Saint-Brieuc	0,087	138	119 949	121 983	2 034	1,70
14	5	Ploërmel	-0,013	28	15 858	15 819	-39	-0,24
15		Pontivy	-0,013	32	23 217	23 159	-58	-0,25
16		Loudéac	-0,014	30	14 392	14 353	-39	-0,27
17		Châteaubriant	-0,036	22	14 313	14 213	-100	-0,70
18		Quimper	-0,126	100	122 526	119 573	-2 953	-2,41
19	2	Morlaix	-0,273	35	27 470	26 051	-1 419	-5,17
20		Lannion	-0,346	49	31 823	29 756	-2 067	-6,50
21	2	Guingamp	-0,348	40	19 514	18 236	-1 278	-6,55
22		Carhaix	-0,359	46	15 614	14 563	-1 051	-6,73
Employment zone 2010	but according to 2020 communal geography		Number of communes	1 415	1 940 024	2 098 385	158 360	8,16
Self-reported active population in Brittany			average annual growth			Number of years	average annual growth	Growth over the period
2 021 400	T201		1,003573			22	1,003573	1,0816

Reading: between 2018 and 2040, the working population of the Rennes EZ would increase by 0.946% on average each year. There is a difference between the active population with a job and the active population self-declared in an employment zone.

Source: Insee, Omphale 2017, labour force projections 2016-2040.

Source: T201 - Employment at the end of the year in Brittany, by status (salaried/unsalaried) and sector of activity (A5)

https://www.insee.fr/fr/statistiques/5365126

https://www.insee.fr/fr/statistiques/fichier/5365126/T201.xlsx Published on 11/05/2021

Neither "Portsall" nor "Fukushima"...

An inevitable evolution, we are assured!

Brittany is far from the main centres of production and economic and political decisions, and it has no energy.

No fossil fuels, that's true.

It has to import its oil the equivalent of **56 Amoco-Cadiz** (227,000 T. x 56) every year. So when one of them runs aground on our shores, Brittany would only have the right to be cleaned up by "national solidarity", then to be beautiful again but to keep quiet.

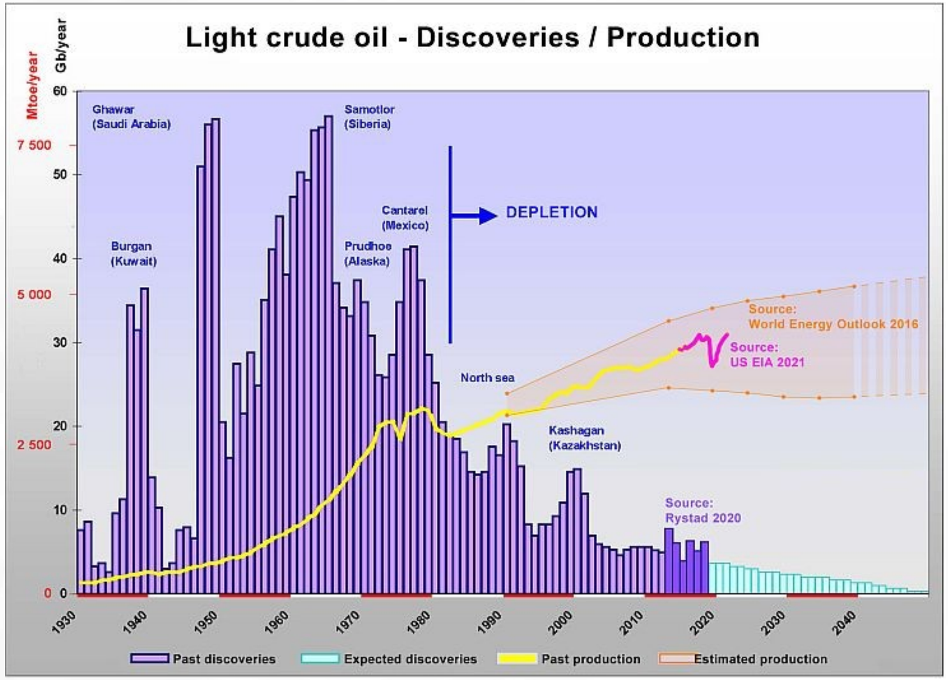
Brittany should therefore accept nuclear power, it would be its only chance to have a surplus of energy! We are among those who refuse this solution. We will also show that Brittany can produce its own electricity. It can perfectly well do without nuclear power, which solves nothing: it is a useless, dangerous and expensive form of energy. **We are not at all determined to accept "Fukushima" in Brittany after having suffered "Amoco Cadiz" in Portsall and "Erika" in Southern Brittany 21 years later.** The nuclear path seems to us like a brother to the one we were forced to take. **It does not change anything in our state of economic dependence.**

The only possible way is through the use of renewable energies; those that are grouped together under the name of solar energies, and which in reality take various forms: apart from direct solar energy. It is a question of using recoverable energy from agricultural biomass, windmills, marine energy, etc. But it will also be necessary to reduce consumption by insulating the building.

In this respect, Brittany is in an exceptional position. Our agricultural area is large. Our shores are battered by westerly winds and swells. Our northern coastline benefits from exceptional tidal ranges. Our sunshine is not negligible: the Gulf of Morbihan is almost as sunny as Carcassonne!

But our type of civilisation in Brittany, of course, and more globally on the entire planet, is about to face two incompatible challenges: providing energy for a rapidly growing world population and reducing GHG emissions at the same time in an attempt to control climate change.

OIL: Peak oil is in sight and will occur in the 2020s. There will certainly be some oil left but the investment needed to extract it has become dissuasive and the returns on investment seem far too uncertain for investors.

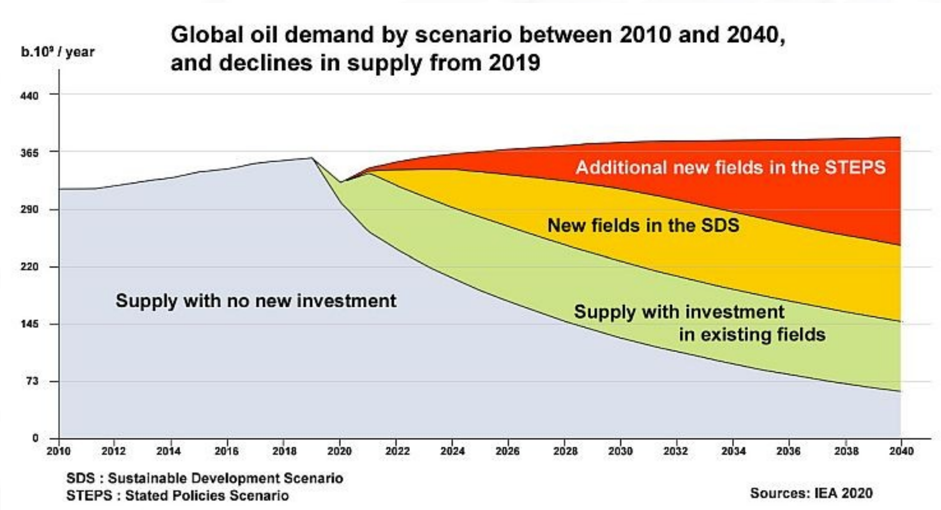


The real problem is that our Western societies are totally dependent on fossil fuel supplies to function.

The discovery of new oilfields has been decreasing since the 1960s while consumption has been increasing dramatically.

But capitalism being what it is, it is to be feared that the exploitation of extreme oil resources (and other fossil resources) will be pursued to the last limits of profitability.

For various reasons, some governments continue to provide "subsidies" to fossil fuels. This contributes to slowing down the transition of the global energy system towards a less carbon intensive mix.



Subsidies to fossil fuels can be either 'consumption' or 'production' subsidies.

Consumption subsidies include price controls and tax exemptions that result in below-market prices for consumers.

Direct subsidies, subsidised loans or tax exemptions that reduce the costs paid by fossil fuel producers are also included in our estimate of consumer subsidies to the extent that they also result in artificially lower than market prices for the final consumer.

So-called "production" subsidies include direct subsidies and fiscal incentives specifically supporting energy production, such as preferential tax rates for oil and gas exploration.

Despite progress in many countries, fossil fuel subsidies are still common. Among other things, they discourage investment in low-carbon technologies and more efficient equipment, which hampers any reduction in energy-related CO_2 emissions.

Therefore, reforms of fossil fuel subsidies are key policy initiatives to combat climate change (2017 Toshiyuki Shirai - World Energy Outlook, IEA annual publication).

The IEA (International Energy Agency) remains unclear about the reality of the oil reserves actually available. It simply makes downward forecasts of oil demand and supply trends, the latter being presented as a consequence of the former, whereas resource depletion is obviously the main cause of the production decline.

The Stated Policies Scenario (STEPS) reflects much more the impact of existing policy frameworks and policy intentions announced today. The aim is to hold up a mirror to the orientations of current policy makers and illustrate their consequences on energy consumption, emissions and energy security.

The IEA's peak oil graph was preceded by one from the Association for the Study of Peak Oil and Gas (ASPO), which has already published numerous studies on the subject of peak oil. Although the ASPO estimated that peak oil would occur earlier than the IEA predicted, in its 2011 study for conventional crude, it is remarkable that the IEA refuted this assertion at the time by stating that peak oil would not be reached before 2020. It does seem that the IEA has taken up this claim today.

URANIUM: It is no more prudent to rely on uranium. The available resources will be depleted quickly, especially if we continue to build new plants.

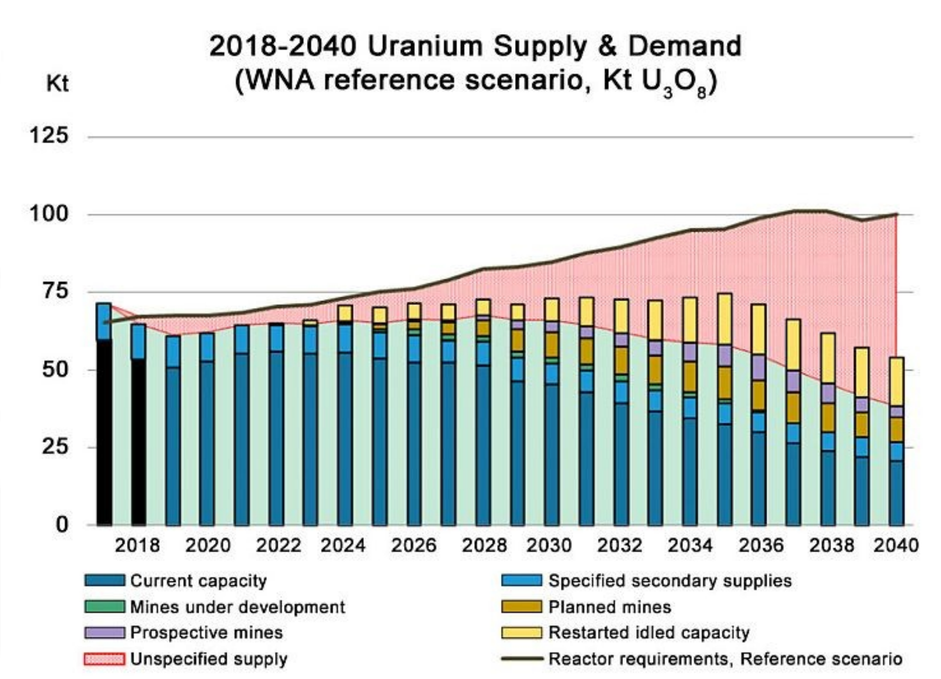
And nuclear energy will not keep our cars running. Nickel and cadmium would be in short supply for the millions of batteries needed to convert the car fleet. Assuming, moreover, that the manufacturers can keep up with the replacement rate.

Some reasons to reject nuclear power!

For more than fifty years the anti-nuclear fight has been built around the theme of safety. Let's reject nuclear power, not because it is an expensive illusion but because it is potentially dangerous. By using the safety argument almost exclusively, critics have given the nuclear lobby free rein to convince the population that the atom is a technically valid and reliable solution.

Today, in order to be listened to, criticism must also focus on the viability of nuclear power as a source of energy available in quantity over time.

For it is the geological and mining limitations that make nuclear power a bad choice, even if all the safety problems could be solved.



Above all, we must remember that the problems inherent in this type of energy have not been resolved. It is totally irresponsible to bequeath this waste to our descendants when they will no longer be able to derive any benefit from it.

A pseudo energy independence

When France chose nuclear power in the 1970s, the country was a major producer of uranium. France produced more than 3,000 tonnes per year.

Production peaked in 1990 and the last mine closed in 2002.

France should be able to continue to source the uranium it needs from outside. But when the irreversible fall in world production occurs, the geopolitical consequences will quickly become severe. Already in Africa, the setbacks that Orano (formerly Areva) is experiencing in the uranium mines in Niger foreshadow, albeit in an understated way, the problems to come. The company is obtaining uranium in Africa at low cost, at the cost of political interference and catastrophic environmental, health and social consequences for the local populations, and this will inevitably lead to conflict.

A threatened supply

Although not technically a fossil resource, uranium is nonetheless non-renewable. The industry claims that there are sufficient reserves to meet global needs for at least 20 years, with identified resources (Jan 2019) - reasonably assured resources and inferred resources - of 8,070,400 tonnes at a maximum uranium price of $130 per kilogram.

However, it is not the reserves that are used to run the nuclear power plants but the production. In 2019, production was only 54,224 tonnes, i.e. 19,052 tonnes below demand. Production therefore only supplies 74% of current world demand and there is no guarantee that it can be ramped up quickly enough to meet the predicted shortfall.

The deferred extra cost of nuclear energy

Moreover, unlike renewable energies, a substantial part of the cost will have to be paid after the end of the active life of the plants, which paradoxically allows nuclear power to appear viable when it is not. Indeed, the costs of decommissioning, rehabilitation and waste management will be postponed to a period when non-renewable energies will no longer be available to meet them.

In fact, unlike renewable energies, nuclear energy works like a loan (we receive the energy now and pay a large part of the price later). In a world of perpetual growth, this would not be a problem, but in a world that is approaching the limits of growth and could be faced with the forced degrowth foreseen by the Club of Rome report, the consequences will rapidly become catastrophic.

The energy yield of nuclear power can only decrease in the future, given the scarcity of good quality ore. Uranium will therefore never be able to provide us with the quantities of energy that some people hope to be able to extract from it.

Oil and uranium are therefore dead ends in the short term. It is becoming urgent to change our energy sources and our social project.

- *The alter breton project is an energy alternative*

Table 1 shows the proposed evolution. The situation in Brittany in 1975 is taken as a reference. The share of fossil fuels is gradually decreasing (Table 1) (Figure 2). The compensation is obtained thanks to direct solar energy and electricity, recoverable fuels, biomass or waste, wind turbines, hydraulic energy and wave or tidal energy.

We will not describe the various options here; the reader is referred to the following chapters in this dossier.

However, one aspect will attract our attention because of the promise it holds for the future of our rural countries: the NPAB envisages producing almost 30% of energy needs from agricultural biomass. Biomass from fields and forest areas within a radius of 20 km will be processed in country-wide agro-energy complexes, which will produce all solid fuels and liquid fuels, as well as the basic organic chemical products currently derived from coal and natural gas.

Production is therefore highly decentralised.

TABLE 1 - NEW ALTER BRETON PROJECT

Unit = Mtoe			Data 1979		Realised	PPE 2020	NAPB
			1975	2000	2019	2028	2050
Primary energy		Total	7,27	14,24	14,15	14,29	9,26
		produced	0,04	0,76	0,72	1,56	8,89
		imported	7,23	13,48	13,43	12,73	0,37
Primary energies used							
Fossil fuels	charbon	produced					
		imported	0,19	0,00	0,16	0,00	0,00
	pétrole	produced					
		imported	5,99	6,82	5,02	4,52	0,00
	gaz	produced					
		imported	0,93	0,00	2,74	2,73	0,00
	uranium	produced		6,66	5,58	5,47	
		imported	0,12				0,00
Energies of the sea			0,04	0,04	0,04	0,04	0,66
New Energies	recuperation				0,20	0,19	0,00
	biomass				0,07	0,89	4,10
	solar	PV		0,72	0,03	0,07	1,36
	generator	hydrogen					0,00
	hydraulic				0,05	0,06	0,05
	wind				0,25	0,20	2,03
	solar thermal				0,01	0,11	1,07
Distributed energy			6,49	9,72	10,14	10,31	8,00
Ratio: distributed E. / primary E.			0,892	0,682	0,717	0,722	0,864

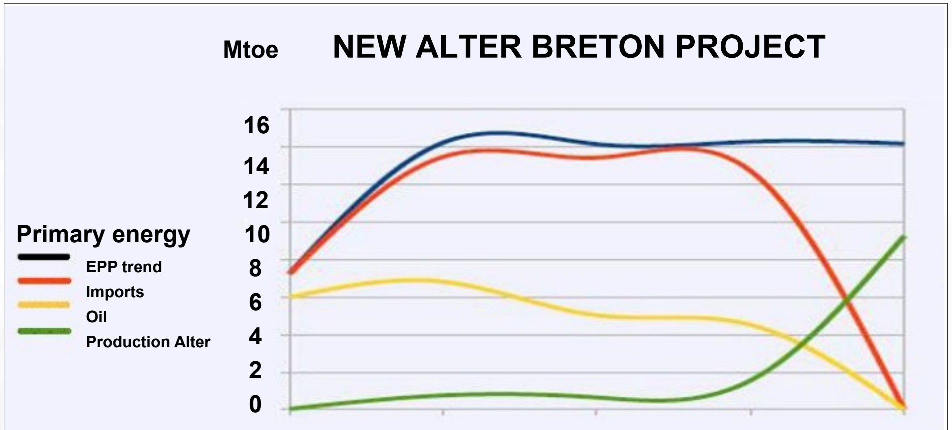


Fig. 2

- *The alter breton project is also a societal alternative*

If the transition from the current regime to the long-term regime is gradual, it should be noted that we no longer have time to postpone achievements in view of peak oil.

By refusing to make the long term an extrapolation of the current society, the Alter project seeks to **satisfy the fundamental needs** of the men and women of our time, **by rejecting all waste.**

It assumes another way of living, more soberly, but comfortably:

- **The housing conditions** and domestic equipment planned are superior to the current situation: housing 100 m² per household; equivalent domestic equipment with 1.5 times the current level, but lasting twice as long: "These levels are sufficient to ensure a comfortable material life for all, provided there is a fair distribution of the corresponding goods".

- **Community life is facilitated**: more social and school facilities.

- **The conditions of production** are completely revised:
■ production units are smaller and better distributed over the territory, rural communes are revitalised around agro-energy complexes;
■ a systematic economy of consumption is sought;
■ more durable goods are produced and waste is recovered and recycled;

- **spatial planning is redesigned**:
■ an end to the anarchic development of metropolises, development of small towns (10,000 inhabitants), the territorial network of Brittany lends itself very well to this;
■ systematic use of land for food crops, energy crops (without excess and in crop rotation) or for solar collectors;

- **external trade is kept to a minimum (overproduction only).**

Based on the recognised needs, the net energy demand in 2050 for almost 5.679 million inhabitants is estimated at 8.004 Mtoe (i.e. 122.4% of the level reached in Brittany in 1975). Compared to the 2019 situation chosen as a reference, it proposes the following distribution of energy by sector of use (tab 2):

TABLE 2 - **NEW ALTER BRETON PROJECT**
Final energy distribution (in Mtoe)

		Brittany			
Energy consumption		**1975**	**1990**	**2019**	**2050**
Total energy	**MTOE**	**6,538**	**7,814**	**10,140**	**8,004**
Industry	MTOE	1,486	1,269	1,477	2,186
Resident./Tertiary	MTOE	2,936	3,241	3,997	3,254
Agriculture	MTOE	0,232	0,349	0,697	0,480
Fishing	MTOE	0,117	0,138	0,129	0,108
Transportation	MTOE	1,767	2,817	3,840	1,976
POPULATION	**M inhab.**	**3,530**	**3,845**	**4,778**	**5,679**
Cons per inhab.	**TOE/inh.**	**1,852**	**2,032**	**2,122**	**1,409**
Industry	%	22,73	16,24	14,57	27,31
Resident./Tertiary	%	44,91	41,48	39,42	40,65
Agriculture	%	3,55	4,47	6,87	6,00
Fishing	%	1,79	1,77	1,27	1,35
Transportation	%	27,03	36,05	37,87	24,69

Source: https://www.data.gouv.fr/fr/datasets/consommation-annuelle-delectricite-et-gaz-par-departement-et-par-code-naf/
Source : https://www.insee.fr/fr/statistiques/fichier/2859843/projections_scenario_central.xls

In the end, the percentage distribution of the 2050 objective returns to the 1975 situation, but in terms of volume, due to the increase in population (+60.88%), an increase in consumption in the industrial sector is targeted in order to adapt the industrial tool, to improve the building and to generate the necessary fuels for the population. On the other hand, by reorganising the territory and making flexible use of individual and collective transport, substantial savings are made in this area.

By reshaping production and land use, the **ALTER project** lays the foundations for ECO-DEVELOPMENT, which "emphasises specific solutions, taking into account ecological as well as cultural data, immediate needs as well as the long term. Without denying the importance of exchanges, it tries to react to the predominant fashion for so-called universalist solutions... Without tipping over into outrageous ecologism, it suggests on the contrary that a creative effort to take advantage of the margin of freedom offered by the environment is always possible.

For all those who are looking for another way of development, the **ALTER project** is therefore of considerable interest.

With this in mind, the 1979 BAP was updated between 2021 and 2022 at the initiative of Gwenael HENRY. It is not a definitive document but rather a precursor.

The "**group for a NEW ALTER BRETON PROJECT (NPAB 2022)**" has been set up. Its objective is to seek a **SCENARIO FOR THE PRODUCTION OF NEW ENERGY**, indefinitely renewable, with a view to thinking about the **ENERGY AUTONOMY OF BRITTANY.**

The NPAB group would like to remobilise locally, by country, technicians, agronomists, farmers' associations, activists from ecological and Breton associations, as well as researchers from INRA, UBS, IFREMER and anyone else interested in the subject. This document could contribute to the definition of calls for future research aimed at re-evaluating all the cultural, energy, geographical, sociological and economic parameters of Brittany, in the light of the paradigm of the necessary energy and ecological transition.

We would like to stress that:

1 - This is essentially a reflection document submitted to all those who are concerned about finding the bases for a new development of Brittany. In our opinion, this "project" could only become a "plan" after a broad and democratic debate. The (reunified) region of Brittany could create the real instrument for planning on a national scale, which was not possible in 1979.

2 - The reader of this document must accept to modify his vision of the present world. No production system is without consequences for the environment, for the ecosystem. It is a question of knowing what is "acceptable", in relation to the long-term objectives of society that we have set ourselves.

3 - We have not taken into account the cost of realising our energy production proposals. Only the technological feasibility was considered. The question of cost is meaningless, apart from the economic system in which we are reasoning. Some processes are already "profitable".

The "NPAB" group, for a new Alter Breton project...

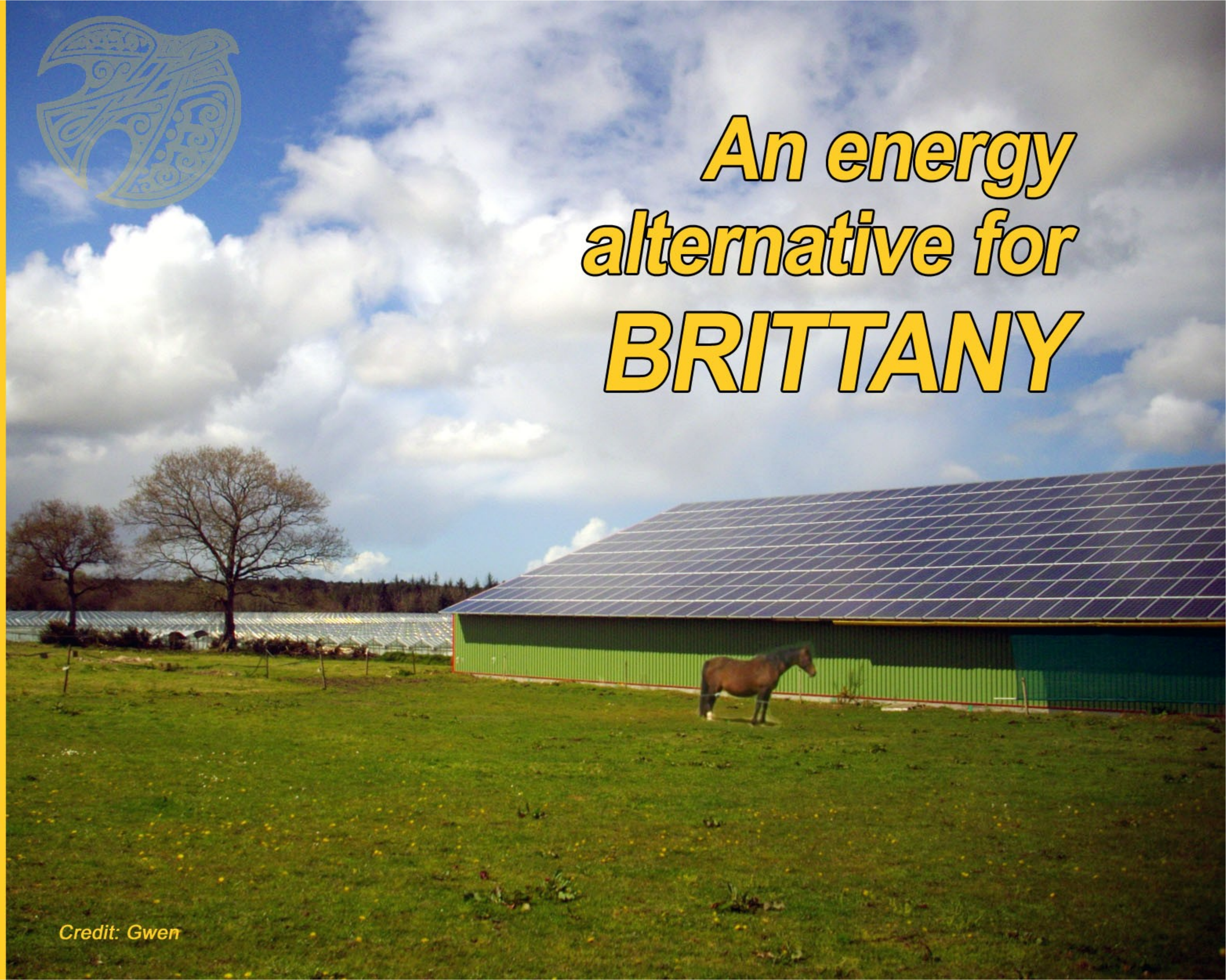
This document presents in its central part the proposed **energy ALTERNATIVE** for Brittany (5 departments). In a stable medium-term regime, it proposes, by using energy from the sea, wind, agricultural biomass and the sun, to produce only 9,264 Mtoe (compared to 6,487 consumed in 1975). This balance is sufficient to allow nearly 5.679 million Bretons (currently 4.784) to live comfortably, but without waste (with a 2.295 Mtoe margin).

The first version of the BAP in 1979 was followed by 3 annexes. Today these annexes have not been updated.

- The first one specified the main lines of the company consistent with this alternative;
- the 2nd gave brief descriptions of the energy sources used
- the third mentioned the important and foreseeable impact on job creation.

It would certainly be appropriate to carry out these updates as well, in order to develop the industrial, social, ecological and cultural policies necessary for the implementation of the energy transition in Brittany.

An energy alternative for BRITTANY



Credit: Gwen

We have sought a real alternative solution for BRITTANY OF THE YEAR 2050, by situating ourselves from the outset in the problematic of the ALTER PROJECT:

- stabilisation of consumption in the long term,
- restructuring of the production system.

The selected scenario follows a few criteria defined a priori:

1) We have chosen not to use any source of fossil energy, whether it be fuel oil, gas or uranium;

2) We will therefore only use indefinitely renewable energies and we have tried to evaluate the global potential available, but without seeking to use it 100%, taking into account the impact on ecosystems;

3) We have rejected, as far as possible, gigantic and centralising projects, but without remaining limited to individualistic solutions;

4) We have retained only those energy sources that are technologically assured, or whose realisation is conceivable in the medium term;

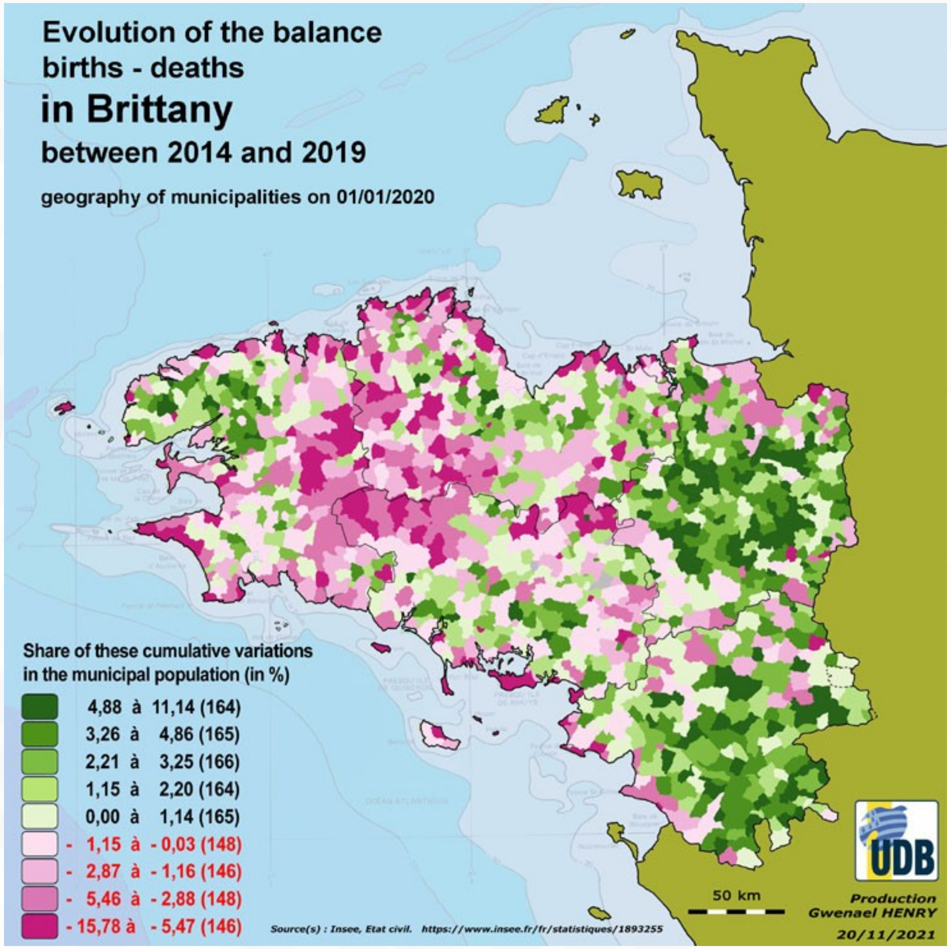
5) In selecting this or that type of option, we have not taken into account the cost of its implementation. This question is currently "meaningless". The basis of calculation naturally depends on the economic system of reference. What will the price of oil be in the year 2050?

B - Our references: Brittany in 1975 and 2019

<u>1) The population</u>

The legal population of the 5 Breton departments amounted to 4,784,126 people in 2019 (i.e. 7.35% of the population of France). It occupied 34,340 km² (i.e. 6.31% of the French territory). The density of 140 inhabitants/km² is therefore slightly higher than that of metropolitan France (120 inhabitants/km²).

However, it is VERY UNEQUALLY DISTRIBUTED: almost 1% of the Breton area is home to about 1/5 of the population, and the territories of the 53 central cities, with almost 6% of the surface area of Brittany, are home to 1/4 of its population. There is a clear contrast between the coast and central Brittany, where densities are often less than 60 inhabitants/km².



These differences are linked to rural emigration due to the destruction of traditional activities and to late urbanisation, sometimes independent of industrialisation, and directed mainly towards the coast.

The population continues to age, but especially in the rural coastal municipalities, due to the emigration of young people and the cost of real estate. However, in the Kreiz Breizh, the intensity of the decline in the population seems to be lightening a little in the area around Carhaix and Rostrenen, even if the second ring of towns is not evolving in this direction. It is enough to compare the current situation with previous decades (see the maps of the NPAB 2009). The territory is not yet gaining population, but it is not far from it. It is true that, having reached the bottom of the hole, the only possible evolution is to get out of it.

2) Spatial organisation

The following map highlights the organisation of the Breton space into catchment areas of cities. The data for some communes outside Brittany are included among those of certain neighbouring catchment areas, as are their populations, which explains the increase of about 0.24% in the divisor used to calculate the percentages, whose values are nevertheless very moderately affected.

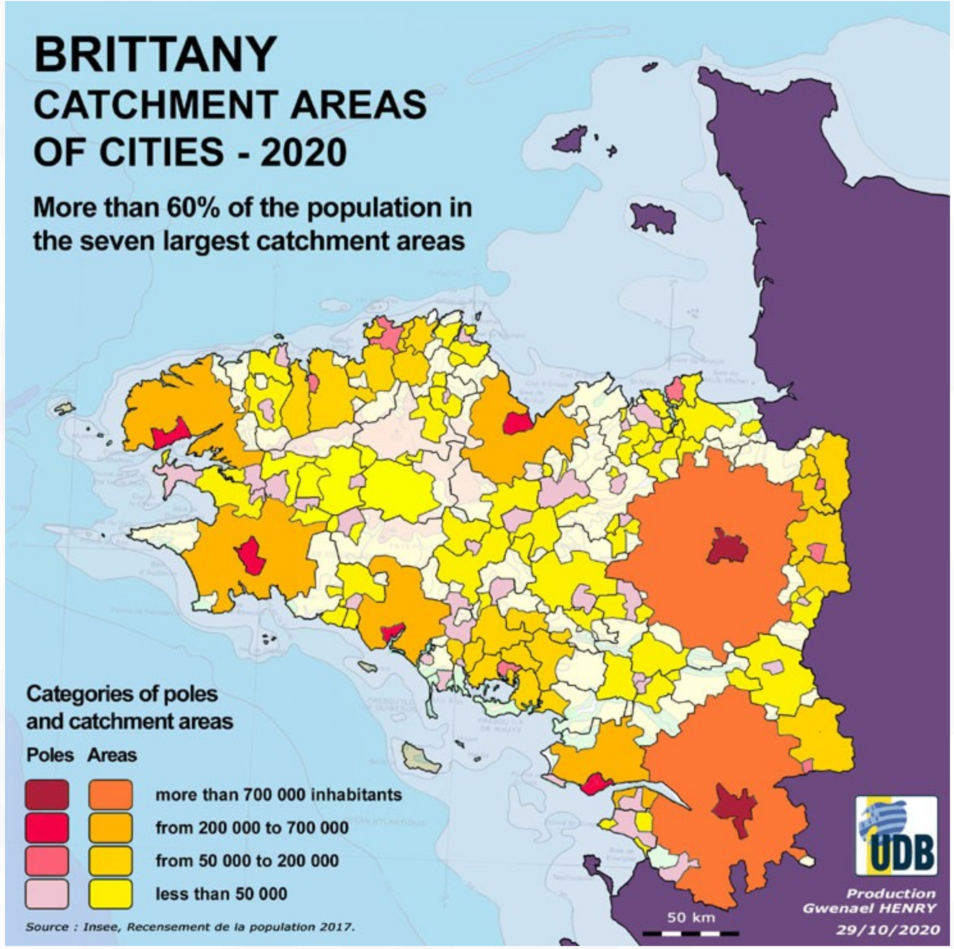
Thus the number of individuals used for the calculations is 4,829,224, when the legal population of the five Breton départements on 1 January 2020 is set at 4,817,845 inhabitants.

Once this has been specified, it should be noted that
- the population of the central cities of the 7 main catchment areas of Brittany (Nantes, Rennes, Quimper, Brest, Saint-Nazaire, Lorient and Saint-Brieuc) is 920,051 inhabitants, i.e. 19.05% of the Breton population, on only 0.98% of the Breton territory, i.e. 335.69 km² ;
- that the population of the 53 central cities of Brittany with 1,380,044 inhabitants represents 28.58% of the Breton population on 5.80% of the territory.
- that the population of the 7 main catchment areas accounts for almost two thirds of the population of Brittany (62.68%).
- that there are still 360 isolated communes, which do not depend on any centre, but which nevertheless have a total of 499,486 inhabitants, i.e. 10.34% of Bretons, established on 26.15% of the territory, i.e. 8,910.93 km² (i.e. 1.784 ha per inhabitant or just over 56 inhabitants per km²)

Note: Vannes does not have a more populated catchment area than Lorient and even if the population of Vannes centre is greater than that of Saint-Brieuc centre, the latter has a more populated catchment area.

This new spatial organisation that has been in place since the 1950s partly explains why overall energy consumption for transport has increased from 1.767 Mtoe in 1975 to 3.840 Mtoe in 2019. To get to work, many people have no other choice than to use their own car. Another reason is probably the growing and ageing population that is able to drive.

The energy consumption per capita for transport has thus increased over the period from 1.822 toe in 1975 to 2.122 toe in 2019.



Main areas of attraction	Legal population 2019 POP	% POP	Surface area km²	% Surface
Nantes	998 252	20,67	3 421	10,04
Rennes	755 464	15,64	3 804	11,16
Quimper	241 588	5,00	1 468	4,31
Brest	378 100	7,83	1 265	3,71
Saint-Nazaire	216 361	4,48	741	2,17
Lorient	230 733	4,78	847	2,49
Saint-Brieuc	206 401	4,27	1 059	3,11
Total	**3 026 899**	**62,68**	**12 605**	**36,99**

3) <u>Production structures</u>

In the introduction, we mentioned the evolution of our economy, characterised by the decline of the primary sector, the stagnation of the secondary sector and the significant growth of the tertiary sector (see figure 1).

The decline of the social strata of peasants and employers, linked to the increase in the number of workers and employees, reflects the upheaval of Breton society. This is **A CONSEQUENCE OF THE TRANSFORMATIONS OF ECONOMIES** adopting the industrial capitalist mode of production:

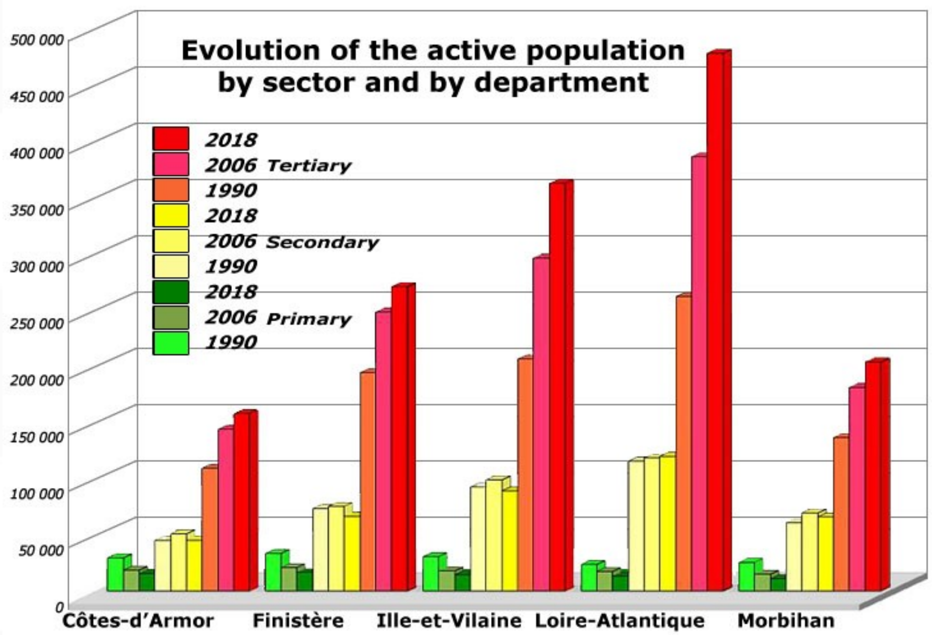
■ industrialisation, concentration of capital and liquidation of traditional activities;

■ rapid extension of capitalist relations into new sectors
(agriculture, trade, fishing, aquaculture)

■ competition between multinational monopoly capital
and the traditional, poorly structured "Breton bourgeoisie".

a) The Breton economy by sector

Over the last century the boundaries have fluctuated in the inter-sectoral contact zones, thus many tasks formerly carried out in the peasant sector have, with the transformation of the production system, migrated into the industrial sector, particularly in certain jobs in the food industry.



Similarly, in industry, the outsourcing of certain internal jobs (accounting, marketing, advertising, etc.) to service companies began some forty years ago and these jobs are no longer counted in the statistics as industrial, but are now included in the service sector. These developments must also be taken into account when interpreting the graph opposite.

However, for the past 60 years we have been witnessing the DESAGGREGATION OF A DECENTRALIZED AGRICULTURAL AND RURAL BLOCK and the creation of a NEW METROPOLITAN SCHEME. But today this development model is questioning its capacity to last. Over-consumption in all areas of activity cannot be maintained for a very long time. The future of all sectors of the economy must be rethought from now on.

b) The primary sector

AGRICULTURE remains an important, but declining, pillar of the Breton production system with 3.1% of the overall value added of all sectors combined. Thus in 2019, with €2,480 billion, the value added of the agricultural sector in the five Breton departments represented 23.88% of the value of agricultural production in Brittany, while in the remaining hexagon it amounted to 35.52%. With €10.388 billion, Breton agricultural production represents 13.53% of that of the entire hexagon. As for the net agricultural added value, it represents, by the same yardstick, only 9.52%, i.e. more production but less profitability.

The concentrations of livestock production in the five Breton departments do not therefore confer any particular economic advantages in terms of added value. These productions require a lot of work and intermediate consumption (67.91% of the value of production in 2019, i.e. €7.089 billion), generate considerable pollution, but do not yield enough profit. The 13,903,678 pigs (59.26% of the French herd) and 720,530 cattle (16.05%) can no longer be supported on 34,340 km², not to mention the fact that Brittany must also supply 29.37% of the poultry and 48.79% of the egg production in France (in market value).

"All in all, Brittany has been assigned a food function of primary importance within France. Traditionally a supplier of labour, our region has also become THE FIRST SUPPLIER OF AGRICULTURAL PRODUCTS for the rest of the country".

However, the export of foodstuffs comes at the cost of VERY HIGH IMPORTS of fertilisers, phytosanitary products and industrial feed for livestock. Moreover, the energy consumption of the agricultural sector has increased threefold between 1975 and 2019 (from 0.232 Mtoe to 0.697 Mtoe). It is likely that crops grown in heated and lit greenhouses are partly responsible for this state of affairs.

It should also be noted the relative importance of Breton fisheries in the French fishing industry, where they still represent more than 25% of total product sales.

It is now time to consider a change of paradigm: the replacement of the objective of quantity by that of quality is necessary in order to be able to work differently, to reduce intermediate consumption and induced pollution and finally to increase the added value and therefore the income of farmers while encouraging the installation of young people on family-type farms.

While in Brussels, the Common Agricultural Policy has been renewed with the same philosophy as the previous period, which is very negative for Europe.

The European Commission's proposals of 1 June 2018 and the debate on the financing of the CAP for the period 2021-2027 are enough to remind us of the extent to which European agriculture is still unable to project itself in the medium and long term in a framework where direct aid would become less essential to the economic balance of the sector.

Europe has certainly made new commitments against global warming, but it is nevertheless imposing this new CAP while openly ignoring them.

Among the urgent issues that needed to be addressed was the territorial impact of the productivist agricultural policies that the new CAP will continue to encourage. It will thus contribute to the concentration of farms in the context of the retirement of many current farmers. Indeed, there are fewer and fewer farmers in Brittany. In 30 years, their number has been reduced from 133,000 to 72,000. And the trend is expected to continue until 2050, when young people will not have the means to take over increasingly large and expensive farms.

It will therefore be necessary to counter the trend towards the financialisation of the agricultural sector, which is increasingly attracting profit-seeking investors with no regard for the environment. This trend is certainly not the solution for maintaining a living countryside with active populations.

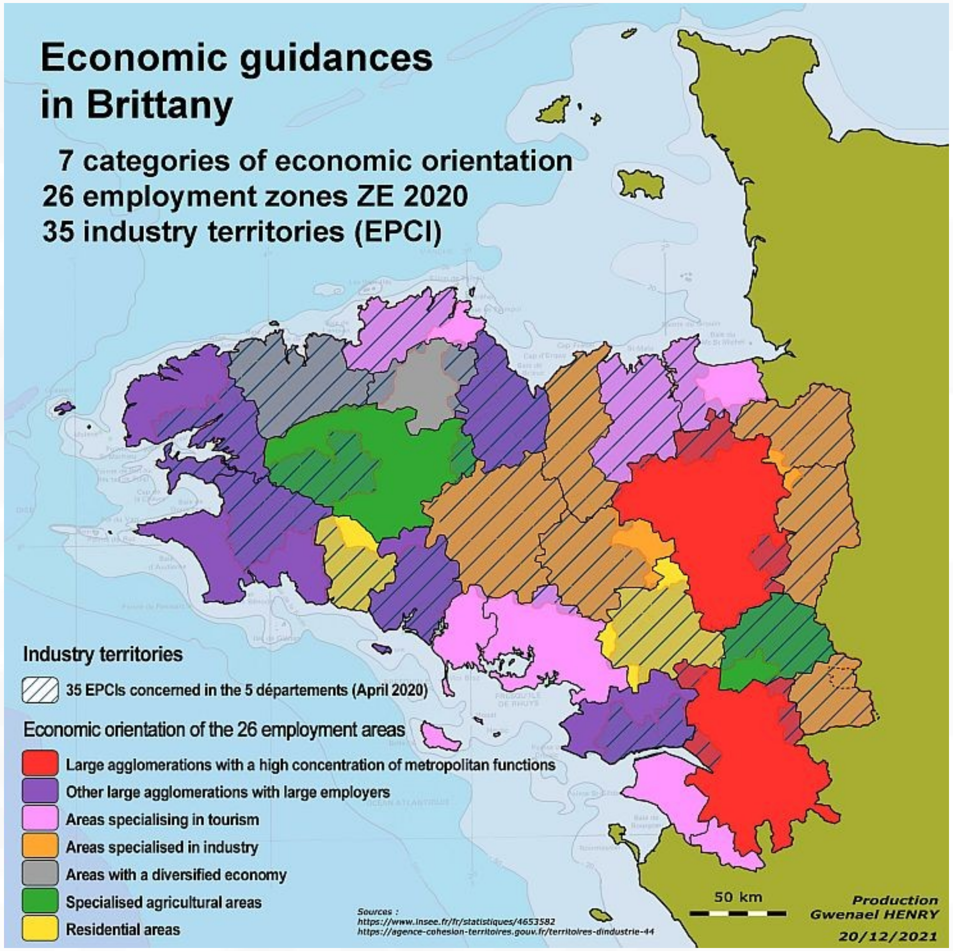
The societal transformations adapted and necessary to the ecological transition of the Breton agricultural sector will have important effects on the quantities of energy to be produced locally and mobilised to build an agriculture at the service of the country's inhabitants. Breton agriculture is not intended to feed the planet. Especially when the increase in the cost of distant transport will no longer make it possible to export as easily. Each region of the world must aim to ensure its food autonomy without its markets being destructured by low-cost imports (our exports) which only have the effect of sending their rural populations on the road to emigration.

c) The secondary sector

Business as usual: in 2019, a relatively solid economic situation in Brittany was confirmed, in a hexagonal context of slight slowdown, with 38,352 jobs created in the region in 2019, all sectors and all statuses combined.

The new division of Brittany into twenty-six employment zones makes it possible to analyse the economic orientation of the territories. Today, the agri-food industry is very present in several of them, reflecting the strong representation of this sector of activity in the region. It is true that a large coastal area relies on activities linked to tourism, but the industrial sector also participates, just as it does in the major agglomerations.

The hexagonal programme "Territoires d'industrie" is an attempt to reconquer industrial territories. Indeed, industry is a vector of development and cohesion of territories. The proof: 70% of industrial employment is located outside the metropolises, in suburban areas, rural areas and medium-sized towns.



However, the health crisis has deeply affected the industrial fabric by putting a brutal stop to the investment of many companies, in territories already often exposed to profound changes. The answer lies in accelerating investments and taking rapid action as close as possible to the regions. This should be done through an ambitious and co-constructed approach between the State and the Regions, led within the framework of the Territoires d'Industrie programme.

In the industrial sector alone, the 362,144 salaried jobs in Brittany represent 8.02% of the total in France, and this share has been steadily increasing since 2000 when it was only 6.88% of the total. As for the 6,797 salaried jobs created in the sector in 2019, they represent 12.50% of all those in France.

This annual progression (+ 1.91% in 2019), as it has been for the last 20 years, is stronger than in the country as a whole (+ 1.22%). And it is in the Loire Atlantique region that we see the most notable increase (2.75%) with 3,046 new creations. The unemployment rate is falling.

Business start-ups are exceeding the previous thresholds and business leaders report a generally favourable situation.

So everything is going well? Perhaps, provided that this situation can be maintained and that the economic parameters remain stable over the next few years. However, the downward variation in energy supply risks seriously disrupting this 'virtuous' cycle.

The last two COVID years have shown the fragility of our economies and we still have unrestricted energy.

Finally, the INDUSTRIAL production structure remains totally unbalanced and export-oriented (at least outside Brittany), with a dominant role in metallurgy (mechanics, cars, aeronautics, naval) and food processing. It is absolutely incapable of meeting the real and basic needs of the Breton people in a perspective of autonomy, **in order to limit imports and transport.**

The current industrial fabric can therefore hardly serve as a basis for any projection for the future.

d) The tertiary sector

The disproportionate weight of the tertiary sector

Companies in the tertiary sector have led to an increase in the number of jobs and activity in Brittany over the last fifteen years, but also to a corresponding increase in energy consumption, particularly for commuting. In terms of value production, the sector represents, depending on the year, up to three quarters of GDP in Brittany, i.e. more than €104 billion in 2019 (in purchasing power standards: PPS, EU27 from 2020)

In the metropolises, "higher" jobs (in research and development, management, wholesale trade, intellectual services and culture, sports and leisure) have increased by more than 50% between 1999 and 2019 in almost all of Brittany's urban areas.

But the health crisis and the containment measures have profoundly affected the evolution of salaried employment in 2020, in Brittany as elsewhere, particularly in the commercial service sector. The biggest upheaval is undoubtedly the development of telework, which has gone from being a virtual concept to a reality in many organisations. Before the crisis, telework was integrated in a minority of companies (only 5% of companies have more than 30% of their workforce in regular or occasional telework according to the DARES).

According to the Nantes Métropole 2020 mobility barometer, in October 30% of the working population surveyed declared that they were teleworking, a use that increased with the second confinement to 44%. Among them, 39% of the working population teleworked 5 days a week.

The commercial service sector in Brittany employed more than 878,800 people at the end of 2020, which represented 52.1% of all Breton employees, a larger share than that observed in France (48.6%). In this sector, salaried employment fell by 1.93% in 2020, less strongly than in France (-2.6%). It fell more in Loire-Atlantique (-2.2%), Ille-et-Vilaine (-2.2%) and Finistère (-2.0%) than in the other two departments (-1.3%).

In 2020, salaried employment in the non-market service sector grew by 1.4%, a higher rate than in France (+0.8%), after a sluggish 2019. With nearly 7,450 more jobs over the year, it totals 590,650 employees in the five departments. This sector has not seen an increase of this magnitude since 2013. Ille-et-Vilaine is clearly leading regional growth (+1.75%, i.e. +2,535 jobs).

Overall, the tertiary sector will obviously remain a major provider of diversified jobs. However, certain employment areas will be greatly affected by the constraints that energy sobriety will impose. The continued urbanisation of society has only been made possible by the availability of low-cost energy for massive commuting to many urban centres.

An alternative economy should reverse the trend and initiate a return of the population to rural areas in which it will have been necessary to deconcentrate many of the activities that are currently centralised.

e) An intellectual revolution

The ecological transition will initially require a strong intellectual reconversion, but awareness has not yet reached the majority of the population. However, it is a major factor that will change the economic and social landscape.

ADEME has reasonably estimated, in comparison with other organisations (Negawatt, WWF), the number of potential jobs created by 2030 in the transition sectors in Brittany at 42,000 in proportion to the Breton population.

It will be necessary to support the very large changes in the skills required of the workforce, because the creative technological destruction dear to Schumpeter actually concerns jobs and therefore workers, and there is nothing to suggest that society and its actors will be able to anticipate and support these changes quickly.

The Climate Action Network and the CFTC did ask in 2018 to launch a "major analysis of professional branches, trades and skills composition in the face of transformations linked to the ecological transition", but nothing has really moved forward since then.

In Brittany, we will have to do our share of the work, even if the reform of vocational training in 2018 only gives the regions a marginal role, which should be reversed to return to the previous situation.

4) Apparent energy consumption by sector

(a) Breakdown of apparent overall energy consumption (Table 3)

TABLE 3 - **Overall energy consumed** (in k toe)

Sector	1975	1990	75 / 90	2005	2019	75 / 19
Industry	1 486	1 269	-15%	1 641	1 477	-1%
Residential Tertiary	2 936	3 241	10%	4 813	3 997	36%
Agriculture	232	349	50%	400	697	200%
Fishing	117	138	18%	75	129	10%
Transport	1 767	2 817	59%	4 057	3 840	117%
Total	**6 538**	**7 814**	**20%**	**10 986**	**10 140**	**55%**

Brittany thus consumed a total of 10.140 Mtoe of final energy in 2019, i.e. an increase of 55% in 44 years.

This table calls for several comments:

1 - The overall annual consumption per capita in Brittany has become very close to the French average in 2019: respectively 2.11 and 2.14 TOE/inh, whereas in 1975 it was 1/3 lower: 1.82 and 2.59 TOE/inh, if we consider the final energy for energy use (actually available).

2 - The overall energy balance by branch reflects the structural imbalance of our economy which favours transport, as shown in Table 4 below:

TABLE 4 - **Comparative structures of energy demand in Brittany and France** (1975 & 2019)

	1975		2019	
Sector	Brittany	France	Brittany	France
Industry + Building and PW	**22,73%**	34,90%	**14,57%**	18,95%
Residential & Tertiary	**44,91%**	41,61%	**39,42%**	46,95%
Agriculture	**3,55%**	2,28%	**6,87%**	3,43%
Fishing	**1,79%**		**1,27%**	
Transportation	**27,03%**	21,20%	**37,87%**	30,66%
Total	**100%**	**100%**	**100%**	**100%**

3 - The energy expenditure of Breton agriculture (0.697 MTEP in 2019) has increased significantly. The contribution of fishing to the "transport" item is considerable, at around 0.129 Mtoe (it takes almost 1.459 tonnes of fuel to catch one tonne of fish: 88,401 tonnes caught in 2019, source: Agrimer).

(b) Breakdown of specific energy consumption :

TABLE 5 **- Breakdown of specific final energy (2019) (unit kTOE)**

Sector	Solid fuels	Liquid fuels	Gas	Electricity	New energies	Total
Industry + Building	5	190	569	612	101	**1 477**
Resident. Tertiary	0	479	1 100	1 788	630	**3 997**
Agriculture	0	446	68	147	36	**697**
Fishing	0	123	0	0	6	**129**
Transportation	0	3 535	7	28	270	**3 840**
Total	**5**	**4 773**	**1 744**	**2 575**	**1 043**	**10 140**

(c) Energy production in Brittany

Table 5 should not be misleading: almost all electrical energy is produced from fossil fuels (coal, gas, oil & uranium) - except for the productions of the Rance.

Despite the EDF's discourse, complacently relayed by the press, Brittany produces nearly 15.8%, insofar as the "official information" only takes into account the administrative region.

For information, the Ile de France only produces 6.59% of the electrical energy it consumes. According to EDF's argumentation, it is there that a nuclear power plant should be built.

Sources: Agence ORE & Enedis, 17/12/2021

TABLE 6 **- Electricity consumption and production in Brittany (in thousands of MWh)**

	Consumption			Production		
	1977	2011	2019	1977	2011	2019
Côtes-du-Nord	1 089	3 886	4 100	41	488	891
Finistère	1 761	5 116	5 651	490	465	998
Ille-et-Vilaine .	1 496	5 742	6 399	455	238	651
Loire-Atlantique	2 413	7 073	8 397	7 734	520	1 392
Morbihan	1 208	4 503	4 974	3	371	735
Total	**7 967**	**26 320**	**29 521**	**8 723**	**2 082**	**4 667**

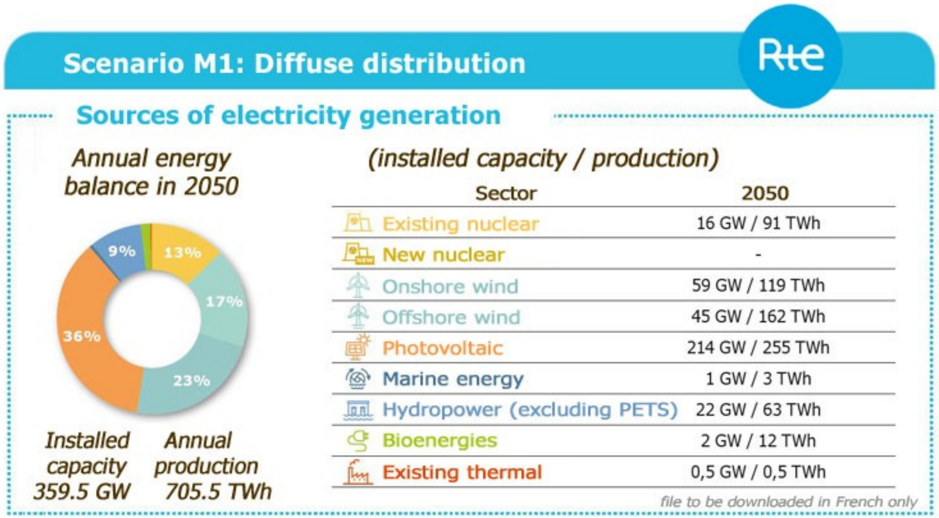
Sources: **Agence ORE & Enedis**, 09/01/2022
Consumption: https://www.data.gouv.fr/fr/datasets/r/e455db41-28c2-419d-bdf1-d44635fdc97e
Production: https://www.data.gouv.fr/fr/datasets/r/86a578ea-9024-489c-8630-2dd14003ab54s

d) Energy consumption and production in Brittany

Today, the public authorities are finally admitting that the necessary energy transition must be taken seriously for at least two good reasons: the depletion of fossil fuels and the impact of carbon-based energy on the climate.

However, the year 2021 will have seen the proponents of a "new nuclear power" once again poke their noses in to sell this critical technology without any democratic debate. All their political, enarchic "Insparchic" (we should say from now on) and media networks are buzzing with a little nuclear music. The fact remains that uranium is not only a non-renewable resource, but often comes from highly politically unstable countries. It is certainly not a very "secure" source of supply and future, not even taking into account the technological risks.

Fortunately today, some "official bodies" have seriously studied several options for producing energy, particularly 100% renewable electricity by 2050. This is a great advance since 1979.



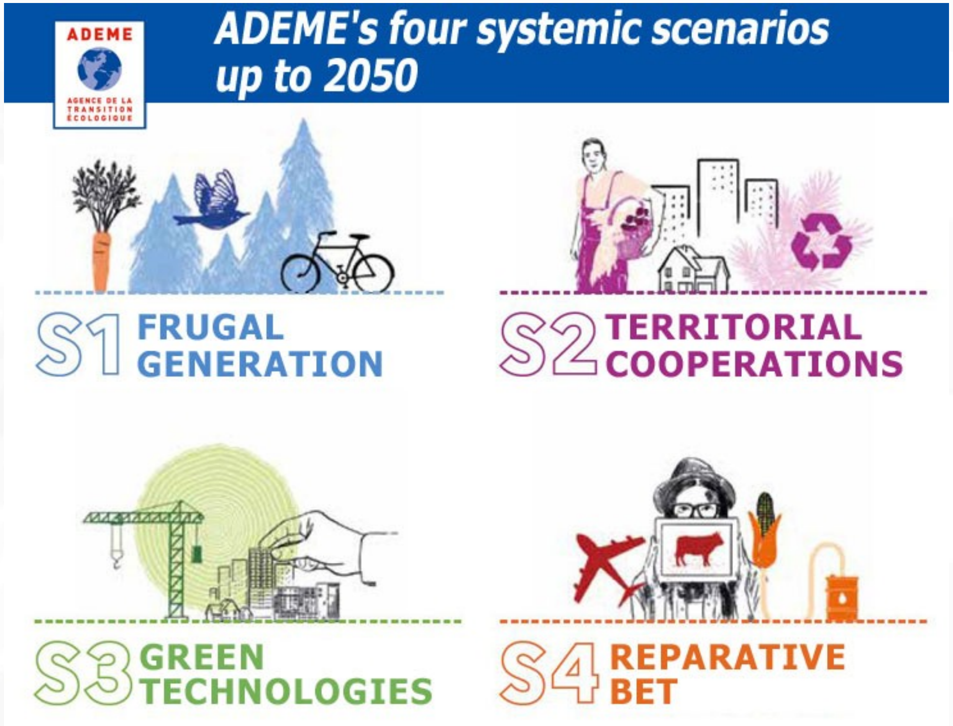
Sector	2050
Existing nuclear	16 GW / 91 TWh
New nuclear	-
Onshore wind	59 GW / 119 TWh
Offshore wind	45 GW / 162 TWh
Photovoltaic	214 GW / 255 TWh
Marine energy	1 GW / 3 TWh
Hydropower (excluding PETS)	22 GW / 63 TWh
Bioenergies	2 GW / 12 TWh
Existing thermal	0,5 GW / 0,5 TWh

You can access the download page of the report on the RTE website by clicking on the image above.

On 25 October 2021, **RTE** made its 2050 study available to the public. The result of two years of work and 4,000 contributions, the prospective study **Energy Futures 2050** proposes six scenarios for the production of electricity in France to move away from fossil fuels. RTE invites us to rely on both nuclear and renewable energies (RE).

But there are three scenarios that envisage a 100% RE system in the long term ("M scenarios").

This is a huge encouragement for the renewable energy sector as it shows that these are credible options.



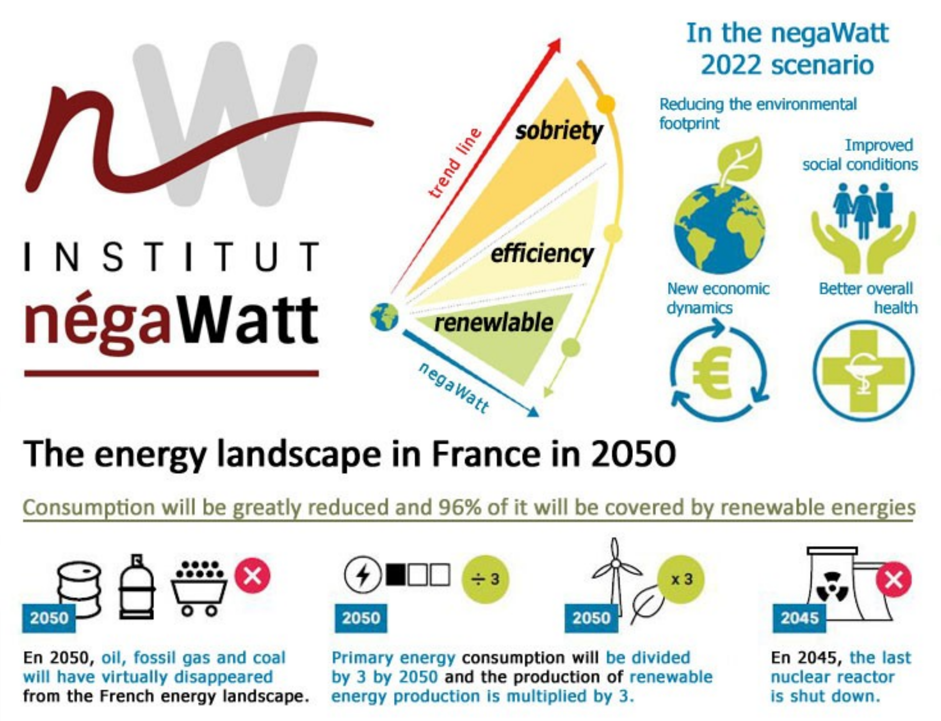
You can access the report download page on the RTE website by clicking on the image above.

On 30 November, **ADEME** presented four new scenarios that could make it possible to achieve carbon neutrality in France by 2050, each with its own internal consistency. According to ADEME, achieving carbon neutrality will depend on strong human and technological bets in all cases, but these will differ significantly depending on the option chosen.

The multi-criteria comparison of these scenarios makes it possible, in a first stage, to identify the orientations of the debates on the changes in our lifestyles that we would collectively be ready to make, particularly in their technical-economic, social and environmental aspects, and then, in a second stage, to define the conditions for their implementation and their consequences.

In order to facilitate the transition to action, ADEME has carried out this unprecedented foresight exercise, based on two years of development work and the mobilisation of a hundred or so ADEME employees and regular exchanges with a scientific committee.

The hypotheses and models were refined and enriched through intensive exchanges with a hundred or so partners and external service providers, specialists in the various fields, as well as through the organisation of two webinars in May 2020 and January 2021, each of which brought together nearly 500 participants to discuss the intermediate results.



You can access the download page of the report on the nW website by clicking on the image above.

The most recent negaWatt scenario (26/10/21) is part of a global sustainability approach. It aims to respond to energy and climate imperatives, while orienting society towards a more sustainable, fairer and more resilient status, addressing issues of biodiversity, precariousness, air pollution, etc.

Through its systemic dimension, this scenario fully contributes to the achievement of the 17 sustainable development objectives defined by the UN. Although it has its own limitations, this reference framework provides a relevant basis for considering the diversity of social, economic and environmental issues surrounding energy transition choices.

Three different organisations but a common implacable observation

Since the time of the pioneers in 1979, there has been a clear reversal in the way we approach the future and economic development.

The arguments and warnings of the happy hairy baba-coolers of the late 30s feed into today's sensible proposals, even if it is to be feared that the boards of many multinationals have not yet given up on pursuing their eco-harmful activities by dressing them up in green. Nevertheless, large sections of the world's population are realising that continuing along this path will not be possible for much longer.

The task now is to make the majority of citizens want this transition.

e) Which alternative forecasts for Brittany

Thirteen years ago, during the thirty-year update of the 1979 BAP, the NPAB took up the presentation of the official but classic forecasts (based on fossil energies) of the time, which predicted that consumption would more than double between 1975 and 2030. In this perspective, the Breton demand for primary energy was expected to rise from 7.36 Mtoe in 1975 to 16.48 Mtoe in 2030, of which only 21.8% would be renewable energy.

Fortunately, among the very recent publications from the three institutions mentioned above, there is **ADEME's S2 scenario**, which is the closest to the spirit of the NPAB, even if it does not totally abandon the use of fossil fuels. It requires the production of 85 TWh (7.30 Mtoe) of primary energy in 2050 for Brittany, i.e. the consumption recorded in 1975 (7.36 Mtoe), presented in the initial BAP of 1979. However, there is a major difference: whereas in 1975, 99.98% of energy was of fossil origin (oil and nuclear), today's forecasts predict 86% of renewable energy in 2050, if the conversion programme is carried out seriously and implemented without delay.

However, these proposals should be compared with the EPP, which forecasts (pro rata) for 2028 an energy production of 14.29 Mtoe still based on fossil fuels, i.e. 10% more than the 2009 forecast (see above).

As a result of the above, in the absence of an official Breton plan, we will take as a usable basis the projections of these three organisations concerning the production and consumption of energy required in France, which will be indexed in proportion to the population for Brittany. In the following, these forecasts will be refined to take into account the specificities of Brittany and partly different strategic choices.

TABLE 7 – **Primary energy consumption forecasts consumption for Brittany**

	publications PAB 79		actual data		PPE 2020	ADEME S2
en MTOE	**1975**	**2000**	**2005**	**2019**	**2028**	**2050**
Fossil fuel	7,11	6,82	8,15	7,93	7,25	0,98
Tidal	0,13	0,13	0,04	0,04	0,04	0,04
Nuclear	0,12	6,66	6,31	5,58	5,47	0,00
Renewable energy	0,00	0,72	0,65	0,61	1,53	6,28
Total Primary Energy	**7,36**	**14,33**	**15,15**	**14,15**	**14,29**	**7,30**

The Multiannual Energy Programmes (PPE), tools for steering energy policy, were created by the law on the energy transition for green growth.

Thus the Breton primary energy demand derived from the ADEME S2 scenario (but not from the NPAB) would be 85 TWh or 7.30 Mtoe in 2050 (Table 7). This tonnage can be taken as the very ambitious target to be reached in Brittany.

5) Summary of the energy situation in Brittany in 2019

a) Breakdown of primary energy consumption by type of production

NUCLEAR	FOSSIL	RENEWABLE
39,40 %	56,01 %	4,59 %
5.58 Mtoe	7.93 Mtoe	0.65 Mtoe
64.90 TWh	92.23 TWh	7.56 TWh

In 2019, most of the primary energy consumed in Brittany was based on fossil fuels, while nuclear energy, which generates 75% of the available electricity, dissipates most of the energy produced in the form of unused heat (between 65 and 70%). Renewable energy production remained marginal.

This extreme dependence on depleting external resources not only generates a huge expense but also presents a major systemic risk.

Energy has become indispensable in all sectors of activity in our society today. At the same time, the massive use of fossil fuels represents an induced climate risk.

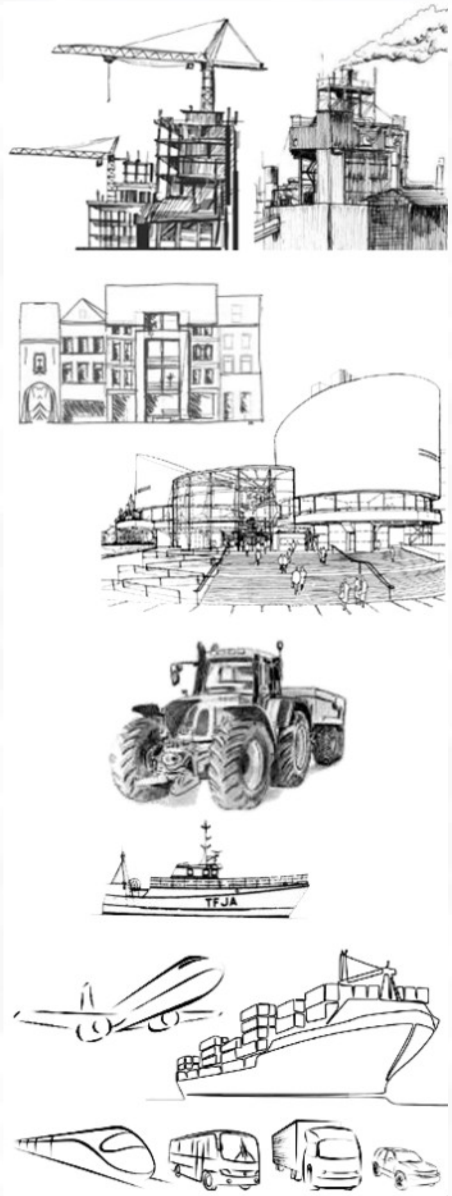
Taking into account these two linked issues is an extremely urgent imperative.

The diagram opposite shows the uses we make in Brittany of the energy we import.

The rest of this report will detail the systems on which our society can rely to provide the decarbonised and renewable energy essential to the population. Their decentralised location in our territories will seem unavoidable.

A massive investment programme associated with an adaptation of our energy uses will prove indispensable in the very short term.

b) Breakdown of final energy consumption by economic sector in Brittany in 2019



Construction & Industry
14,57 %

Residential & Tertiary
39,42 %

Agriculture
6,87%

Fishing
1,27 %

Transport
37,87 %

C - An energy scenario based on renewable energy scenario for 2050

We have retained as an objective an annual consumption of 1.623 TOE of final energy per inhabitant in 2050 (compared to 2.122 TOE at present), i.e. A 23.7% REDUCTION PER INHABITANT OF PRIMARY ENERGY DEPENDENCE BETWEEN 2019 AND 2050.

For a Brittany of almost 5.679 million inhabitants (currently 4.784), the overall final energy demand would then be 8.004 Mtoe (or 9.264 Mtoe of primary energy).

Table 1 on page 15 shows the proposed distribution, within which three energy carriers will have to be distinguished later:

- Heat (Low Temperature, Medium T., High T.) (LV, MV, HV) ;
- Fuels (Solid F., Liquid F., Gaseous F.) (SF, LF, GF);
- electricity.

The same table presents the different energy production channels and Figure 7 (p. 28) shows the essential differences between actual energy consumption in 2019, the official consumption projection for 2028 and the projection we propose for 2050. Of particular note is THE GREAT DIVERSIFICATION OF THE FILIERES which should allow a much more stable operating regime.

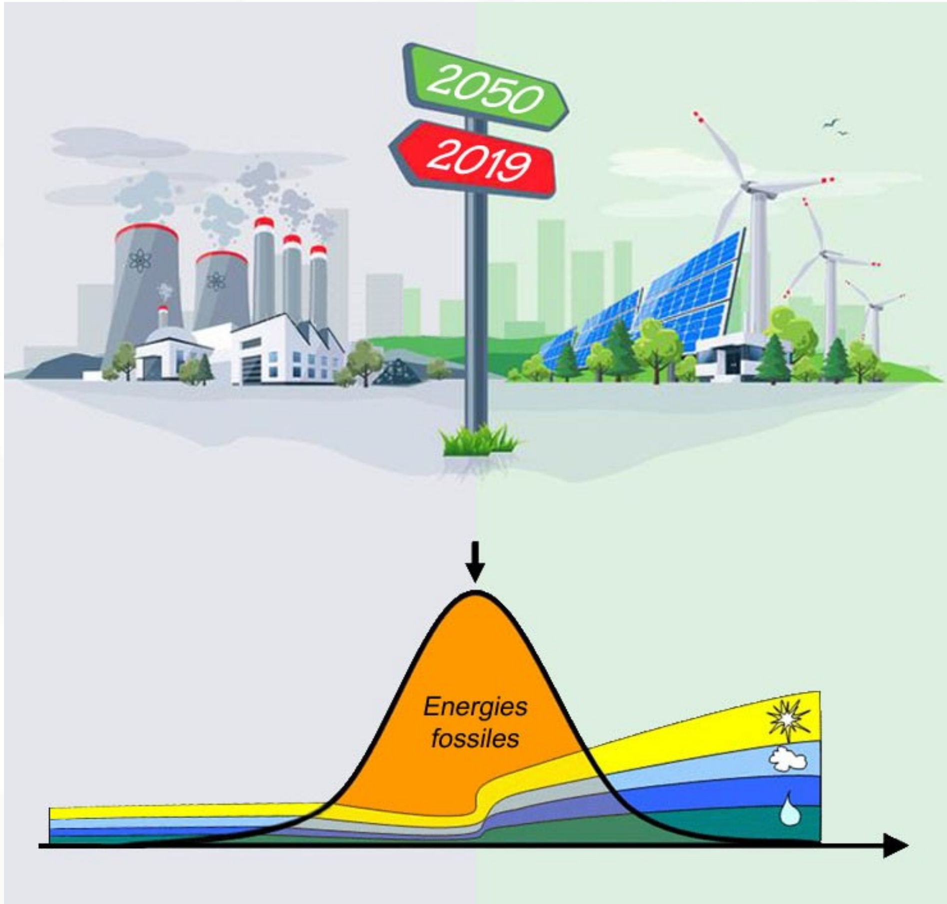
We will now comment on these choices in broad terms, referring to the online annexes for details.

Preliminary remark

These are proposals for possible developments. It is the trends that are important, not the absolute values. The discussion is of course open-ended.

Note: The illustration opposite is the cover page of the first Breton alter project of 1979, the author of the drawing is Christian Anat.

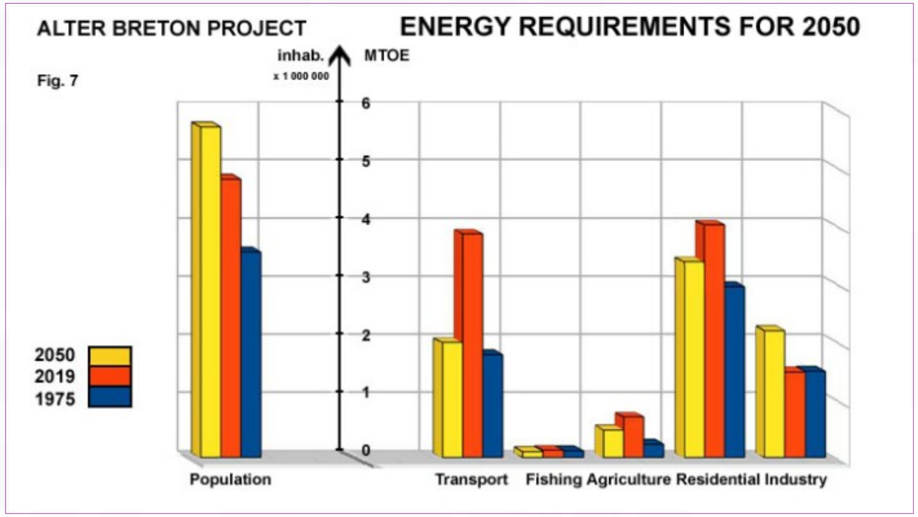
HOW TO MOVE FROM FOSSIL FUEL CONSUMPTION TO SUSTAINABLE ENERGY PRODUCTION?



In the following four chapters, after having evaluated the energy needs in 2050 with regard to current consumption, a scenario of sustainable energy production will follow, leading to their distribution between the different generation systems, then the transformation channels will be briefly described before concluding with the limits of such an exercise.

1) <u>Energy needs for 2050</u>

Our objective is to evaluate **THE REAL NEEDS OF THE BRETONS**, within the **FRAMEWORK OF A MORE EQUAL SOCIETY**. Given the reference situation, this has led us (fig. 7) to emphasise the need to improve the standard of living, to rebalance our economy by giving a greater share to the exploitation of our natural resources, and to favour collective life and exchanges. In other words, we have tried to define **a comfortable but not wasteful society, a society in which the country's actual resources are exploited but without productivism.**



a) <u>the population</u>

Based on the current birth rate, the increase in the migratory balance and the desire of many emigrants to return to live, work and make decisions in their own country, we have assumed a population of **5.679 MILLION** (+61% compared to the 1975 level).

The reality of the development of teleworking over the last two years seems to demonstrate that it is possible to envisage population transfers almost everywhere in Brittany as soon as high-speed digital networks are deployed.

However, the lack of public services and the weakness of the mobility solutions offered in the rural communes will be obstacles to these installations. A new decentralised territorial organisation will have to be devised at all levels.

b) <u>the residential and tertiary sector</u>

These two sub-sectors are generally grouped together in official statistics because they have relatively similar energy consumption profiles. Energy consumption in these two areas concerns five basic uses: heating, cooling, domestic hot water (DHW) production, lighting and auxiliary consumption, particularly for ventilation and distribution.

Obviously, depending on the purpose and type of these buildings, the distribution of consumption between the different uses may vary.

At the turn of the 2020s (2019 data), these two sectors account for 39.42% of **final** energy consumption in Brittany with 3.997 Mtoe in total. The residential sector takes a 24.68% share for 2.502 Mtoe and the tertiary sector 14.74% for 1.495 Mtoe. This level has stabilised for several years.

Aware of the potential for reducing consumption in this sector, the designers of the thermal regulations have constantly reinforced them since 1974, especially during the last two phases: with RT2012 and now with the RE2020 which applies since 1 January 2022.

The fifty years of experience in this field and the involvement of building craftsmen, their professional organisations and their training centres suggest that concrete results will be obtained quickly, initially in new construction, but also in the renovation of the old stock, which will be spread out over time.

It is certainly in this field that public policies and the involvement of citizens in favour of environmental transition will give the most visible results.

● The residential sector:

The energy expenditure of this sector is also dependent on the distribution of **housing** on the territory.

We place ourselves in the perspective of **a much more decentralised society**, where the growth of the large urban agglomerations (Nantes, Rennes, Brest) is stopped, and where the rural communes are revitalised, in particular around teleworking centres, agro-energy complexes and the redeployment of public services.

However, it should be noted that the evolution over the 43 years since 1975 has led to an increase in the population in the fourteen catchment areas of towns with more than 50,000 inhabitants in Brittany.

TABLE 8 **- Distribution of dwellings by type of catchment area**

Types of catchment area	1975		2018	
	No. of dwellings / No. of inhabitants	%	No. of dwellings / No. of inhabitants	%
Dwellings in municipalities outside the city's catchment area	196 123	14	343 889	13
Number of inhabitants	438 174	12	499 486	10
Dwellings in areas with less than 50,000 inhabitants	265 369	19	408 957	15
Number of inhabitants	618 813	18	661 895	14
Dwellings in areas with more than 50,000 inhabitants	929 402	67	1 938 646	72
Number of inhabitants	2 473 326	70	3 667 843	76
Total dwellings	**1 390 894**	**100**	**2 691 492**	**100**
Total inhabitants	**3 530 313**	**100**	**4 829 224**	**100**

details of the data can be downloaded by clicking on the illustration above

It will be difficult to relocate the population to rural communes as there is little housing available there and the demand from newcomers is directed towards the coastal communes rather than those of the Kreiz Breizh. (center of Brittany)

In order to slow down the transformation of coastal residences into holiday resorts, and to allow local workers to reside near their place of work, it will be necessary to set up a **resident status**.

Another way of accommodating young natives could be to start renovating and building new houses in the 360 or so municipalities located outside the catchment areas of the cities, but this would require the development of suitable infrastructures and the deployment of all the economic activities and public services that are essential for the population.

This is because the number of available jobs is not in line with either current or future needs, even before the permanent resident population is increased.

However, this redeployment of activities and populations is vital because urban concentration leads to ever increasing energy costs.

The NPAB 2022 does not pretend to set out a rigid planning of housing construction, but rather will focus on ways to reduce energy consumption in the residential sector, expected as a result of the progressive deployment of the RE2020 in building construction and renovation.

The building sector has undergone a major technological shift by integrating evolving and ambitious thermal regulations over the past two decades.

Brittany's housing stock consists of 2,691,492 dwellings (INSEE 2018). Of these, the 2,114,136 **principal residences** are divided between 1,424,346 single-family homes and 689,790 flats. By deduction the number of second homes can be estimated at 577,356. In this remainder, occasional and vacant dwellings are unfortunately not detailed.

The estimate of the theoretical **maximum** energy consumption of the residential sector in 2018 in Brittany (if all residents did not consume more than the ECD for their dwelling) is based on calculations applied to INSEE statistical series. These recent and documented series provide data on the number, size and energy performance diagnosis (DPE: A, B, C, D, E, F and G) of **principal residences** in the five Breton departments.

The **principal residences** are broken down into 7 classes according to their average living area (-30 of m², 35, 50, 70, 90, 110 and +120 m²) and between 7 other classes according to their DPE. A quick calculation gives the overall surface areas per ECD level, which are then multiplied by the corresponding energy consumption threshold, expressed in KWh/m²/year, and added together.

The **maximum theoretical annual consumption** for the cumulated surfaces of the 7 ECD classes is **40,460 GWh/year**, or **3.479 Mtoe/year**, expressed in **primary energy** for the year **2018**.

Unfortunately, the **actual consumption** values recorded in Brittany in the residential sector on the data.gouv.fr and statistiques.developpement-durable.gouv websites cannot be compared directly with the result of the theoretical calculation as set out above because it is impossible to convert a global value expressed in primary energy into final energy, without having details of the production sources and quantities produced by energy vector.

However, it is interesting to present these actual consumption data obtained from energy suppliers (electricity, gas and fuel oil) and restituted on the official websites already mentioned, as they can be compared with the projections calculated for 2050.

The suppliers' statements establish a consumption of **3.642 Mtoe** of final energy in the residential sector in Brittany in 2018.

A calculation based on the official statistics of consumption by use in France applied pro rata to the population in Brittany gives a global consumption of final energy of **3.572 Mtoe** for the same year.

The interest of the theoretical exercise applied to the 2050 situation lies in the fact that the basic hypotheses of the energy scenario proposed in the NPAB 2022 ban the use of nuclear electricity. As a result, it becomes possible to convert primary energy into final energy without too much distortion and then having this theoretical data to be able to compare the actual consumption in 2018 with the maximum consumption forecast in 2050, thus highlighting the energy savings reasonably expected.

This table is based on data collected from various official sites, the access links to which are provided in the detailed data file that can be downloaded by clicking on the image below. The link is also reproduced in full in the annexes to this document.

ASSUMPTIONS FOR THE IMPROVEMENT OF THE STOCK OF MAIN RESIDENCES BETWEEN 2020 AND 2050 | **HYPOTHESIS**

Evolution of the housing stock	2020 – 2050	increase in the number of dwellings			insulation work is undertaken on these categories				Park 2018
Duration of the programme in years	30	Improvement	Improvement	Improvement.	Annual reduction in stock after improvement			Destruction	2 114 136
	rate of change	0,800%	0,350%	0,550%	-0,930%	-0,533%	-0,282%	-0,143%	
Dwellings improved per year		16 913	7 399	11 628	-10 661	-11 268	-5 970	-3 021	
Dwellings improved in 30 years	or new!!	1 078 209	221 984	348 832	589 844	338 036	-179 091	-90 617	Park 2050
Dwellings remaining by EPD after 30 years		1 078 209	365 650	780 279	144 083	141 365	0	0	2 509 586
of which buildings less than 20 years old		*592 142*			number of unimproved dwellings after 30 years of programme				Δ (delta)
									395 450

ENERGIE / Energie moyenne	kWh/m²/year	EPD A 70	EPD B 90	EPD C 145	EPD D 215	EPD E 290	EPD F 375	EPD G 420	Conso 2050 kWh/year
BZH Less than 30 m²		15 851 121	11 870 109	37 421 772	18 943 827	42 183 689	0	0	126 270 518
BZH From 30 to less than 40 m²		59 269 412	32 462 948	82 126 571	35 238 143	59 201 892	0	0	268 298 966
BZH From 40 to less than 60 m²		431 172 860	244 441 669	681 799 920	211 178 998	283 962 678	0	0	1 852 556 124
BZH From 60 to less than 80 m²		1 125 031 489	567 444 083	1 872 524 284	483 993 146	629 532 629	0	0	4 678 525 632
BZH From 80 to less than 100 m²		1 450 274 250	541 421 839	2 090 648 014	597 012 372	852 750 710	0	0	5 532 107 186
BZH From 100 to less than 120 m²		1 545 951 422	498 138 301	1 982 614 401	569 741 346	760 578 658	0	0	5 357 024 128
BZH 120 m² or more		2 206 711 622	965 495 613	3 348 848 394	766 668 497	820 349 051	0	0	8 108 073 177
BZH Total energie in kWh/year		6 834 262 175	2 861 274 562	10 095 983 355	2 682 776 329	3 448 559 307	0	0	
							GWh/year	25 923	25 922 855 730
								DIWALL	primary energy
							Theoretical calculation	2,229	Mtoe/year
							reduction	35,929	%

DATA Download

It is therefore possible to calculate a **theoretical maximum energy consumption** value for the building stock in **2050** using the same principle (see opposite) and by making some realistic working assumptions based on trends already at work in the building industry today.

The housing stock is renewing at about 1% per year, which means that new construction that meets the new thermal standards is most often replacing old construction that did not meet them and is being torn down when it cannot be renovated.

In addition, additional housing must be built each year to accommodate a growing population, and these new homes will also meet the ER 2020 standards.

Finally, communities are mobilizing to encourage homeowners to have their homes renovated to bring them up to energy standards and thus lower overall consumption. The renovation rate is estimated at between 2 and 3% per year.

In this way, from 2020 to 2050, the stock will have been developed, part of the old stock will have been renovated and the oldest housing (of little value) will have been destroyed. The overall savings on maximum energy consumption in the residential sector will represent 36% of the overall consumption in 2018, despite the increase in population and the number of dwellings.

The major novelty introduced by the RE 2020 imposes that buildings that meet the standards will now have to produce a share of the energy they consume.

But the renewable energies captured on the building or its adjoining plot will not be counted in the calculation of consumption. With the RE 2020 this calculation will be made on the energy vectors used to cover the remaining needs after self-consumption.

This provision implies that the unknown part of self-consumption will have to be evaluated and added to the balance sheet of the sector, or that the regulation will have to evolve by 2050 **to impose the current ECD thresholds as strict limits**. In addition, the heat loss houses will have to be eradicated.

With the construction/renovation assumptions outlined above, it appears that in 2050 about 1,078,000 homes (43% of the stock) will comply with level A of the standard, because either they will have been built after its entry into force for 592,000 of them (55%), or they will have been renovated to this level for the rest.

At the Breton level, **2.229 Mtoe** of primary energy will be needed in 2050, i.e. about **2.006 Mtoe** of final energy (of which 1.019 Mtoe in low-temperature energy, 0.132 in gas and 0.855 in electricity), to be compared with the actual consumption of 2018: **3.642 Mtoe**

On a per capita basis, this amounts to 0.353 toe per inhabitant.

Residential: **2.006 Mtoe**

● **The tertiary sector**

As regards the tertiary sector, in 2050 we shall retain practically the same distribution ratio as in 2019. Thus, according to the actual data of 2019, we will estimate the following distribution, residential: 27.99% and tertiary: 17.41%, which will lead to an increase of approximately 6.00% of the share allocated to the building in the final energy consumption.

In order to promote community life, we felt it was necessary to provide for an extension of school premises (+10%), care and hospital premises (+50%). Offices, shops and hotels will remain at the same level as at present, with the same population.

At the Breton level, the energy expenditure to be expected is 1.248 Mtoe (of which 0.540 in low temperature energy, 0.330 in fuel and 0.378 in electricity).

Tertiary : **1,248 Mtoe**

● **the balance of the residential + tertiary sector:**

The amount of final energy needed in 2050 for the whole sector is then easily calculated: 3.254 Mtoe.

Residential and tertiary are traditionally grouped together in the statistics. The overall expenditure is therefore 3.254 Mtoe, i.e. 0.573 toe per inhabitant, of which 1.559 in heat, 0.462 in fuel and 1.233 in electricity.

Total R+T sector: **3.254 Mtoe**

c) <u>Passenger and freight transport</u>

Some data on the vehicle fleet and traffic in 2019

Road travel

According to official statistics (developpement.durable.gouv), the road passenger vehicle fleet in Brittany is made up of the following motorised vehicles

2,384,835 private cars
1,632 buses
4,594 coaches

The respective average annual mileage is as follows

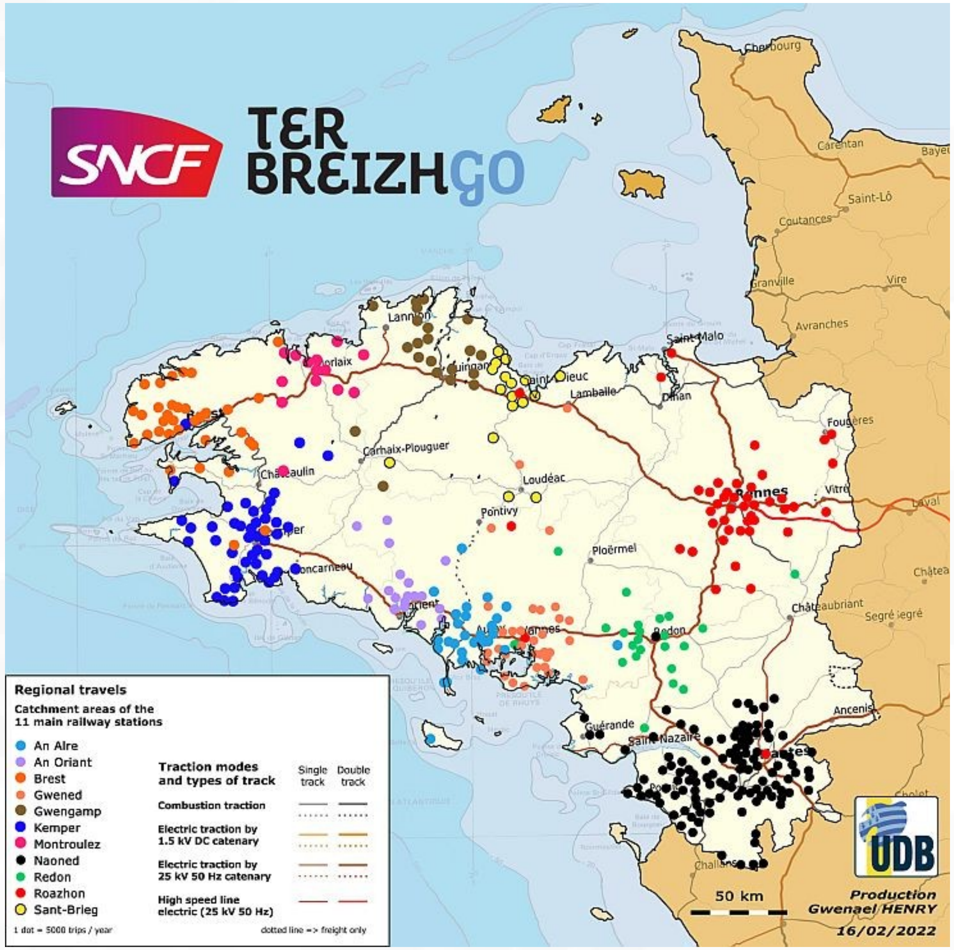
passenger cars 12,223 km/year
buses and coaches 34,263 km/year

Rail travel

It is difficult to collect detailed data on passenger rail transport in Brittany over its 5 departments. However, by cross-referencing various sources, it is possible to reconstruct some general data.

Thus 52.274 million journeys were recorded in 2019 from the 183 stations in Brittany (data.sncf.com), an increase of 18% compared to 2015 (national and regional traffic combined).

Of this total, 22.590 million (43.2%) were made on the Breton regional express network (TER Breizh Go), but among the 10,691 million journeys made from stations in Loire Atlantique located on the 13 lines departing from Nantes, a significant, but unquantified, proportion of commuter journeys involves passengers living outside Brittany but coming to work there daily.



Overall, the TGV accounts for 51% of rail travel in Brittany. Approximately 10% of the traffic on Breton lines concerns TER/TGV connecting traffic at the main Breton stations. This indicates that 39% of TER traffic remains. Finally, 45% of the regional population resides in a commune located less than 5 km from a station.

The data provided by the transport authority indicates that the average length of travel per passenger on TER lines is 50 km and 477 km on TCHS lines (trains capable of high speed).

* TER = Transport Express Regional = RET * TGV = Train à Grande Vitesse = HST

Using this data, it can be calculated that in 2019, for the 4,784,126 inhabitants of Brittany, the distances travelled reached an average of 236 and 2,774 km/year/inhabitant, respectively on the TER and TAGV networks.

Air travel

While it is easy to find the number of passengers who flew to the ten airports receiving passengers from Brittany in 2019, it is more difficult to determine the overall sum of the kilometres travelled by these passengers. This is because some of the passengers arrive from other countries and those who leave Brittany are not necessarily Breton residents. The catchment areas of the airports of Nantes, Rennes and even Pleurtuit extend well to the east of Brittany.

Fortunately, the administration of the eternal hexagon produces various hexagonal statistics, and from these it is possible to estimate the probable distance that the inhabitants of Brittany travel by plane each year.

In the absence of a more precise method and by making debatable assumptions: distribution of mileage according to population weighted by the ratio between Breton GDP per capita and hexagonal GDP per capita, such a calculation method gives a result that is usable if not exact, given that the higher the available income and the greater the economic activity in a territory, the more recourse to air transport can be envisaged.

Under these conditions, the 421 billion passenger-kilometres recorded in 2019 in official publications (ecologie.gouv.fr) multiplied by the 7.14% which represents the share of the inhabitants of Brittany, affected by a coefficient of 82.54% relating to the GDP gap and finally divided by the legal number of inhabitants of Brittany for the year in question (4,784,126 inhabitants) gives a theoretical average distance **travelled by air of 2,342 km/year/inhabitant.**

Maritime and river journeys

Travellers using these modes of transport constitute a relatively small group. In addition, on most journeys, goods are also carried on ferries, which carry many tractors with semi-trailers alongside passengers.

Finally, of the 1,113,142 passengers who embarked or disembarked at one of the three main ports dedicated to this activity in 2019, an undetermined but certainly significant number were Irish or British citizens.

More local traffic on routes linking the Breton islands to the mainland also involves a large number of summer tourists. For all these reasons, consumption in this transport sector will be dealt with in the chapter on freight transport.

The consumption envisaged for 2050

Only four categories of transport have been considered:

- local trips (less than 100 km) made by car (T1): according to the future dispersion of housing and production structures, and despite the necessary doubling of public transport, the average mileage required will remain high: 10,000 km per "household" each year. In 2018, there were 2,294 people and 2,385 cars per Breton household, so this will mean reducing current travel by about 20%.

- Urban and peri-urban travel (T2): the city centres will be developed to double the number of public transport vehicles (buses and coaches): they will reach 2,000 km per year per citizen.

- Long-distance travel (more than 100 km) using the RAILWAYS (T3). We advocate the rehabilitation of domestic lines: Auray-Saint-Brieuc, Carhaix-Rosporden, Châteaulin-Carhaix-Rennes, Châteaulin-Camaret, Morlaix-Roscoff etc. We will remain on the current basis of 3,000 km per year and per inhabitant (875 km in 1973).

- Air transport (T4): this will remain limited to very long distances, and because of the energy costs involved, we expect only 800 km per year per inhabitant, i.e. a reduction of 2/3.

IN TOTAL: T1 + T2 + T3 + T4 = 0.631 + 0.056 + 0.173 + 0.396 = 1.256 MTEP (of which 0.452 in fuel and 0.804 in electricity) or 0.221 TOE/year/inhabitant.

Passenger transport: **1,256 Mtoe**

Road transport

According to the same sources as in the previous chapter, the fleet of goods transport vehicles in Brittany is made up of the following various motorised and non-motorised vehicles

74,850 specialised vehicles
5,626 specialised heavy vehicles
246,957 vans < 2.5 t.
271,381 trucks > 2.5 t.
20,286 road tractors
30,504 semi-trailers
4,553 trailers:

The current respective average annual mileage is as follows:
- light commercial vehicles 14,678 km/year
- heavy vehicles 43,057 km/year

The mass of road freight transport is estimated at **219.5 M.tons** in 2019.

Rail transport

Freight tonnage calculated from global data due to track length: 4.845 M.tons or due to population: **6.453 M.tons** in 2019. (pending detailed data from SNCF).

Air transport

Air freight transport remains marginal today as the total for the three Breton airports concerned was **17,671** tonnes in 2019. It could remain at this level in 2050. There has been no air freight since 2014.

Maritime transport

The data below are given as an indication in order to reflect the orders of magnitude within the current maritime traffic.

2019	Vessels entered	Passengers		Goods	
		landed	embarked	landed	embarked
Ports of Brittany	*number*	*number*	*number*	*K tonne*	*K tonne*
Brest	755	15 125	3 508	2 064	578
Concarneau	4	0	0	0	0
Douarnenez	32	0	0	0	0
Le Légué	135	0	0	250	32
Lorient	623	0	0	2 598	87
Nantes - Saint-Nazaire	2 592	1 724	0	22 472	8 211
Quimper	0	0	0	0	0
Roscoff	541	185 470	169 050	252	171
Saint-Malo	1 318	404 721	333 544	1 018	247
Tréguier	36	0	0	67	2
Total Breton ports	**6 036**	**607 040**	**506 102**	**28 721**	**9 328**
share in Hexagon in %	10,69	3,87	4,73	12,84	7,59
Change / (2018) in %	-4,27	-15,18	-21,52	1,81	-19,82
Total metropolitan ports	**56 466**	**15 673 000**	**10 697 000**	**223 630**	**122 867**
Change / (2018) in %	-11,67	3,39	-10,17	-1,52	-4,14

Future needs for goods transport (rail, sea, road) will be determined by the assumptions made for the activity of the productive sectors (industry, fishing, agriculture). On the basis of the COP 79, the energy expenditure for this item should be 0.53 Mtoe, including fishing and maritime transport. However, due to the particular potential of maritime transport in Brittany, the needs allocated to it will be increased, in particular to develop coastal shipping and maritime works. Given the planned structure of production, which is highly decentralised, we will retain the value of 0.720 Mtoe for the "transport of goods" item for 2050.

Freight Transport: **0,720 Mtoe**

Consumption envisaged for 2050

IN TOTAL THE TRANSPORT SECTOR will require 1.976 Mtoe (of which 0.444 in fuels and 1.532 in electricity), i.e. 0.348 Mtoe per inhabitant

d) fishing

The current level of consumption (0.129 MTEP) is significant, and it is necessary to introduce "new" modes of production and locomotion for a more rational management of this energy expenditure. The use of mixed motor and sail trawlers, for example, seems promising.

However, it must be realised that the fishing sector has been strongly affected by the current social model, which is accelerating its marginalisation. This trend must be reversed: its development seems essential for the future, within the framework of a true management of the sea's resources. Several avenues are available: repopulation of the seabed, aquaculture, rational management of fisheries while safeguarding the balance of ecosystems, etc...

In view of the gains that can be made by using less energy-intensive modes of propulsion, we think it is plausible to expect a significant reduction in this sector. We have retained the figure of 0.108 Mtoe, corresponding to an energy expenditure of 0.019 Mtoe per inhabitant.

Fishing sub-sector: **0,108 Mtoe**

e) agriculture

Different scenarios were studied for the use of agricultural land. The selected scenario ensures :

1 - the food needs of the Breton people in terms of plant and animal products: we recommend a slightly less meaty diet than at present;

2 - the needs of the herds (stop importing oil cakes);

3 - an export level equal to the consumption of plant and animal proteins;

4 - energy production (which in the proposed scenario amounts to 3.96 Mtoe).

Note the use of 5800 km² of land for crops that can be converted into energy, including 1800 km² for the energy production needed to exploit the entire UAA in Brittany and 3300 km² of wooded areas for energy plantations.

The energy needs of agriculture are as follows (see appendix "Needs - Society Model"):

Heat: 0.133 Mtoe, Fuels 0.185 Mtoe, Specific electricity: 0.162 Mtoe.

The needs of agriculture amount to **a total of 0.480 Mtoe, i.e. 0.085 toe per inhabitant** (+29% compared to 1975). This is the sector for which the greatest increase in energy expenditure is forecast; but it will be seen that it alone will provide 39% of the total in primary energy.

Agriculture sub-sector: **0,480 Mtoe**

ABLE 9 **– Distribution of soils**
(in hectares)

CORINE Land Covert	Situation 1975	Situation 1990	Situation 2006	Situation 2018	Forecasts 2050
Utilised agricultural area (UAA)	**2 474 000**	**2 709 740**	**2 651 806**	**2 618 293**	**2 638 000**
Prohibited areas	3 550	2 110	2 110	2 110	2 110
Natural Areas		512 029	535 616	543 661	512 000
Agricultural areas	2 474 000	2 709 740	2 651 806	2 618 293	2 308 000
Energy plantations					330 000
Artificial Zones		210 104	244 450	269 918	281 890
Total surface (Teruti)		**3 433 982**	**3 433 982**	**3 433 982**	**3 434 000**
Rocks and waters	98 000	47 300	50 952	51 813	52 000
Landes, routes, alpine pastures		110 631	132 635	141 147	110 000
Forests	548 000	354 098	352 028	350 701	250 000
Hedges, poplar plantations, paths		1 072 990	981 578	955 195	900 000
Prairies	560 000	477 230	417 421	419 055	360 000
Perennial crops (vines, orchards)		17 892	17 093	17 169	18 000
Annual Crops	1 910 000	1 141 627	1 235 715	1 226 874	880 000
energy crops					550 000
industrial crops					30 000
Sub total		3 221 769	3 187 422	3 161 954	3 150 000
Built artificial floors		85 406	97 113	106 724	120 000
Undeveloped artificial floors	318 000	28 506	37 117	43 277	44 000
Roads and car parks		98 301	112 330	122 028	120 000
Sub total		212 214	246 560	272 028	284 000
Total surface (Teruti)	**3 434 000**	**3 433 982**	**3 433 982**	**3 433 982**	**3 434 000**

DATA

Primary sector : **0,588 Mtoe**

f) Industry

Due to the structural imbalance of the current Breton economy, any correct assessment of our future energy needs for industry is difficult.

We consider that it will be necessary to maintain a per capita consumption of 0.385 TOE for 25 years to allow for technological change (compared to 0.309 TOE at present). This corresponds to an overall energy expenditure of 2.186 Mtoe in 2050.

The evaluation by energy vector is: 18.30% in LV, MV and HV heat, i.e. 0.400 Mtoe (of which 0.10 in very high temperature obtained by hydrogen combustion); 38.70% in fuels, i.e. 0.846 Mtoe and 43% in electricity, i.e. 0.940 Mtoe.

No valid comparison with the current situation of the industry can be attempted. We believe that we must **totally remodel our PRODUCTION SYSTEM**. The new Breton energy gamble can be an excellent stimulus for the **conversion of industry in Brittany**.

Secteur secondaire : **2,186 Mtoe**

Let's suggest a few avenues for the transition phase, between now and 2050:

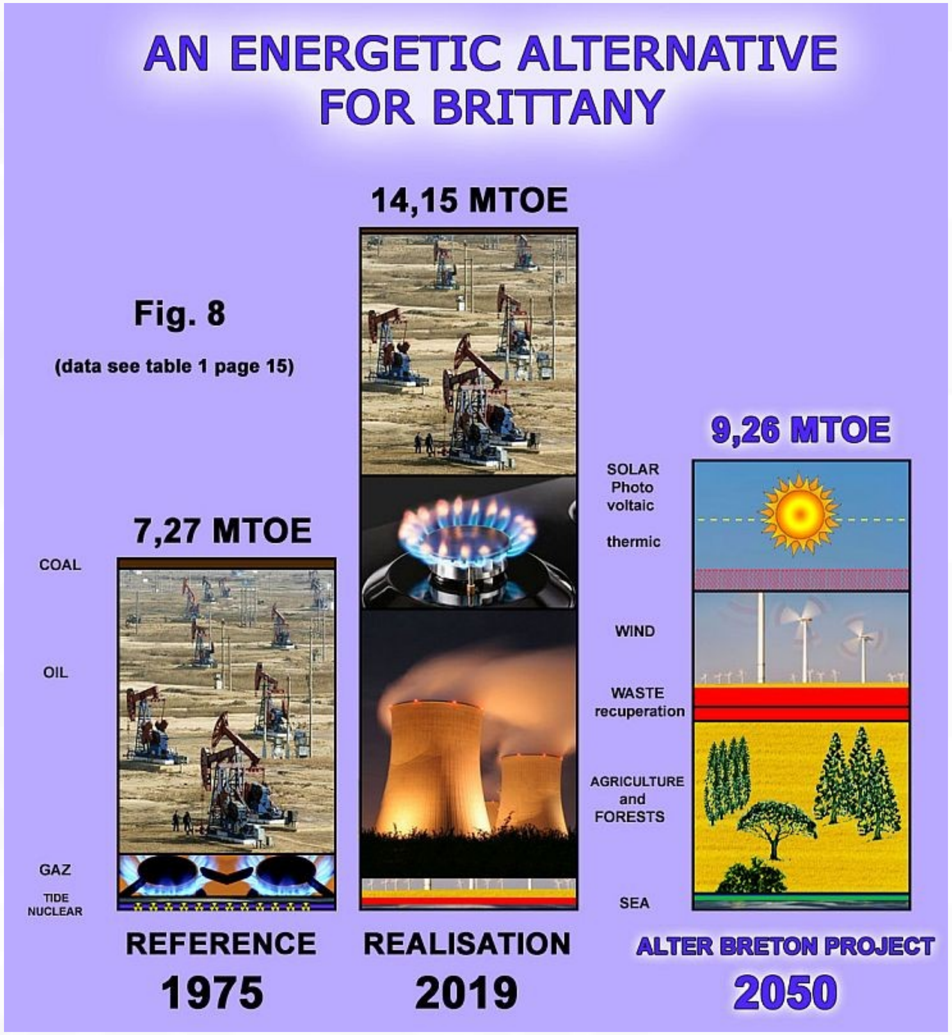
- reconversion of the metallurgical potential (including arsenals) for the manufacture of wind turbines, wave and tidal power stations. The construction of platforms for off-shore energy plants will require the implementation of advanced technologies;
- Creation of chemical industries using our natural resources (energy crops, algae extracts), either for agricultural needs or for everyday consumption;
- production in small units, with close monitoring of the impact on the environment;
- systematic treatment of industrial waste, effluents, etc.

In the field of industry, a major research effort is needed to prepare an industrial production structure compatible with the new development model whose main lines we have defined. We are of course open to any proposal.

g) Summary

- The proposed evolution from 2005 to 2050 (Fig. 8) allows for **a significant increase in the average standard of living of the Breton people** and allows for an overhaul of our economy, taking into account a significant increase in energy needs in the field of industry (+56%), fishing and agriculture (+20%). The profound change in current transport habits allows for significant savings.

In total, the structure of our energy consumption in 2050, compared to 1975 and 2019, is as follows (see illustration opposite):



The increase in final energy consumption per capita is 14% between 1975 and 2019, but in 2050 it will be 43% lower than in 2019. By way of comparison, the current official assumptions predict an increase in per capita energy needs of around 1.6% by 2028.

Compared to the long-term evolution outlined for France in the report entitled "Energy prospects for France" by the DGEMP, the new type of development sought in Brittany is more focused on the exploitation of our natural resources (agriculture, fishing). The dispersion of our habitat, which is favourable to a more balanced evolution of the occupation of the territory, maintains a relatively high expenditure on transport.

2) A renewable energy production scenario

The level of needs being specified (8.004 Mtoe in final energy), it is necessary to plan the production of the equivalent of 9.264 Mtoe/year (108 TWh/year) in primary energy in 2050.

It should be noted that we have not sought to exploit 100% of the Breton energy potential. The level retained remains compatible with respect for the major natural balances.

The following sectors are described in turn:

- marine energy sources (floating and land-based wind energy, wave and current energy)
- land-based biomass (wood, energy crops, livestock & domestic waste)
- the wind energy sector (onshore)
- thermal and photovoltaic solar energy
- the hydraulic sector.

The transformations and losses of the primary energies produced in this way will also be specified in order to arrive at the final energies and match supply and demand.

a) Marine energy sources

Brittany's oceanographic situation is in many ways exceptional, with its wide continental shelf, its high tides, its swell-beaten shores and its indented coastline, which is conducive to the development of marine flora and fauna.

Three sectors have been selected to exploit the marine potential;

● **"Marine wind energy":** land-based or floating, this is the maritime part of wind energy, for which certain professional skills are necessary for their deployment, requiring those found in the large shipyards of industrial ports.

● **"marine white coal"**: this represents the energy that can be recovered from tidal currents. It is therefore an energy of lunar and solar origin.

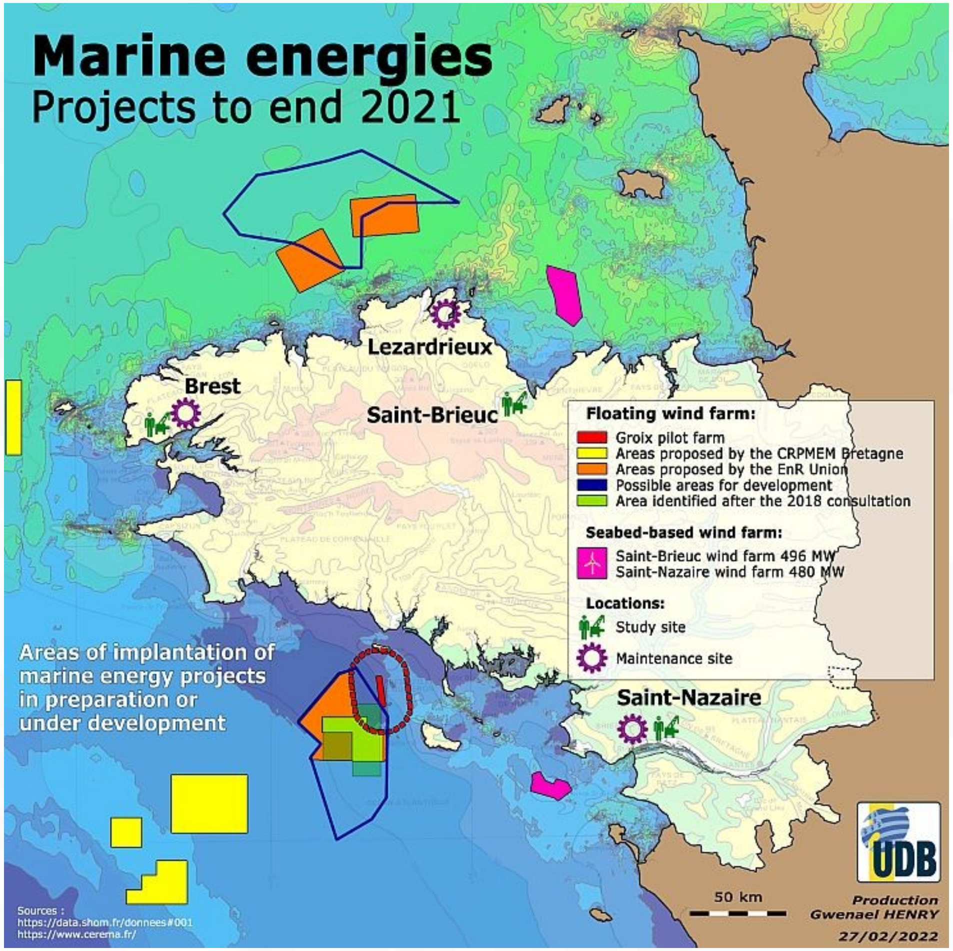
● **"Blue gold"**: it represents the energy that can be recovered from the waves, from the swell. It is a particular form of wind energy.

a1 ● offshore wind:

Offshore wind is not strictly speaking a marine energy, however given the location of these wind farms, all stages of intervention on site call for specific skills of shipbuilding and navigation.

There are two types of wind turbines; the land-based type, which is directly anchored in the ground, and the floating type, which is clearly in the maritime domain, but which is still in the research and development phase.

In 2022, only two onshore wind farms are under construction. On the northern coast, off Cape Fréhel in the north-east of the Bay of Saint-Brieuc, a wind farm of 62 8 MW machines is expected to produce 1 141 GWh of electrical energy each year.



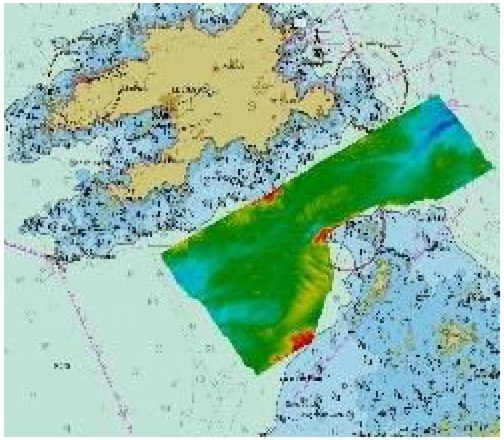
On the southern coast opposite Saint-Nazaire on the Guérande bank, the first offshore wind farm in Brittany should be operational by the end of the year. There are 80 6 MW machines that are calibrated to produce 1,104 GWh per year.

By looking for new sites, which are quite rare, for the installation of wind farms and/or by developing floating wind turbines, it is necessary to plan the tripling of the power currently being installed. That is ((62 x 8) + (80 x 6)) x 3 = 2,928 MW.

This means that offshore wind will allow us to produce about 7,105 GWh/year (load capacity 28% = 2,450 h/year), which is the annual equivalent in oil of :

Offshore wind: 0,611 MTOE

a2 ● white coal: tidal energy



Fromveur Passage - Ushant Island

Currents are caused by the daily rise and fall of the tides, which occurs twice a day around the coast of Brittany. As the water flows and fills or empties bays and estuaries, it carries energy. The amount of energy that can be extracted depends on the speed of the current and the cross-section of the flow captured.

It is a technique similar to the extraction of wind power. But because water is much denser than air, an equivalent amount of power can be extracted from the treatment of a smaller cross-section of flow and with a slower flow velocity. The peak current velocity in spring is a first indicator of the energy value of a tidal site. The rotation of the blades of a tidal turbine converts the kinetic energy of the current into rotational energy. The latter is transformed into electrical energy by generators. The distribution to the homes is done afterwards thanks to cables connected to the shore.

The characteristics of this tidal turbine make it one of the most powerful machines developed to date and tested in real operating conditions

Placed on the seabed and held in position by its gravity base, the tidal turbine has no visual or acoustic impact on the surface.

Moreover, because the turbines are located at depth and in areas of strong current, neither maritime traffic nor fishing activities are disturbed, thus avoiding the conflicts of use usually encountered when deploying marine technologies.

On the previous page, the background map highlights the areas of strong currents, which are mostly located in the Channel. The strength of the currents is indicated by the colour ranging from blue to yellow. The area to the north-east of the island of Bréhat is particularly suitable for this type of machine.

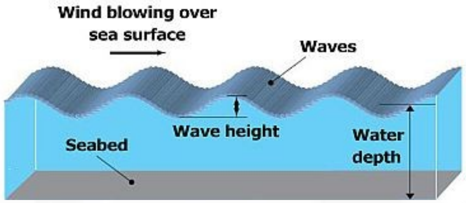
But in some cases the extraction of tidal energy requires the construction of dams, as on the Rance, which strongly modify the ecosystems. Only small-scale projects are socially acceptable today.

Rance dam (540 GWh/year) ...,..................... 0.046 MTOE
100 Sabella D10 units of 540 MWh .... 0.005 MTOE

Tidal power allows us to produce: 0.051 MTOE

Tidal power: 0,051 MTOE

a3 ● blue gold: wave energy



Waves and swell are formed as a result of the frictional dissipation of the energy of the wind blowing across the sea. The mechanical power of this phenomenon is expressed in kW per metre of peak width. Every year, about 180 TWh are dissipated on the 2800 km of Brittany's coastline.

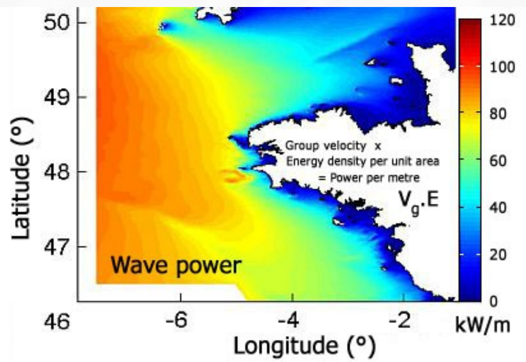
Water acts as an energy carrier. The amount of energy in the waves depends on their size and period (the time between successive crests). The average annual power per unit wave crest width (e.g. 40 kW/m) is a first indicator of the energy value of a particular location. Wave energy to electricity systems are often categorised according to their location at sea, in particular according to the water depth of the site, because this determines the size of the waves and therefore the amount of energy. There are three types of siting: offshore, inshore or directly on shore.

Although the potential is great and a lot of research is being carried out in Europe, the industry is still struggling to produce equipment that can operate in extreme conditions.

Waves Energy, a company that developed the promising Pelamis process at the turn of the 2010s, although it had reached the pre-industrial stage, had to stop its activity in 2014 due to irremediable weaknesses in its equipment.

However, in the UK, which has a strong wave energy potential, the Engineering and Physical Sciences Research Council (EPSRC) has allocated nearly €9 million (£7.5 million) to eight wave energy converter (WEC) projects in 2021. The council believes that the UK has excellent wave resources and advanced technologies that need to be rapidly developed to meet the target of 22 GW of installed capacity by 2050.

According to Ocean Energy Europe (OEE) and WindEurope in 2020, while in offshore wind 14.7 GW of capacity was installed, only 220 kW was installed in wave power in Europe that year.



The European Commission, the EU's executive body, wants the capacity of wave energy technologies to reach 100 megawatts by 2025 and at least 1 gigawatt by 2030.

In Brittany too, research is ongoing, including
- SEAREV, a project launched by the École Centrale de Nantes in 2003
- WAVEGEM, a platform resulting from SEAREV to be installed off the coast of Le Croisic in 2019;
- the project to install the WaveRoller system in Brittany, developed by AW Energy

However, it is still premature to make medium-term forecasts. It is better to consider that the future contributions of these technologies will constitute a surplus to compensate for the uncertainties of current forecasts in the marine energy sector.

WAVEGEM platform installed by the IHES consortium led by GEPS Techno off the coast of Le Croisic in 2019 on the SEM-REV site operated by Centrale Nantes.

For the moment it is not possible to make any predictions, but it is likely that within a few years these technologies will be able to make their contribution.

There are other types of marine energy but we will consider that they have not been the subject of studies on their installation in Brittany, either because the local conditions do not lend themselves to it, or because they are recent and tested elsewhere, or finally because studies show a random valorization.

a4 ● thermal energy from the seas (temperature gradient: bottom / surface)

a5 ● osmotic energy (salinity gradient in an estuary: river/sea)

Waves power : 0,000 MTOE

Total marine energy : 0,662 MTOE

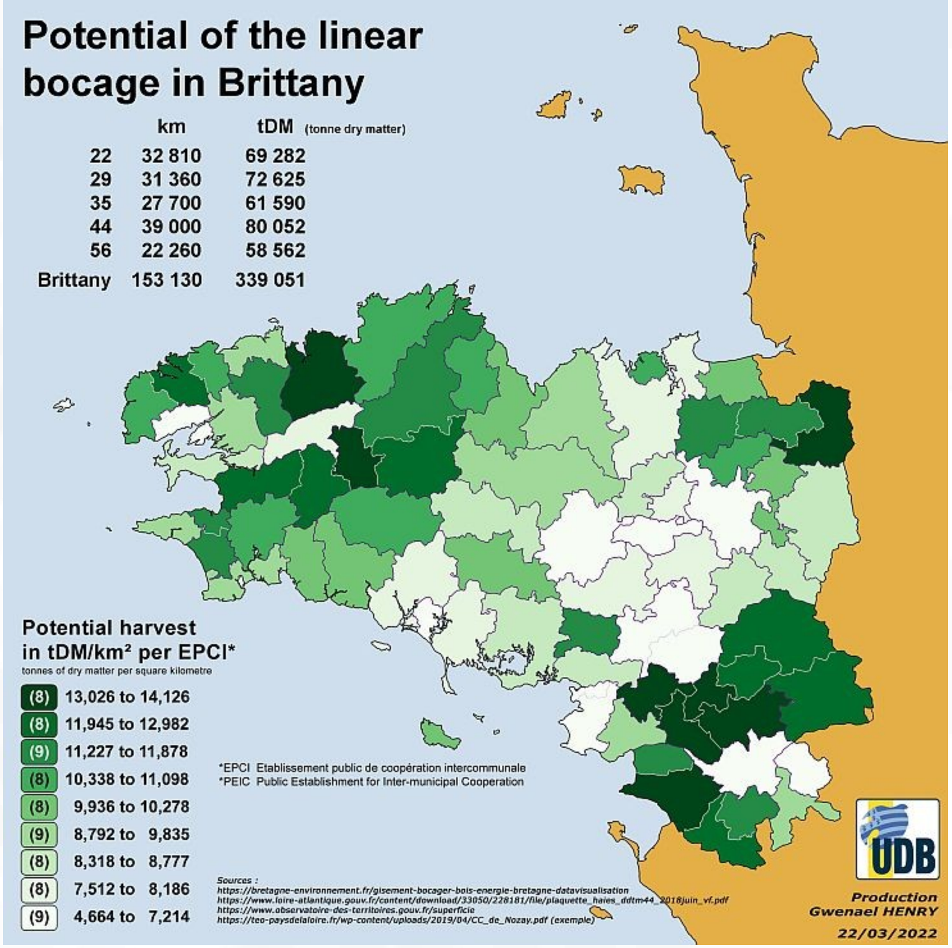
b) The terrestrial biomass sectors

We will discuss in turn :
- energy production from wooded areas; forestry waste; linear forestry and energy plantations.
- Production from agricultural land: energy crops and livestock waste,

b1 ● Energy production from woodland:

We give here only the broad outlines of a scenario that will need to be detailed.
● We have based ourselves on a probable distribution of the different formations (moorland, forests, poplar groves, copses & hedgerows...). according to the classification of the survey: 'Land use - TERUTI - LUCAS 2018'. (Table 12a).
● However, it should be noted that more than 40,000 ha (-5.34%) of the areas detailed in this table disappeared between 2006 and 2018 and that changes in use occurred in favour of woodland (+38.21%) to the detriment of heathland (-39.6%) and the group copses and linear forest (hedgerows bocagères) (-45.1%)
● Forest resources will be exploited at a rate of 65% of the deposit per year.
● Copses, coppices and hedgerows will be partially converted into energy plantations (30,000 ha) for the production of fuels,
● Half of the former heathland (300,000 ha in 1976) which had been converted into arable plots during the last 44 years (TAM), will be reallocated to the use of natural vegetation: gorse, reeds (wetlands) or to reforestation (TTCR),
● The maintenance of the linear forest (hedges, embankments, etc.) will allow the production of chipped wood chips (9 year rotation).

● **Yields**:
We retain yields of 10 tDM/ha for energy plantations, and 7.5 tDM/ha for copses, coppices, as well as for the linear forest (average yield of the French forest exploited: 10 tDM/ha per year; tDM = tonne of dry matter)
● **Production of timber and industrial wood:**
In this scenario, 60% of Brittany's needs in 2050 would be covered for timber, and 75% for industrial wood.
● **Energy production from wooded areas.**
The figures are presented net of the sector's self-consumption: 1.5 TOE/km/year for the 153,000 km of hedgerows and 1.9 TOE/ha/year for the exploitation of energy plantations and for high forest (± young forests) and coppice under high forest.



This map shows the density of potential harvesting on hedgerows in 75 EPCIs in Brittany (2021). This density ranges from 4.664 to 14.126 tDM/km². The length of hedgerows and the potential annual tonnages are given by department.

TABLE 12a - **Net area of forest**

Data 2018	Landes		Forests		Poplar groves		Groves, hedges		Workable surfaces	
	Area	Share	Area	Share	Area	Share	Area	Share	Area	Share
	ha	%	ha	%	ha	%	ha	%	ha	%
COTES-D'ARMOR	13 658	8,78	108 109	69,47	2 472	1,59	31 372	20,16	155 611	100
FINISTERE	27 658	17,36	105 307	66,09	615	0,39	25 769	16,17	159 349	100
ILLE-ET-VILAINE	5 315	4,71	84 717	75,00	501	0,44	22 419	19,85	112 952	100
LOIRE-ATLANTIQUE	13 155	11,17	63 031	53,52	1 096	0,93	40 491	34,38	117 773	100
MORBIHAN	21 708	11,66	134 683	72,37	624	0,34	29 086	15,63	186 101	100
BRITTANY	**81 494**	**11,14**	**495 847**	**67,76**	**5 308**	**0,73**	**149 137**	**20,38**	**731 786**	**100**

Producer: Ministry of Agriculture (AGRESTE). Source: TERUTI- LUCAS land use survey. Natural land use source TERUTI-LUCAS 2018

We can note that the average efficiency of the transformation of dry biomass into solid fuels is 72% and 56% into fuels.

TABLE 13 **- Distribution of wooded areas in 2050 (in hectares)**

Type	Heath (H)	Forest (F)	Poplar (P)	Grove Hedges (G)	Cultivated land (MAL)*	Energetic Plantations or exploitation	
Planned surfaces	70 000	320 000	3 800	240 000		289 000	
transformation						30 000	(G)
balances	-65 000	-40 000	-4 000	-30 000	-150 000	44 000	(F) (P)
(2050 / 2018)						215 000	(H) (MAL)*

*MAL marginal agricultural land

As far as high forest and coppice are concerned, only pruning and sawmill waste is used for energy purposes (logs provide timber and industrial wood).

Production of the forest, linear forest, heathland and energy plantations (TTFR) sector:

Note: for energy plantations, only one third of the planned area, i.e. 96,000 ha, will be retained in order to harvest only one year in three.

	2019	2050
Woody biomass supply	0.065 MTOE	0.098 MTOE
End of life & related wood.	0.056 MTOE	0.084 MTOE
Linear forest	0.148 MTOE	0.167 MTOE
Sawmill waste	0.078 MTOE	0.118 MTOE
Energy plantations...		0.480 MTOE
Recovered heat		0.084 MTOE

Energie bois : 0,871 MTOE

b2 ● Energy production from agricultural land:

The aim here is not to propose a project for the orientation of the agricultural and agri-food sector in Brittany up to 2050. This topic alone would merit a dedicated study. The aim of this paragraph is to evaluate the UAA area necessary for self-sufficient agricultural energy production by setting a few simple parameters.

It will be up to the profession, if it so wishes, to take up these modest proposals in order to criticise and improve them. The energy autonomy of Breton agriculture is a vital issue for the whole population in Brittany and elsewhere.

note: to access the details of the (tedious) calculations on the following pages, you will need to download an open office table, the link to which is provided in the appendix. The links to the sources are also inserted in this spreadsheet (SAANR - AGRESTE & others).

Distribution of UAA in Brittany

We have taken into account the priority objectives: feeding the Breton population and ensuring a certain level of food exports.

The changes we propose to make to Breton agriculture can be summarised as follows:

- Agriculture will remain focused on the production of animal and vegetable proteins
- The livestock will be fed entirely by regional production

Part of the forage area will be converted into energy and industrial crops. It will therefore be necessary either to limit the level of animal protein exports or to generalise a less meaty diet.

We envisage an average diet of 2,700 calories per day per inhabitant, including 90 grams of protein, 50% of which is of animal origin.

It is to be hoped that Brittany will still be able to export at least a mass equal to the consumption of its population in **animal proteins**; Breton agriculture will have to provide **1,866 x 10^5 tonnes** at the turn of the year 2050 (compared to 5.570 x 10^5 tonnes at present) just for human consumption (of which 50% for the Breton people).

The availability of fertilisers, especially phosphates, the production of nitrates dependent on natural gas and the foreseeable strengthening of regulations on the use of pesticides could reduce production to 34% of today's level, which would still allow it to continue exporting in 2050. The use that will be made of agricultural land (preparation, inputs, spreading), the energy consumed in production and transport, but also the availability of waste to produce energy, etc **will depend on the responses to these constraints**. The risk, if the situation is not anticipated, is that we will have to suffer from a scarcity of farm inputs, which will lead to a total disorganisation of the production chain.

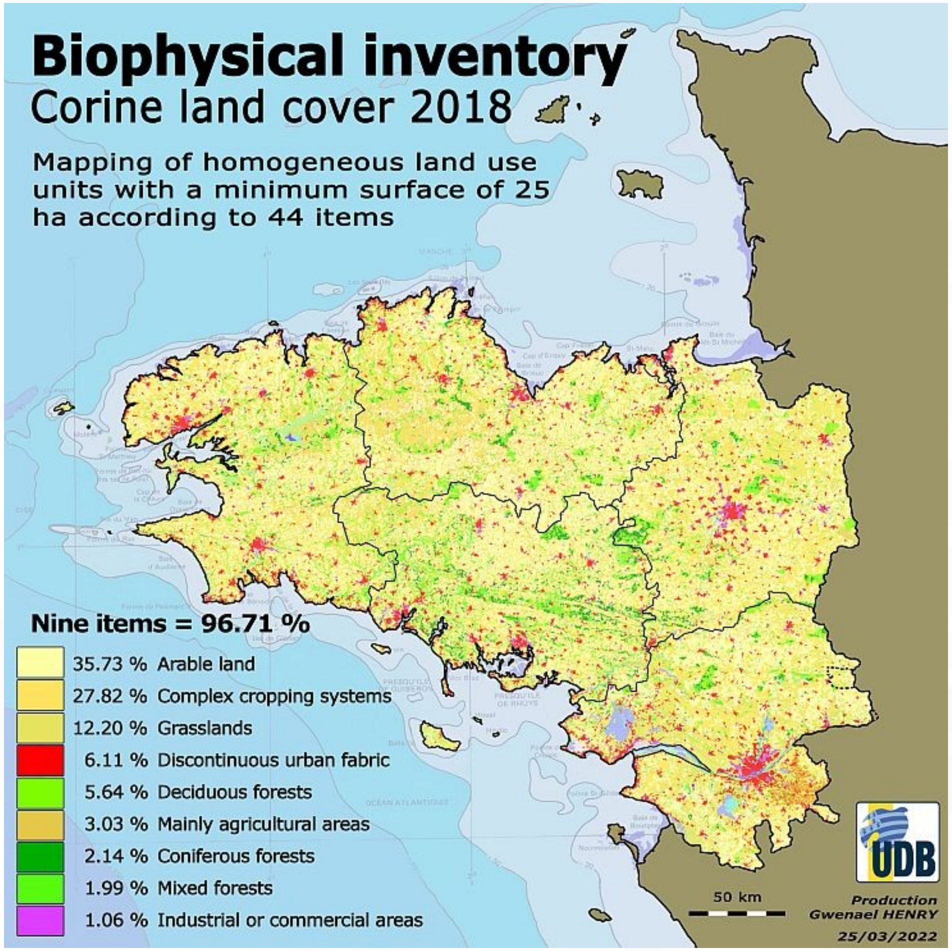
The breakdown of animal proteins for humans would be as follows

Eggs	0.132 x 105 tonnes
Milk	1.214 x 105 tonnes
Beef	0.221 x 105 tonnes
Pork	0.221 x 105 tonnes
Chicken	0.077 x 105 tonnes
Total	1.866 x 105 tonnes = 186,555 tonnes

The area required for feed production would therefore be divided between

fodder crops	1.456 million ha
crops for human consumption	0.808 million ha
i.e. a total of	2.264 million ha

With the essential function of food production assured, only 464,000 hectares (20.05%) of UAA remained available for possible energy crops.



Legend: CORINE Land Cover (CLC) is a biophysical inventory of land cover and its evolution according to a 44-item nomenclature. This inventory is produced by visual interpretation of satellite images. The production scale is 1:100,000. CLC makes it possible to map homogeneous land use units with a minimum surface area of 25 ha. This database was initiated in 1985. In Brittany, there are only 34 items out of the 44 in the nomenclature ***and the first 9 cover 96.71% of the territory.***

b21 ● Production of fuel dedicated to motorisation of agriculture:

According to an article published in the weekly Paysan Breton in 2015, direct energy consumption (fuel oil, electricity, gas, wood) in Breton agriculture is divided between livestock buildings (39%), greenhouses (33%) and **crops (28%).**

Above all, it is important to emphasise the following point: unless we switch to 100% human labour, there is only animal or mechanical labour left to carry out agricultural tasks.

The revival of animal traction.

Animal traction has certainly experienced a timid craze over the last twenty years, but is it possible to envisage a generalized return to this practice?

It should be borne in mind that a horse, in order to do its work, must be fed properly and that a proportion of the UAA must therefore be set aside to produce its feed. Roughly speaking, a 900 kg draught horse that can work for 7 hours in a 9-hour working day must be able to count on 6.4 HFU for its maintenance plus 3 to 4 HFU for its production. (Horse feed unit = 1 kg of barley at 2250 cal of net energy).

We consider that a horse can be satisfied with fresh grass, hay and oats or sunflower or linseed cake (but not rapeseed because they don't like it too much) plus some occasional treats, apples, pears, carrots and crushed gorse.

But to provide the ration, you need to mobilise about 1 ha of UAA per year.

A study estimated the number of draught horses in France at 1,700,000 in 1959, or 119,000 in Brittany in proportion to the UAA (and there were already tractors). In general, one horse was needed for every 8 ha of a farm, one of which was used for the horse's subsistence, i.e. 12.5% of the arable land.

Today, 327,000 horses and at least 150,000 drivers would be needed (there were already only 72,000 agricultural jobs left in 2018), but also 327,000 ha would have to be set aside for feeding the horses using the 26,183 km² of UAA in Brittany. In 2018, there were only about 5,000 Breton draft horses left, including 495 stallions (breeders), and there were only 2,350 foalings on average between 2015 and 2018. Under these conditions, it is difficult and above all time-consuming (several half-centuries) to reconstitute a sufficient number of horses to carry out the estimated agricultural work.

This leaves mechanised work with a tractor.

Today, it takes about 100 litres of fuel per hectare per year to work the land (in the current technical conditions characterised by over-motorisation per hectare, because it is gratifying to own a bigger tractor than your neighbour, even if it is not necessarily very useful).

Then, when diesel becomes scarce and expensive, we will have to consider switching to vegetable oil. One hectare of rapeseed, for example, with an average yield of 30 quintals per hectare can produce 2000 kg of rapeseed cake and 1000 kg of oil by mechanical pressing only (without using chemicals), i.e. 1090 litres of oil per tonne.

Thus, for a 48 ha farm (4,800 litres/year), 4.4 ha of rapeseed cultivation, i.e. 9.2% of the UAA, would be needed to obtain the fuel necessary to cultivate the land, whereas 6 ha would be needed for horses.

Finally, these 4.4 ha would make it possible to produce, at the same time, 8.8 tonnes of rapeseed cake, rich in protein, intended for cattle and pig feed, whereas the horses would only produce dung in variable quantities.

The switch to agrofuel (and not biofuel) is at least a technical solution that can be implemented quickly to continue to have self-sufficient agricultural production in Brittany and to export surpluses. And it will be quicker and easier to convert the tractor fleet from diesel to oil than to increase the horse population.

The Menergol project: from farmer to "energy farmer

The various constraints on the price of hydrocarbons will inexorably lead to an increase in the cost of energy, which is essential for agriculture and fishing, which are priority industries, because the first necessity is to make foodstuffs of sufficient quality and quantity accessible to all citizens.

Search for autonomy

Faced with this problem, which was widely anticipated, the community of communes of Mené (22) reacted some fifteen years ago. Its vice-president, Jacky Aignel (mayor of St Gouéno at the time), and the MIR association (Mené Initiatives Rurales), launched several energy production projects, including Menergol (Mené Energie Oléo protéagineux).

Menergol is a CUMA that originally brought together some forty farmers from the neighbouring communes. Most of these farmers had tried to develop an individual oil mill, without any real success. In St Gouéno, a fixed oil mill for processing the production of 1,200 ha of rapeseed was created in 2007.

The aim was for the CUMA farmers to become self-sufficient in fuel on their farms.

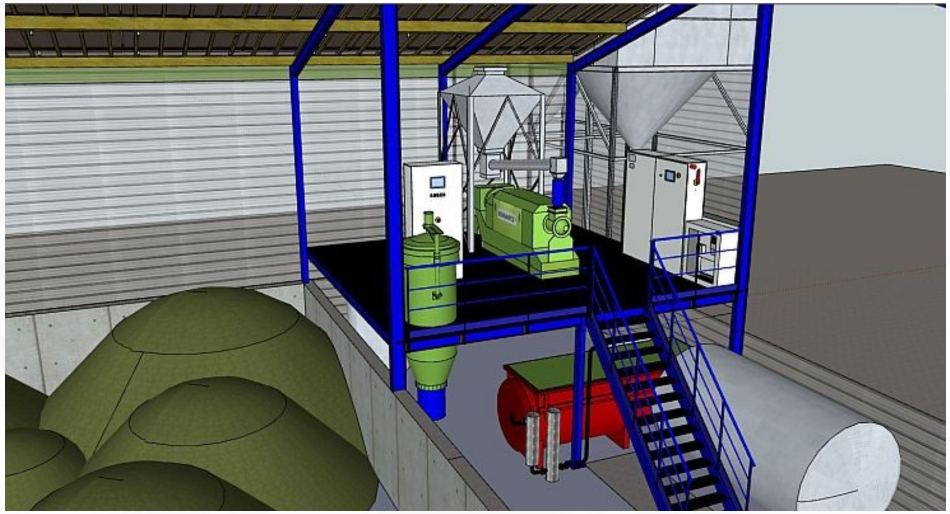
Today, in 2022, the cost price of a litre of oil should be around € 0,54.

The difference with the current price of tax-free diesel oil is therefore significant.

It should be noted that some CUMA members have already used oil in their tractors, either after equipping them with a kit that allows 100% use (€ 6,000), or without modification, in addition to 30% diesel oil. Several farmers also use oil cake with satisfaction, for feeding pigs and cattle.

The Coop Ménergol cooperative could welcome new members

Interior 3D view (dynamic, with the appropriate software) made from photos taken on site in 2014 during a guided tour by Marc Théry. The walls of the hangar have been made transparent so as to allow a glimpse of the silos for storing rapeseed before processing, located to the south-west at the rear of the building (see photo opposite).



With a 150 m² roof surface facing almost south (left side of the photo), this area could accommodate a photovoltaic plant capable of producing 16,000 kWh per year to contribute to the energy production necessary for the crushing of the seeds.

Such a unit can therefore effectively produce 1200 * 1,091 = 1,309 m3 of fuel each year. It would therefore be sufficient to create about 200 units of this size (modest: 300 m²), i.e. about eight for five cantons or three per EPCI, to secure the supply of 0.211 Mtoe per year (1 tonne of rapeseed oil is equivalent to 0.881 toe). This is the share of energy that is essential and specific to the sole work of the land (28% of current agricultural energy expenditure) in the Breton agricultural sector and thus guarantees the food autonomy of Brittany. Moreover, the roofs of these 200 or so oil mills, provided they are well oriented, mono-sloped (at 20°) or flat and equipped with photovoltaic panels, would allow the production of 6.4 GWh of electrical energy (not accounted for here). Finally, we must take into account the 480,000 tonnes of oilcake co-produced for livestock farming, 1/3 of which is raw protein.

Oleries : 0,211 MTOE

b2.2 ● Energy production from fermentable materials:

It could be particularly judicious to establish locally, at the level of the EPCIs and perhaps even at the level of the countries; which remain central actors in terms of local development in rural areas; audits listing the tonnages of the various fermentable materials available in the territories concerned. These are necessary prerequisites for the efficient installation of methanisation units.

b2.2.1 - Energy crops :

An imperative: preserve cultivated and wild biodiversity

Non-food outlets for agriculture offer an opportunity to diversify cultivated species. This diversification will be welcome, as the current regional specialisation favours the development of weeds and crop pests (and therefore the use of pesticides) and reduces habitats for wildlife.

Advantages:

- the whole plant can be used: stems, leaves and not only the seeds. This increases the biomass collected
- For the same productivity, perennial lignocellulosic resources require less fossil inputs than annual crops.
- The fact that lignocellulosic raw material can be cultivated in all regions represents a major asset in terms of land use planning.

The transformation of lignocellulose into agrofuel will require the development of innovative plants and industrial processes. The versatility of the plants, their size, and their geographical distribution will be essential parameters for the impact of agrofuels on biodiversity and land use.

At the interface between economics, agronomy and ecology, there is therefore a need to think about how to organise production basins while preserving biodiversity.

It will be necessary to organise the coexistence of all sectors in the agricultural territory

Managing territorial dynamics

Among the examples of territorial dynamics already at work, we can see the emergence of collectives bringing together farmers and often their non-farming neighbours, organised around the local production of energy, for collective heating or agrofuel.

We are also seeing local authorities promoting the development of agro-resources on their territory, by developing biomass, using land contaminated by heavy metals for non-food crops.

More generally, in recent years we have seen the emergence of collective arrangements for managing landscapes that include crops, forests, rangelands and interstitial spaces where farmers and other local stakeholders work together to protect water resources or species (Fertimieux, SAGE, Natura2000, etc.). Why not to accompany the development of agro-resources?

Miscanthus

This crop involves a significant investment at the time of its establishment: 3500 €/ha, because of the technique and the specific material used. However, being perennial, it will give harvests from the third to the fifteenth year. During this period there will be no great need for inputs (fertiliser, fuel, treatment, etc.).

Switchgrass

This crop can be grown with standard farm equipment without any specific investment.

At 15 tonnes of dry matter per hectare, it could provide **4.720 Tep/ha/year**. (net)

The production would be distributed: 55% solid fuel and 45% liquid fuel.

The mobilised UAA would be limited to 75% of the land remaining after reserving that needed for food production, i.e. 348,000 ha. The remaining 116,000 ha (5.00%) will be used according to the hazards.

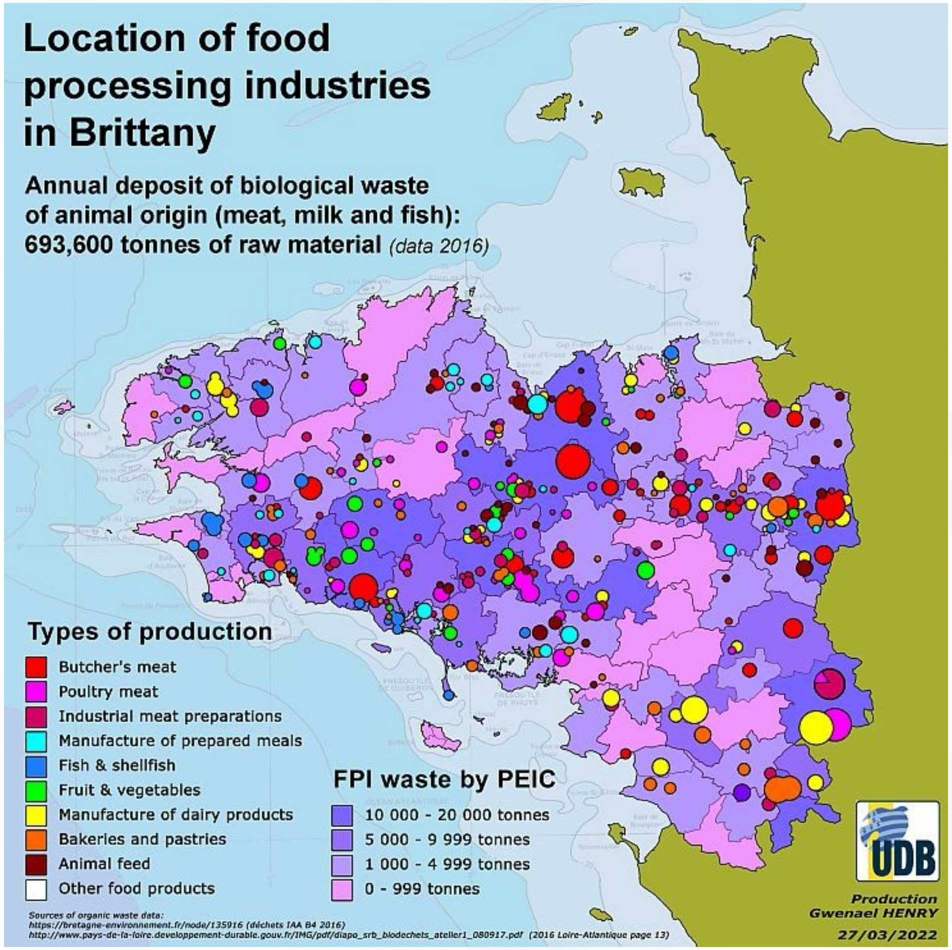
The energy produced annually would therefore be equivalent to **1.639 Mtoe** in the form of fuels plus 0.070 Mtoe in heat.

Energetic crops: 1.709 MTOE

b2.2.2. - Biological waste from the AFIs :

A significant source that still needs to be recovered

In 2016, the agri-food industries (AFIs) in Brittany generated 872,600 tonnes of bio-waste. Only 178,400 tonnes were not animal by-products from the meat, milk or fisheries processing sectors. These three main sectors therefore produce a share of 693,600 tonnes, or 79.49% of the total. (Note: the 87,500 tonnes of dairy residues found in the Loire Atlantique do not come solely from milk collected in this department).



However, in order to remain consistent with the objective of readjusting animal protein production set out in the previous chapter, it will be necessary to rely on only 30% of the current deposit, i.e. a little more than 200,000 tonnes of exploitable waste.

This waste could be used as input for methanisation units dedicated to other methanogenic sources such as livestock residues (see next chapter).

Energy production by methanisation of livestock residues :

Given the high share of crop production envisaged, the supply of straw (cellulosic material) will be sufficient to optimise the yield of the methanisation.

With the livestock structure of 2050, approximately 1.724 M. LLU (Million Large Livestock Units: 0.544 M. LLU of cattle, 0.498 M. LLU of pigs and 0.682 M. LLU of poultry) will be needed to provide the 1.866 x 105 tons of protein (milk, beef, pork and poultry). The effluents from these livestock and the induced waste from the AFIs will give **0.894 MTOE** from agro-gas. **Note: this is a slightly smaller herd than that envisaged in 1979 (2 million LLU).**

Méthanisation effluents et IAA : 0,894 MTEP

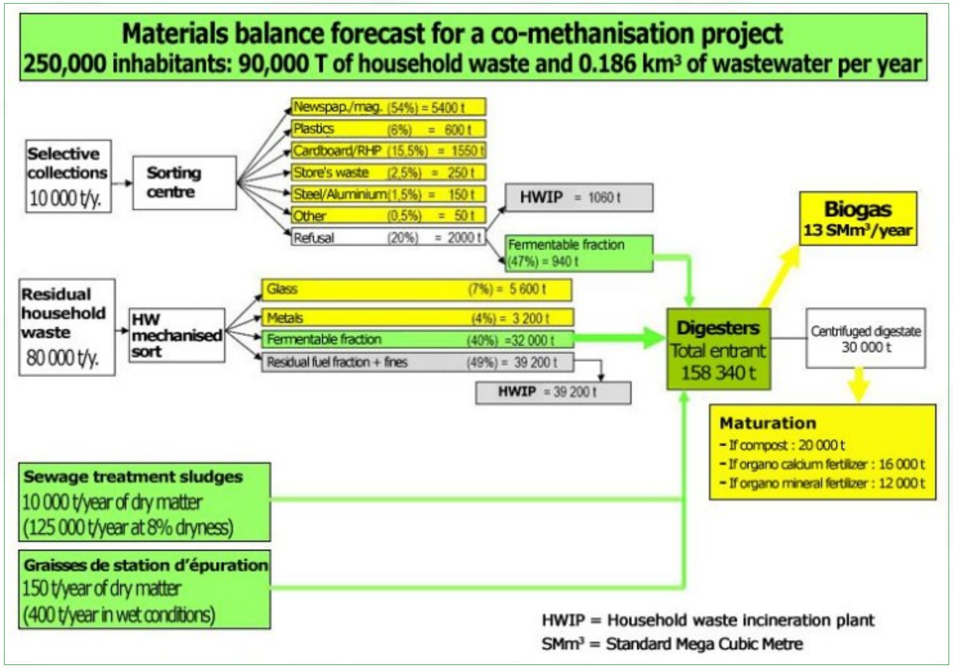
b3 ● Household waste:

In 2019, the 4,784 thousand inhabitants of Brittany generated about 900,000 tonnes of household waste (HW), i.e. about 190 kg / year / inhabitant.

By 2050 it will be necessary to reduce this mass without it being easy to propose an optimal objective. The energy produced by the methanisation of this deposit will obviously be linked to the achievement of this objective.

To assess their energy potential, we have taken as a reference the data from the **VALORGA** process, which is in fact a complete and integrated household waste treatment system, which includes (or may include, depending on the case) sorting of the waste at the entrance, methanisation of the fermentable part, composting of the fermentation residue, incineration of the combustible sorting refusals and landfilling of the final residues. This process makes it possible to treat household waste in units with capacities ranging from 10,000 to 300,000 tonnes per year. It has been in use for some thirty years and is constantly being optimised.

Example of a treatment unit for the production of gas and compost



What quantities of gas and compost could be produced in Brittany if the overall production of household waste was reduced by half in 2050?

So, starting from this objective, how can we treat these 450,000 tonnes?

Let's take as an example the existing flows in Tregor, in the EPCIs of Lannion Trégor Communauté and Guingamp Paimpol Agglomération, which have a population of 174,000 inhabitants spread over 118 municipalities.

The annual report for 2019 from **Valorys** (the collection organisation) shows the collection of 164,211 tonnes.

In the following paragraph we will show the breakdown by type of waste of a 50% reduction in mass, which is the theoretical objective for 2050. Then the results will be extrapolated taking into account the expected 5,679,000 inhabitants in Brittany.

DATA

The Valorys site in Pluzunet (22)

This site does not currently use methanisation but incineration. Part of the energy released by the process is used in nearby agricultural greenhouses. But what interests us most here is the **breakdown of flows in a clearly identified area.**

The flows detailed below represent half of what was collected in 2019 increased by 18.7% to account for the population increase in 2050.

The population of the area could increase by 18.71% by 2050 to 206,500. If per capita household waste production were to be halved between 2019 and 2050, household waste (HW) collection would be around 23,000 tonnes. WWTP sludge production would follow the population increase from 3,090 to 3,668 tonnes ("dry"), but there would be no need to dewater the sludge since the anaerobic digestion process requires a substrate with a maximum dry matter content of 25%, so the 45,848 m³ of water should not be removed from the mass of sludge collected expressed as "dry" value. On the other hand, there is no reason to believe that plant collection will decrease, so it should remain at the 2019 level of 62,127 tonnes, but an additional 63,000 m³ of water should be brought in.

The total mass of fermentable substrate flowing would then be 197,644 tonnes leading to the production of approximately 16.23 NMm³ of raw gas per year and the recovery of 25,000 tonnes of compost.

Extrapolated to the population of Brittany in 2050, this would result in 440 NMm³ of raw gas per year and 680,000 tonnes of compost. Considering a methane content of 60% in the raw gas, the energy value can be estimated at 2,963 GWh PCI.

In addition, a residual part of the collected waste could continue to be recovered in thermal form by perpetuating some of the existing incinerators.

Household waste & WWTP sludge: 0.255 MTOE

This value will depend on the evolution of the treatment of green waste from households, which could also be sent to agricultural methanisation units, and on the capacity to collect and transport wastewater from wastewater treatment plants.

Summary of biomass & organic waste streams

Information on UAA used

496,000 ha of forests
289,000 ha of energy plantations
153,000 km of hedgerows

Wood energy: 0.871 MTOE

240,000 ha of rapeseed crops
Only one third of the production will be used as fuel oil and the other two as protein for livestock

Oileries: 0.211 MTOE

464,000 ha of UAA remain available for energy crops.
In the current projection, the share of land used is 348,000 ha.
This leaves 116,000 ha available.

Energetic crops: 1.709 MTOE

1.456 million ha will be cultivated to produce feed for livestock. The crop production consumed by the livestock will The crop production consumed by the livestock will generate effluent for energy purposes.

Methanisation of effluents and AFIs: 0.894 MTOE

0.808 million ha will be cultivated to produce food for humans. The crop and livestock production consumed will generate usable effluents.

Household waste & WWTP sludge: 0.255 MTOE

Recoverable heat: 0.083 MTOE

Some benchmarks :

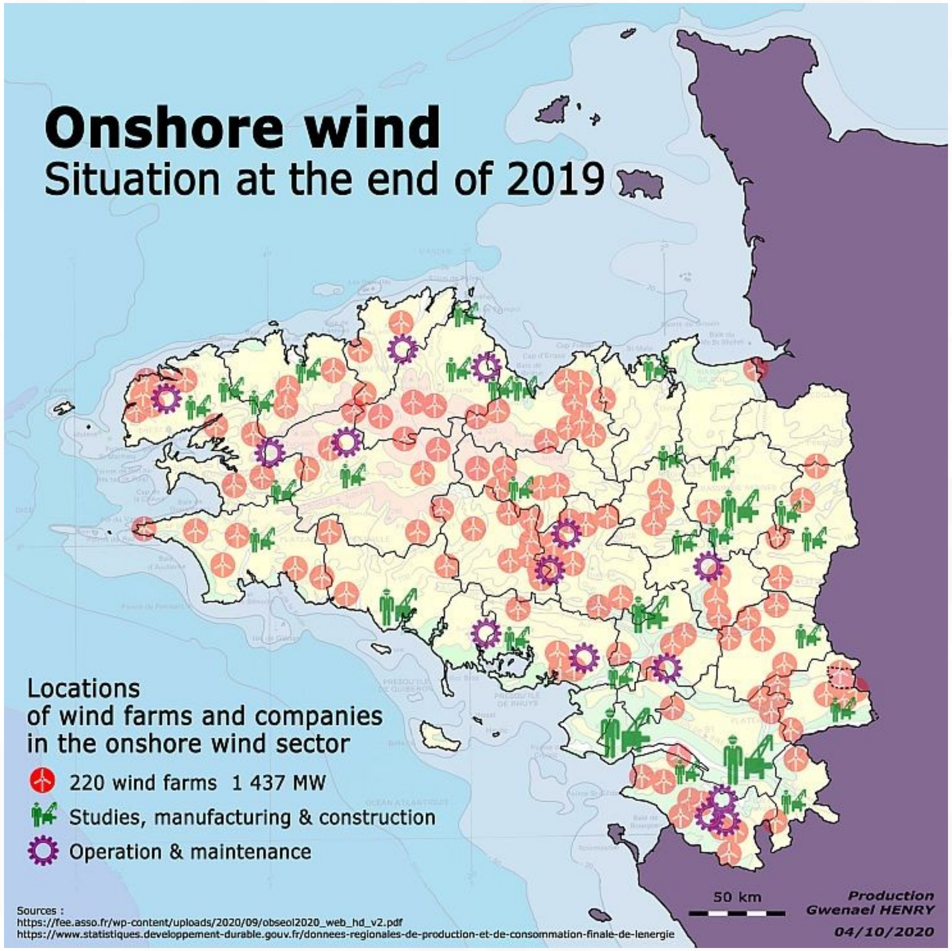
- 1 NMm3 of methane CH_4 = 11.05 GWh (M = 10^6)
- 11.63 GWh = 1,000 toe
- the energy of the crop gas is proportional to its methane content
- the average methane content of the crop gas is approximately 60%.

therefore for crop gas: 1000 NMm3 = 11.05 x 0.60 / 11.63 = 0.570 Mtoe

TOTAL BIOMASS: 4,098 MTOE

c) Onshore wind energy

Brittany is the most favoured region in France as far as wind energy is concerned. In the coastal zone, the potential energy available annually can be theoretically estimated at 4000 kWh/m². In the inland area, it is twice as low on average. (example: $S = \pi.D^2/4$ i.e. a wind turbine with 50 m blades => potential energy production: 31.416 GWh/year at sea and 15.708 GWh/year on land)



The maximum energy that can be recovered each year in Brittany is around 69.78 TWh, or 6 Mtoe. Deviations from this potential will depend on the type of grid and the power of the wind turbines used.

As a basis, we will take 2.0 MW wind turbines of the type most often installed in Brittany today. (diameter: 65 m; horizontal axis 50 m above ground level; surface area: 3300 m²; operation 2300 hours/year equivalent full power). The maximum permissible density is 4 machines per km².

A PROVEN TECHNOLOGY

At the end of 2019, there were 811 onshore wind turbines in Brittany.

A reasonable objective would be to double the installed power and the number of machines while increasing the unit power of the wind turbines replaced after 25 years of service. The second option will be socially more acceptable in the first years, then the growing needs combined with the rejection of nuclear power and the end of hydrocarbons, the understanding and the adhesion of the new generations to the technical innovations will make it possible to reach this ambitious objective, or even to do more.

The average unit power per machine installed in 2019 was 1.718 MW.

After this gradual increase from 30 to 200 machines per year when they are replaced (25 years ago the number of annual installations was lower than today), and this until 2050, the final distribution could be as follows:

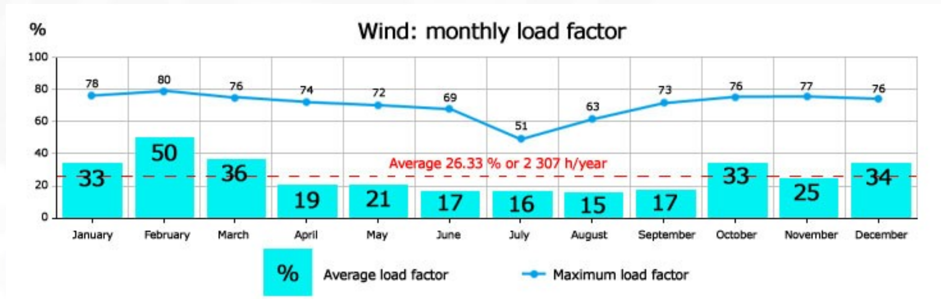
- In coastal areas: a 4 MW machine will provide 9.8 GWh of energy per year (2450 h/year). We propose the refurbishment of 200 wind turbines and the installation of 200 additional machines allowing the recovery of **3.920 TWh or 0.337 MTOE** (the coastal law will have to be adapted).

- In the interior: a 4 MW machine will provide 8.0 GWh of energy annually. We propose the refurbishment of 600 wind turbines and the installation of 600 additional machines to recover **11.040 TWh or 0.949 Mtoe.**

The distribution of the production units could be
- 600 for the Monts d'Arrée (150 km²),
- 400 for the Montagnes Noires (100 km²),
- 200 for each of the other areas: Méné; Landes de Lanveaux; Sillon de Bretagne,

Eventually, 1,600 machines will have to be operational in 2050 in order to produce **14.960 TWh or 1.286 MTOE** each year. Their installation will require 500 km² of space.

- Decentralised production: In addition to this industrial production, decentralised production (1 kW / 20 kW) is obtained from 750,000 domestic wind turbines with an average power of 5 kW (operating 2300 hours per year), equipping homes, farms, warehouses and workshops, with adequate land, in rural, peri-urban, urban or small-scale areas.



Load factor = equivalent operating time at full power 2,307 h/year.
Thus, by equipping one third of the main rural housing stock consisting of single-family

houses (see next chapter for wind farm assessment method):

750,000 wind turbines will produce **8.625 TWh** or **0.742 MTOE.**

Coastal areas (400 wind turbines) ..,,... 0.337 MTOE
Inland area (1,200 wind turbines) ... 0.949 MTOE
Domestic production (5 kW) ...... 0.742 MTOE

The onshore wind power sector can produce the equivalent of 2.028 MTOE in total.

Onshore wind: 2.028 MTOE

It is now necessary to estimate the feasibility of such a project in the time available. Brittany had 811 wind turbines in 220 farms in 2019, developing a power of **1,355 MW for an effective production of 2.715 TWh equivalent to 0.233 MTOE.**

The result was thus rather disappointing insofar as, as early as 2009, a prospective study for the 2015 horizon of the B4 administrative region envisaged reaching a target of 1.5 GW of installed wind power capacity for an expected production of 3.450 TWh, i.e. the equivalent of 0.297 MTOE per year.

Unfortunately, we have seen since then that this was not the case.

However, there are some reasons for hope because in Loire-Atlantique alone, 89 machines had a permit at the end of 2019 but had not yet been installed, while 43 additional machines were in the process of being appraised at the same time for a nominal power of 339 MW.

The objective of 1600 wind turbines in Brittany is therefore not unrealistic and could be reached by 2050 at an average rate of 40 new wind turbine installations per year. (i.e. 8 additional machines per year and per department)

A European example

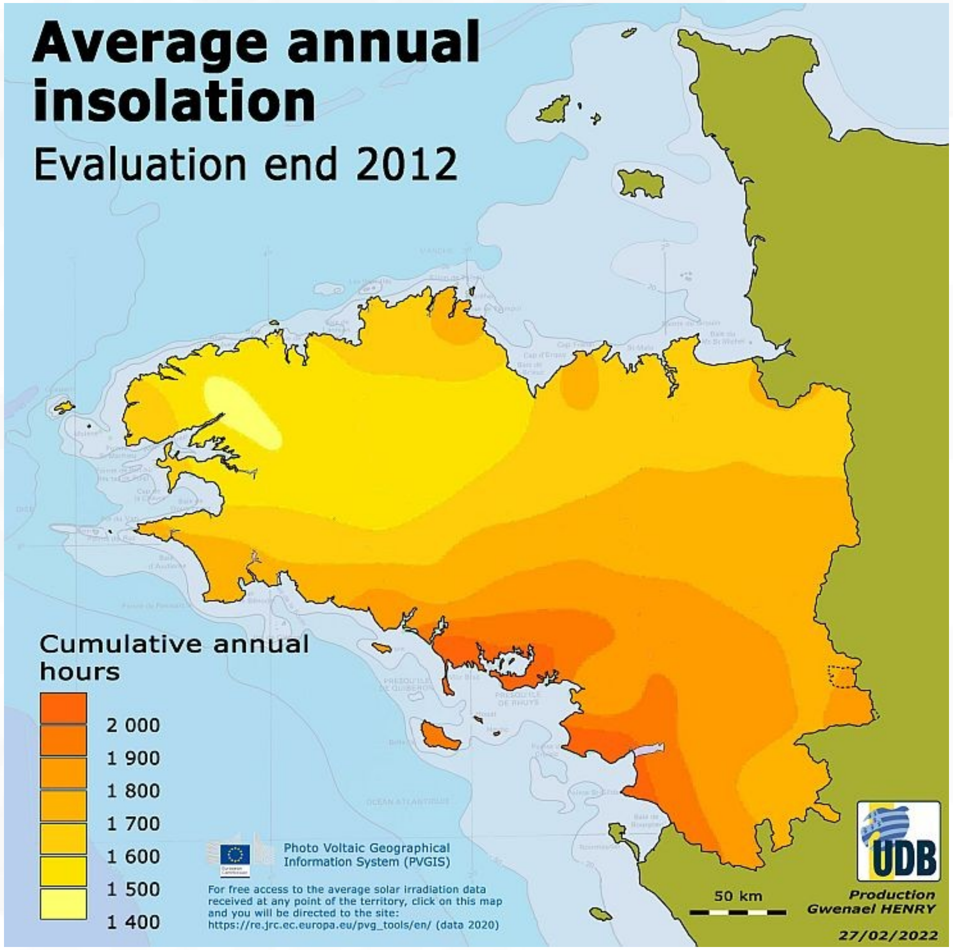
In Denmark (5.6 million inhabitants) wind energy has been developed for more than 40 years. In 2019 the 5,500 wind turbines with an installed capacity of 6.128 GW supplied **16.15 TWh equivalent to 1.389 MTOE** (this corresponds to a full operation of 2,637 h/year, or a load factor of 30.1%). The share of wind power in the electricity supply reached 48% in 2019.

At the same time, Denmark has developed a wind industry that still employed 32,721 full time people in 2020 (down 2% from 2019).

d) Direct solar sector (thermal)

It allows the recovery of LV heat for direct consumption. Irradiation (kWh/m²/year) in Brittany is between that of Vestland (N) and Andalusia (E). As for the insolation (h/year), we distinguish 3 zones

- the coastal zone (from Auray to Pornic) which benefits from 1900 hours of sunshine.
- The inland area (Pleyben - Pontivy - Saint-Brieuc) less than 1600 hours per year.
- The rest of Brittany has at least 1800 hours of sunshine.



The recoverable solar energy will depend on the exposure of the main residences.

Let's already recall the territorial distribution of the different types of main residences, which will have to be upgraded in terms of energy efficiency, since since since January 2022 new constructions must integrate the installation of individual domestic energy production systems.

INSEE produces numerous data bases that allow the composition and location of all principal residences to be evaluated, from which it is possible to extract new data specifically adapted to the 5 Breton departments.

Thus, by aggregating the data of the communal density grid, the rural and urban categories with those of the types of dwellings, it becomes possible to identify categories of dwellings by means of simple sorting operations according to 4 criteria of population density (from 1 for the lowest to 4), according to 6 categories from the isolated rural to the concentrated hyper-urban and according to 3 types of dwellings (houses, flats, others).

But in order to simplify the presentation of the results, only three main categories will be retained below (but each person can carry out his own research from the downloadable file by integrating even more sorting criteria: 6 for the number of rooms and 6 for the type of heating fuel used, if necessary).

- Rural and hamlet housing	877,965 houses	70,872 flats
- Medium-sized towns and cities	432,901 houses	183,908 flats
- Central cities	178,916 houses	408,682 flats

DATA

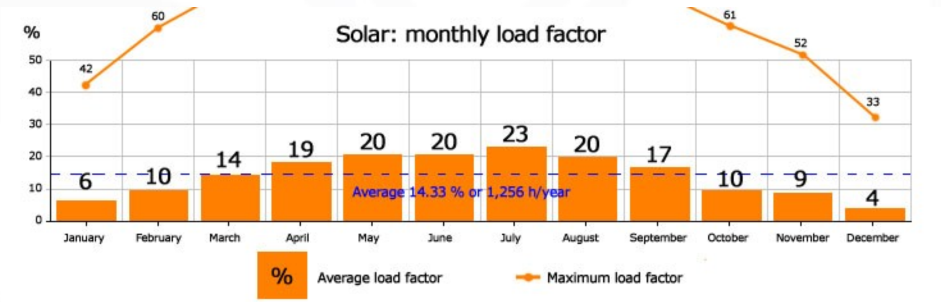
The work required to bring the buildings up to RE 2020 standards is still very important. This is a source of employment that will require an increase in the number of employees, while at the same time strengthening the training of young construction professionals.

Solar installations that provide both domestic hot water and part of the heating are called "Combi-Systems" or SSC (Combined Solar Systems).

A family installation consists of 10 to 50 m² of collectors, covering 15 to 60% of the heating needs, in addition to domestic hot water.

Most "combi-systems" work in conjunction with a conventional central heating system, using water pre-heated by the sun in the boiler. Or, for direct heating, by circulating solar hot water (at low temperature) through the walls or floor of a house.

Overall, for the most efficient installations, the following order of magnitude can be used: a well-functioning and correctly sized installation can save around 350 kWh/m².year. For an average project with a solar collector surface of about 20 m², located under average sunshine, 7000 kWh are saved annually.



The sunshine is obviously more important in summer, so it is necessary to take advantage of this period to store heat in insulated tanks in the basement.

● Solar production of houses in isolated rural areas and hamlets:

A house of 150 m² for three people can be equipped with 30 m² of collectors, which covers about 30% of the needs for a house of DPE type C.

This individual production method can produce the equivalent of 0.903 toe per house per year. By estimating the equipment of half of this type of dwelling (440,000), the equivalent of **0.397 MTOE** can be recovered.

● Solar production in medium-sized towns and cities:

The solution chosen here is collective heating (solar power plant + storage + channelled hot water distribution). The heating of a small town of 2,000 inhabitants can be fully ensured thanks to an installation of solar collectors and an underground storage tank. We consider that one third of the 617,000 dwellings (together) in this category are heated 100% by solar heat (30 m² of panels per dwelling): at 0.903 toe per dwelling, the expected overall annual production is **0.186 MTOE.**

● Solar production in major cities:

If the type of heating described above can be easily applied to the outskirts and new housing estates of the largest cities, it is easy to understand that it is not easy to use in the context of cities (space, style unit, etc.).

We consider that a quarter of the 588,000 dwellings in our "cities" in 2050 (i.e. 147,000 units) could be heated using solar collectors. The heat production will therefore be **0.133 MTOE.**

Solaire thermique résidentiel : 0,716 MTEP

<= note on this graph

compare with the graph of the same type on page 48
wind and solar production compensate each other during the year

● **Tertiary sector:**

In the same way as the previous case, we consider that half of the LV heat needs of tertiary premises in 2050, which have for the most part large roof surfaces, and/or land to be covered that can be developed (factories, workshops, hospitals, shopping centres and all their car parks), will come from solar collectors, i.e**. 0.350 Mtoe.**

Tertiary thermal solar: 0,350 MTOE

The solar (thermal) sector produces a total of 2.41 Mtoe. The total surface area required for solar collectors is about 100 km², i.e. 0.3% of the total surface area of the territory, most of which is for mixed use (roofs of houses).

Global thermal solar: 1,066 MTOE

e) Solar photovoltaic sector

The photovoltaic sector is currently the most profitable source of renewable electricity production and its profitability should increase in the coming years. According to IRENA, production costs have decreased by 82% between 2010 and 2019, reducing the cost per kWh from €0.358 to €0.064. Moreover, the long-term interest is linked to the search for efficiency and the development of the industrial know-how needed to create an inexhaustible and clean source of electrical energy for the future.

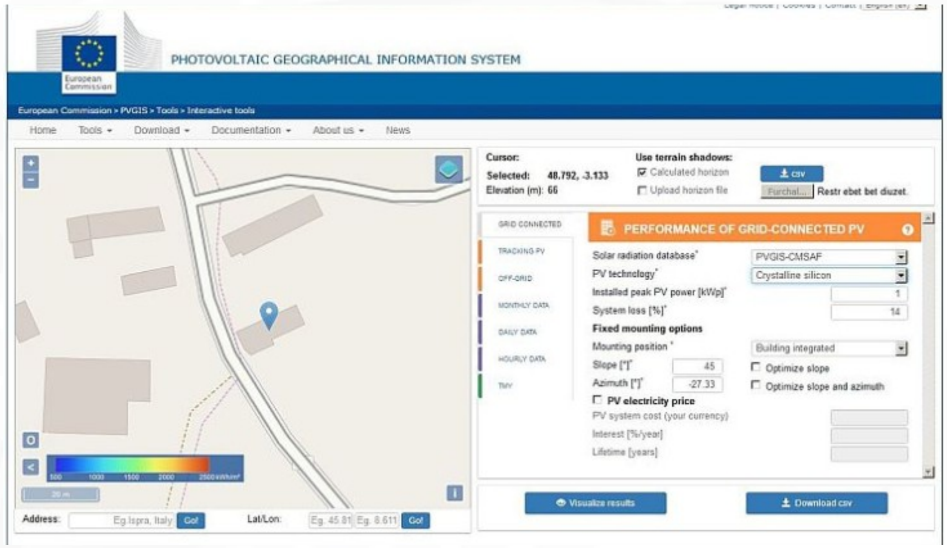
Photovoltaic systems can complete the energy mix of a building by allowing the production of electricity for self-consumption, while using the grid (smart grid) for storage and distribution, depending on demand.

A grid-connected PV array does not need energy storage and therefore eliminates the most problematic (and expensive) link in a stand-alone installation. Instead, the grid as a whole serves as an energy reservoir.

At the end of 2019, photovoltaic electricity production in Brittany remains rather anecdotal since the production recorded by Enedis (click on the icon) amounted to 319,637 MWh, i.e. the equivalent of 0.027 Mtoe

DATA

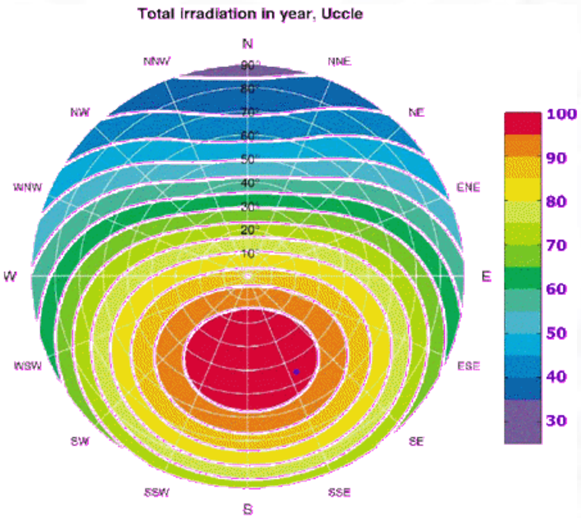
To understand the calculation leading to the production of 15.817 TWh/year in 2050, let's take an example:



This free online tool (click on the image) on a web page of a European Commission website allows to estimate the photovoltaic potential of any European building if you have the basic information about it. The map on the left side allows to extract the position easily, but you need to know the slope of the roof in degrees and the azimuth of its exposure (the difference between the south direction 180° and a perpendicular to the roof here : -27.33° in decimal degrees).

Once this information has been entered, the simplest thing to do is to look for an estimate of the annual production of electrical energy for an installed "power plant" of 1 kWp(c) (kilowatt peak) or 1 m² of roof, **i.e.: 1,089 kWh/kWp/year or 204 kWh/m²/year.**

A current mid-range photovoltaic panel, with a surface area of 1.60 m², provides, according to the manufacturers, an average peak power of 250 to 350 Wp. There is no doubt that by 2050 the average performance will have increased, but for the calculation that interests us here we will content ourselves with the value of 300 Wp per panel, i.e. an average power of 187.5 Wp/m², which will produce 0.204 kWh/m²/year at this location (this result is obtained by the software).



In this diagram, the point positioned in the red sector corresponds to the data of the building tested with the PGIS software. This point is located south-southeast (27.33°) in the ring between 40 and 50° (roof slope). It is located in the area of maximum irradiation between 95 and 100%. It is interesting to note that the southern orientation gives the best results, but that an orientation between east and west, provided that the slope of the panel is at least equal to 35°, still offers 60% potential.

We then propose to reach in 2050, by multiplying by a factor of 50, the installed surface to expose a cumulative surface of 77.5 million m² in order to produce the **15.817 TWh or 1.360 Mtoe** planned. Obviously this may seem large, but it only represents 7,750 ha or 77.5 km². In order to consider the relative importance of this, please refer to the table on page 35 (Corine land cover) which compiles the surface area of artificial built-up land to the tune of 1,067 km² in the five Breton departments, without even counting the car park areas which could also support photovoltaic gantries. So even if all the buildings are not ideally oriented or are obscured by masks, it will be enough to equip 'only' 7.26% of this surface, i.e. an average of four buildings out of 55.

Solar photovoltaic : 1,360 MTOE

The first of the two major problems that remain is that they will have to be manufactured in 25 years, and then start again to replace the depreciated plants. But at the production rate of the Lannion factory of 400,000 m² per year (40 ha), it will still take 194 years to achieve this. In the meantime, it will be necessary to increase the production capacity by a factor of 10 to keep a pilot plant, i.e. two such plants per department. (But the panels can in fact remain operational for 40 years and their initial efficiency will have been increased).

The second is the material balance, given the quantities of modules to be produced not only for Brittany, but for the whole planet. (see opposite).

Average composition of a standard 1.60 m² module

Materials	Mass for a standard module of 60 cells per 1.60 m²	% of total mass	Notes	Equivalent in kg/kWp	Material balance to achieve the production target
	kg	%		kg/kWp	tonnes
Glass	12,80	65,82		42,67	619 864
Aluminium	2,60	13,37	for roof-integrated installation	8,67	125 910
Polysilicon	1,13	5,79		3,77	54 722
EVA	1,54	7,92		5,13	74 577
PET	0,86	4,42	For the junction box	2,87	41 647
Polypropylène	0,25	1,29		0,83	12 107
Lead	0,0130	0,07	Approximation	0,0433	630
Copper	0,2500	1,2900	Approximation	0,8333	12 107
Silver	0,0069	0,0350	Average	0,0230	334
Total	**19,45**	**100,00**		**64,83**	**941 898**

https://www.ecologie.gouv.fr/sites/default/files/Plan%20ressources%20Photovoltaique.pdf page 32

The **overall material balance** of the sector is presented in the last column .

Total solar energy: 2,426 MTOE

f) Hydraulic energy

Contrary to a widespread idea, the possibilities of producing electrical energy by equipping the Breton hydraulic network remain very limited.

The total average annual flow arriving at the sea (excluding the Loire Atlantique) is around 186 m^3/s. This allows a theoretical potential of 0.815 TWh, of which a small part is recoverable. It should be noted, however, that hydraulic energy is of interest for a few specific sites.

We will therefore retain only a target of **0.050 Mtoe** (70% of the potential) of exploitable energy from hydropower for Brittany.

Hydraulic energy : 0,050 MTOE

g) Summary: Renewable energy sources

It is important to note the large share of terrestrial biomass (44% of the total). However, the selected scenario leaves room for the satisfaction of the complete food needs of the Breton people and for exports.

The contribution of onshore wind energy (22%) and direct solar energy (26%) is also significant.

On the other hand, we have only proposed a modest contribution from marine energy (7%) because of the difficulties of implementing these technologies, which have been tried and tested elsewhere in Europe. We have resolutely rejected any gigantic project that would lead to profound changes in coastal ecosystems.

Tolal primary energy production: 9.264 MTOE

3) The transformation channels

Once the primary energy production scenario has been specified, it is important to match it to the actual needs in heat (LT, MT, HT), fuels (SC, LC, GC) and specific electricity, to adapt supply to demand (Table 17), and to allow a stable production regime over time.

a) Distribution losses

They are evaluated at 20% in low temperature heat, 3.5% in fuel and 10% in electricity, which corresponds to the usual standards.

Taking into account the compulsory losses, we are left with a surplus of 0.078 Mtoe in heat (part of which is evaluated at 0.08 Mtoe - in H.T. for industry); an excess of 0.353 Mtoe in fuels and 0.087 Mtoe in electricity, i.e. a total of 5.59% of the production

b) Seasonal and daily regulation of electricity production

The production of electricity by wind power is subject to a significant seasonal variation (30% of the production in winter, 26% in autumn, 24% in spring and 20% in summer). It will therefore be necessary to link production with that of the photovoltaic sector, which will allow seasonal regulation of supply to demand. This can be achieved by also using storage techniques, conventional thermal power plants burning part of the excess fuel or new types of thermal power plants that do not emit CO_2. These latter plants are currently well developed, only fuel recycling is not yet fully developed (see the section on future technologies).

The perfect adaptation of supply to demand during the day will also be ensured by the interconnection of the Breton network to the European regional networks and thanks to the use of AI through smart grids.

c) Heat production for industry

We indicate, for information, this particular use of hydrogen to produce HT heat for industry. This hydrogen will be produced by HT electrolysis of water. The hydrogen will thus be used to store excess electrical energy in order to have heat available later, on demand.

CEA Liten's hydrogen production laboratory has developed a high-temperature electrolysis system (700°C) producing hydrogen from water vapour at 150°C and electricity with an electrical consumption of 3.9 kWh per Nm3 of hydrogen produced.

Hydrogen has a very high mass density of energy (1 kg of hydrogen contains as much energy as about 3 kg of oil) but it takes just over 11 Nm3 of hydrogen to obtain a mass of one kilogram with a lower calorific value (LCV) equivalent to 33.33 kWh and a GCV equivalent to 39.41 kWh.

Therefore, if 3.9 kWh of electricity are needed to obtain 1 Nm3 of hydrogen, 43.82 kWh will be needed for 1 kg, i.e. a theoretical efficiency of 76% (which is excellent) that can be improved if we manage to recover some of the energy contained in the water during combustion.

To obtain 0.080 Mtoe of hydrogen, 0.105 Mtoe of electricity are needed. The combustion (with an efficiency of 0.80) finally produces the equivalent of 0.064 Mtoe of heat HT.

d) The low and medium temperature heat deficit

This is made up by the use of :
- heat pumps with a coefficient of performance of 3: the consumption of 0.100 Mtoe of electricity thus makes it possible to recover 0.300 Mtoe of LV heat.
- Combustion of part of the surplus of solid, liquid and gaseous fuels (SGLF), i.e. 0.360 Mtoe to obtain (efficiency 0.83) 0.300 Mtoe of LV, MV heat.

The transformation methods used: thermal power stations, hydrogen, heat pumps, boilers ensure that our balance sheet is completed, i.e. an average annual supply of 2.170 Mtoe of heat; 2.867 Mtoe of fuels and 3.485 Mtoe of electricity.

e) The production surplus

The surplus of 0.518 Mtoe will be used to compensate for possible climatic fluctuations that could affect certain productions. They can be exported or stored and/or transformed to serve as fuel.

Available after processing: 0.557 MTOE

TABLE 17 **- The transformation sectors (in Mtoe)**

	SECTOR	HEAT	FUEL	ELECTRICITY	TOTAL	
USE	- Residential	1,019	0,132	0,855	2,006	
	- Tertiary	0,540	0,330	0,378	1,248	3,254
	Transport passenger		0,452	0,804	1,256	
	wares		0,461	0,259	0,720	1,976
	Agriculture	0,133	0,185	0,162		0,480
	Fisheries, aquaculture		0,108			0,108
	Industry	0,400	0,846	0,940		2,186
	TOTAL requirements	**2,092**	**2,514**	**3,398**		**8,004**
PRODUCTION	1 offshore wind turbines			0,611	0,611	
	waves			0,051	0,051	
	tidal			0,000	0,000	0,662
	2 forests, slopes, etc.	0,060	1,180		1,240	
	energy crops .	0,070	1,639		1,709	
	livestock waste		0,894		0,894	
	domestic waste	0,080	0,175		0,255	4,098
	3 onshore wind turbines			2,028		2,028
	4 solar thermal	1,066				1,066
				1,360		1,360
	5 hydraulics			0,050		0,050
	TOTAL primary......	**1,276**	**3,888**	**4,100**		**9,264**
TRANSFORMATION AND LOSSES	losses distributions	-0,191	-0,136	-0,410		-0,737
	production - requirements	-1,007	1,238	0,292		
	hydrogen production		0,064	-0,105		-0,041
	hydrogen combustion	0,040	-0,050			-0,010
	other combustion	0,300	-0,360			-0,060
	heat pumps	0,300		-0,100		0,200
	thermal power stations	0,445	-0,500			-0,055
	FINAL TOTAL.....	**2,170**	**2,906**	**3,485**		**8,561**
	SURPLUS	**0,078**	**0,392**	**0,087**		**0,557**

LT, MT, HT = low, medium and high temperature.
SGLF = solid, gaseous and liquid fuels.
H2 = hydrogen Fe = iron powder

It is necessary to have a "pilot plant" in fuel to compensate for variations in production.

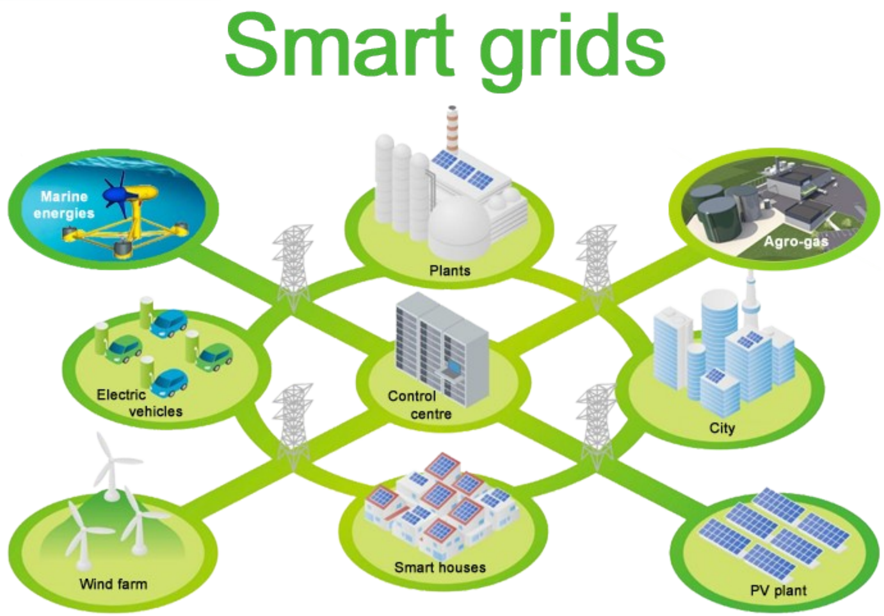
The balance is therefore achievable ....

All that remains is to secure it!

4) Technologies under development

So far, only mature technologies have been presented, whose production is unfortunately insufficient, but which are already being fed into existing distribution networks.

But we will have to do better in several areas: firstly in the management of production and distribution, secondly in energy storage technologies and finally in the development of individual means of transport which cannot be reduced to the electric car, unless the design of batteries undergoes a major technological leap and their mass production allows it.



General operating principle of smart grids

A smart grid is an energy network that integrates information and communication technologies

The smart grid is based on a computer interface placed on the supply source (power station, wind turbine, etc.), which will be linked to a second interface generally placed on the customer's premises, whether he is a private individual or a professional.

The data collected by the customer's interface will be sent to the DSO (Distribution System Operator). The latter will adjust the electricity supply.

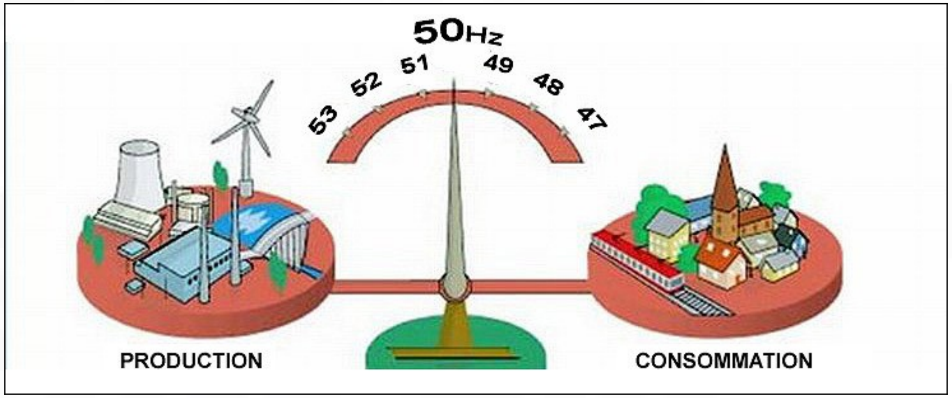
Thus, in addition to the physical layer for the transit of energy in the networks, a digital layer is being superimposed which plays an increasingly important role in its management. Numerous interface points (sensors, automates, etc.) link these two layers.

Alongside smart grids, **load shedding** is another means of better matching electricity production and consumption.

On the electricity network, there are :

- electricity producers: large power stations, often nuclear, wind farms, spread over the territory, hydroelectric power stations, often far away, except for the Rance and Guerlédan dams. Some of these power stations produce in a very constant way and have difficulty in modulating (nuclear power stations); others produce when they can (wind turbines, depending on the wind); very few are capable of varying their production very quickly to adapt to the need.

- Consumers of electricity: all of us, in our homes and professional activities; industries and economic and tertiary activities of all kinds. We want to be able to consume when we need and want to, for all applications, and particularly in winter, for heating, which is very (too) heavy. In fact, a lot of this consumption is triggered automatically, which is the case for heating, depending on the temperature.



But at all times, the available production must remain equal to the consumption requested. We must therefore constantly manage an adjustment between the two, which is done with the available resources, and, during peak full stops, when all the production sites are running at a level close to the maximum, finding a back-up is extremely expensive. For example, we have to buy electricity from hydroelectric power stations in Switzerland, or install so-called "peak" power stations, which are very expensive to produce and which only operate during peak periods of the year, at a very high price.

Another path can be taken in the opposite direction: rather than adding very expensive production, let's try to reduce peak consumption, when production cannot keep up at reasonable costs. This does not mean suppressing consumption, but rather shifting it to a time when production will be under normal conditions. This will make it possible to build a much more flexible system, where everyone will benefit.

Both systems will have to be thought out and piloted locally to give the most efficient results, develop local employment and ensure a better sharing of the gains.

There is a "French" trend, driven by our hexagonal champion of the electricity supply: the boxes are French, the installers local, but load shedding is controlled "from afar" and the profits will finance the international adventures of this giant and, if there are any left, its shareholders, including the French state. The consumer remains a stranger to sharing, as usual.

It's up to everyone to take a stand: what model do we need today to face the challenges of tomorrow in Brittany, in our small territories? The globalized/relocalized model, whose devastating effects we see every day? The monopolistic model, under which we have been living for decades, and which leaves us with a hypercentralised system highly sclerotised in the "single thought"?

The storage of overproduction of electrical energy

The intermittency of renewable energy production is the real problem pointed out by opponents of wind turbines, solar power plants and other methanisation units.

But every problem has a solution, it remains to implement it. When too much energy is produced in an area but not enough is consumed, it is lost unless this surplus energy can be fed directly into the grid, which is one of the purposes of the smart grids described in the previous paragraph, or stored in another way, either in batteries or by converting electricity into "fuels" to be used at a later date during peaks in consumption.

Hydrogen is still the best known energy carrier, and there is no need to present it. Some examples of hydrogen-powered buses have been widely publicised.

However, although this 'fuel' is easy to produce in a profitable manner (note that today 90% of the hydrogen produced is extracted from hydrocarbons), it is not extraordinarily flexible in its use. It is an extremely explosive product and its leakproof storage is difficult to guarantee. For these two reasons, its use on a large scale is difficult to envisage. It does not seem to be destined to replace petrol and diesel in the internal combustion engines of our vehicles.

Batteries are technologies that attract significant research and development resources. However, one of their major disadvantages is the use of very large quantities of rare raw materials. These quantities can be estimated in tens of thousands of tonnes if the world's fleet of combustion engine vehicles had to be converted.

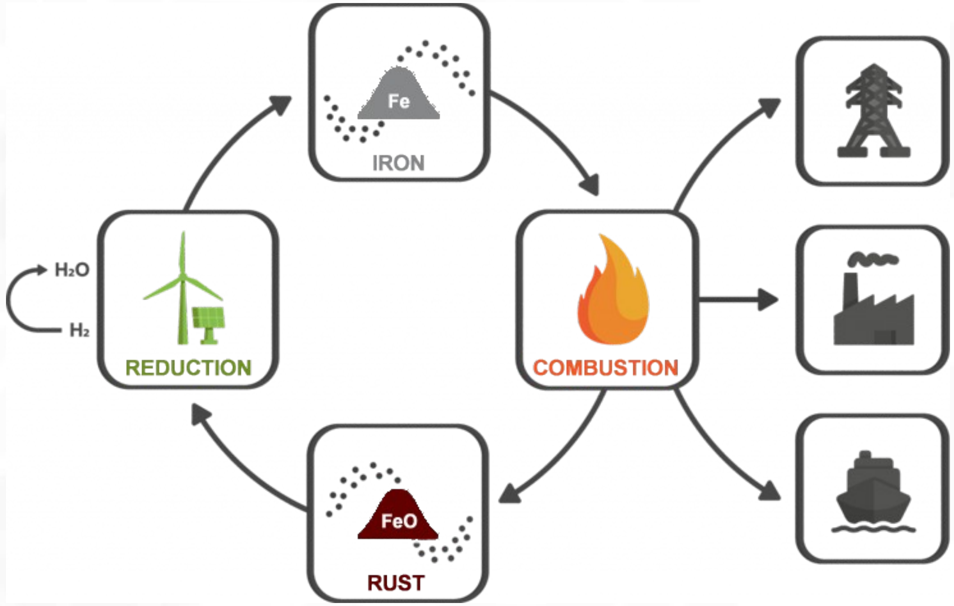
Iron fuel: Let us now turn to a technology that is still in the prototype stage, but has interesting potential, it is the technology of iron fuel.

Usable thermal energy is produced by the rapid oxidation of iron powder in a furnace adapted to this 'fuel'.

Cars will not be able to run on iron, but industrial units requiring thermal processes will be able to use it without any problem. At present, at least one industrial boiler of this type is operating in a brewery in the Netherlands. It should be remembered that the combustion of iron powder does not release any CO_2.

Description of the process

The various phases of the process require the application of energy to two simple products; firstly to water (H_2O) to obtain dihydrogen (H_2) molecules (and residual oxygen) by electrolysis and then secondly to Iron (Fe) to reduce it mechanically to a fine particle powder (20 µm).



Some explanations of the phases of the cycle

1 - Excess electrical energy is used on the one hand to obtain hydrogene and on the other hand to produce iron powder.
2 - The iron powder injected with air at high temperature oxidises in a suitable furnace, this chemical reaction causes energy to be released in the form of heat and produces a residue, rust powder (FeO).
3 - This rust powder is recovered and mixed with hydrogen at high temperature (600 to 1000°C), the chemical reaction obtained makes it possible to link the dihydrogen molecules to the oxygen atoms contained in the rust powder to form water (steam), thus freeing the iron atoms.
4 - Provided that the rate of "de-rusting" is very high (over 99%) and that the iron particles do not agglomerate during the treatment, the powder obtained can be oxidised again in a furnace and release thermal energy.

The aim of the cycle is to store excess electrical energy in a form that can be used thermally and then to recycle the combustion residues, consisting of rust particles, in a circular and reproducible manner, if the iron losses are controlled.

ADVANTAGES

This unexpected 'fuel' has its drawbacks but also many advantages:
- iron is a very abundant and cheap metal on the planet,
- its combustion does not emit CO_2, so it has no effect on the climate
- the combustion residues are inert and recyclable: simple rust.
- iron powder has an energy density of 11.3 kWh/dm3, better than diesel
- its combustion allows high temperatures of over 1800°C to be reached
- it is possible to recover up to 80% of the energy used during regeneration

Compared to hydrogen
- its transport, distribution and storage are relatively easy,
- iron powder does not lose capacity, even after a long storage period
- it does not need to be compressed or cooled
- it does not explode at room temperature

DISADVANTAGES :

- especially when compared to hydrocarbons
- its mass is very high, with only 1.4 kWh/kg required
- to obtain the same energy, it is necessary to handle 10 times more mass

Once the processes have been finely tuned, setting combustion and reduction temperatures, iron powder recovery method, residual rust rate after reduction, material recovery rate at the end of the cycle, iron powder could become a means of storing and distributing excess electrical energy for industrial use in the form of heat.

The profitability of the process can be compared with other technologies to determine which is the easiest to develop on a large scale.

Commuting in private vehicles

The vast majority of commuting trips to work, to take children to school or to do shopping are made within a 20 km radius of the home. To achieve this, is it really necessary to take the ton of steel that makes up a car with you?

And the arrival of electric cars with heavy batteries, some of which are made of rare metals, is not likely to make things any better.

We need to find something else: lighter vehicles and an alternative solution for the batteries. We will have to innovate and change our view of the car.

However, a solution has existed since the 19th century, in Nantes for example, from 1879 to 1917 compressed air trams ran on 39 km of track.

Compressed Air Vehicle Engines

The compressed air engine for motor vehicles is a promising solution for the energy transition in the field of individual transport.

MDI, a Provençal-Luxembourgish company, has been developing this technology for several decades, but unfortunately no vehicle has yet been marketed. The reasons for this are still unclear at the moment. However, MDI has managed to convince large groups such as Véolia and the Indian car giant Tata Motors.

Thus, almost ten years ago, in Provence, four Tata Motors vehicles were equipped with compressed air engines: two Tata Nano and two Tata Ace pickup trucks. At least one of the Nano's was already working properly in July of that year.

Unfortunately, they were not shown at the New Delhi show a few months later.

Of course, there is still the energy consumption, which seems to be unfavourable to compressed air if we do not take into account the energy required for the manufacture, transport and recycling of the batteries. The efficiency of the air motor is around 40%. It is therefore necessary to consume approximately 20 kWh of electrical energy to compress 300 litres of air to 300 bars and thus have a range of 150 km. At the current price of the electric kWh, the cost of use is therefore around 1.50 € per 100 km.

On the other hand, the life of the air tank is guaranteed for 100,000 cycles, whereas the number of charging/discharging cycles of an otherwise more expensive battery is estimated at only 2,000 cycles.

And it should be borne in mind that the mechanical efficiency of petrol is only 30%.

Finally, as long as the electricity used to compress the air is of renewable origin, there will be no CO_2 pollution.

The current teenage craze for "L-free" is great news and will help to normalise the use of light air vehicles for work-related commuting.

To further popularise the concept, community or private fleets could be introduced, for example, by personal assistance associations or the post office.

New energy technologies are therefore continually being developed. Some of them will lead to useful solutions for society that will replace equipment that we still only know how to operate with hydrocarbons.

5) Limits and development of the scenario

The energy question has become a global issue, so what is the point of acting at the Breton level?

Today, the Breton energy system, like all others, faces two major constraints: the scarcity of exogenous energy resources (oil and nuclear) in the medium term and anthropogenic climate change at work on the entire planet: a phenomenon that has been widely documented by scientists and is now undeniable.

The sustainability of our energy system and our development model is seriously compromised.

This leaves only one option: to act. But the necessary energy transition will then have a strong impact on the socio-economic, spatial and political spheres that structure our way of life.

The gradualist policies pursued over the past few years are no longer sufficient; a sense of urgency must be developed among the population and among decision-makers. It is true that numerous international conferences have prompted a number of states to declare a climate emergency, without any real action being taken on the ground to match.

But one thing must be remembered from the current crisis: the longer we delay taking real measures for change, the more limited and less resilient our capacities will be... and the more the fight to respect planetary limits will expose us to the risk of authoritarian evolution of our democracies.

So yes, the Bretons alone will not be able to change the civilisation in which we live, but they must do their part at their level, while hoping that others will do so on their part of the planet.

Fortunately, some countries are already ahead of the game and are leading the way: Norway, New Zealand and Finland, the top three countries in the EIU's Democracy Index, published last January.

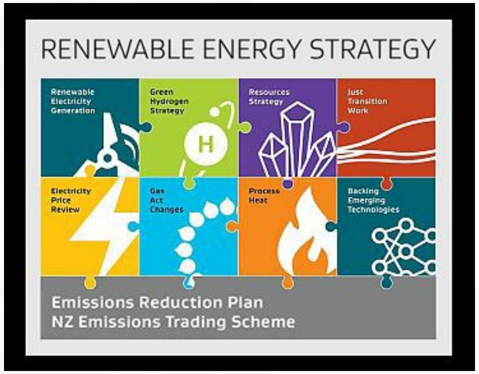
With its 5,471,753 inhabitants, Finland is the most populous of the three, so democratic excellence does not seem to be correlated with population size. In fact, the opposite is true, with a relevant average threshold of around 5 million inhabitants. How about that!

This is the threshold that makes it possible to articulate democracy, a social project, the economy and shared culture, provided that the means of administration are available: a budget and normative competences.

The locks are here, but the keys are in Paris!

A quick overview of "small" democratic countries that are taking action

Norway, the democratic champion (first twelve years in a row) for its 5,165,802 inhabitants, has developed an energy transition project with substantial resources by associating numerous institutional and private partners, in a sort of NAPN.



New Zealand, in second place this year (in the top five for the last twelve years) is committing its 4,926,551 inhabitants to an energy transition strategy.

The government's energy strategies set the policy direction and priorities for New Zealand's energy sector and focus on the transition to net zero carbon emissions by 2050, while building a more productive, sustainable and inclusive economy.

Finland, in third place (in the top ten since 2006), calls on its 5,471,753 inhabitants to support a sustainable growth agenda.

The goal of Prime Minister Sanna Marin's government programme is to make Finland a carbon-neutral country and the first fossil fuel-free welfare society by 2035. This requires an even faster reduction of emissions in all sectors and a strengthening of carbon sinks (Finland has 5 nuclear reactors, the decision to have a sixth built by a Russian consortium has just been reversed).

The list could be continued by adding **Denmark** and **Scotland**, each of which is developing ambitious programmes.

The size of the state is therefore not a relevant criterion, but the exemplary level of democracy implemented within it is!

This trust granted to citizens and the power that is devolved to them allow society to make shared choices that are supported by the people.

And for Brittany ....

Those who say "abandoning nuclear power means returning to the age of candlelight" are no longer credible! The exclusive use of indefinitely renewable energies releases enough energy to envisage a real energy transition for Brittany by 2050.

If we have sought to limit trade - the long-term objective is to achieve not the ultra-specialisation of our current societies, but on the contrary a greater diversification of production - it should be noted that Brittany would remain a major exporter of land and sea products, at the cost of a slight modification of our diet.

Natural balances are respected...

We can see that the rejection of nuclear power has in no way led us into the camp of the "oil companies". Fossil fuels are the object of radical criticism by ecologists; their combustion releases carbon dioxide into the atmosphere, the main cause of climate change. At the current rate of emissions, it can be calculated that the carbon dioxide content of the atmosphere would increase by 1% each year. It is true that terrestrial and marine ecosystems are capable of regulating the atmosphere through photosynthesis. This seems insufficient and in fact the imbalance is increasing. The only coherent position for an ecologist is therefore to never accept the release into the atmosphere of quantities of carbon dioxide greater than those removed each year by photosynthesis. In plain language, this means that fuels must be made from terrestrial or marine biomass. This is what we propose in this N.P.A.B. and in this we respect, a priori, the great natural balances. (This part of the text dates from 1979).

However, we must go further and ask ourselves whether the development of energy crops does not lead to an overuse of the soil. In fact, alfalfa or ryegrass crops have a clearly positive humic balance. As far as the mineral nitrogen balance is concerned, regular inputs of household waste and methanisation residues are also favourable to a balance.

What are the limits of our scenario?

We will come back to the international constraints that will be imposed on our scenario in our general conclusion. We will only examine here its limits and possible developments, as far as energy production in Brittany is concerned.

The direct solar potential is significant. The amount of recoverable energy is directly proportional to the surface of the collectors. The photovoltaic sector is likely to supply the equivalent of 1.360 Mtoe of electricity in Brittany in the long term.

The "agricultural" solar potential has not been exploited to the full. The average annual yield envisaged is only 6.075 TOE per hectare for energy crops. The production of this sector can be increased either by extending the cultivated area - but there is competition with food needs and the desired level of exports - or by increasing the yield.

A level of 18 tonnes ofdry matter per hectare is feasible, without soil exhaustion and massive fertiliser inputs, for crops capable of directly assimilating atmospheric nitrogen. Under these conditions, a level of 4,100 Mtoe of fuel could be achieved. It should be noted that agricultural solar energy can also provide LV and MV heat by pyrolysis and co-generation of organic waste or dry matter.

The exploitation of the onshore wind potential (around 6 Mtoe) should not, in our opinion, exceed the envisaged level of 2,030 Mtoe due to landscape constraints. Offshore systems can now be used to meet any additional demand for electricity without these constraints.

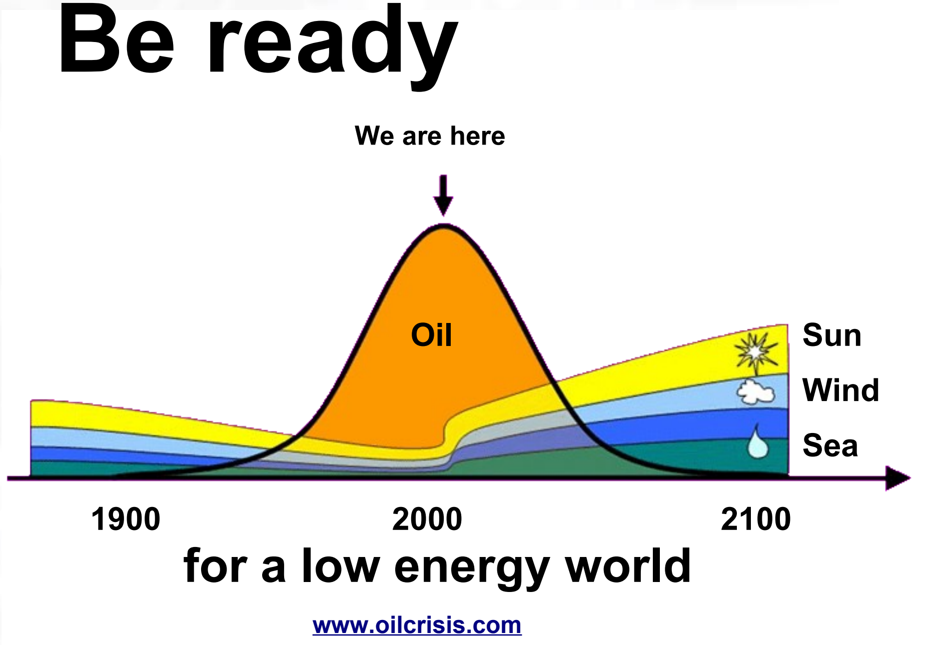
Thus, Brittany is full of energy! It is urgent to develop a coherent and sustained research policy - both applied and fundamental - in the field of "new energies" and to finance a concerted and coordinated installation policy for the various production equipment.

The responsibility of the official state authorities is largely committed...

If it is unwilling or unable to commit itself, it must devolve this competence to the regional institution.

Who can do more, can do less...

The scenario studied in this document foresees a rapid change from the current situation - where fossil fuels provide a large part of our energy production - to 2050 where we consider only renewable energies.



CONCLUSION: A NECESSARY HISTORICAL BREAK WHICH MUST MOBILISE ALL THE PEOPLE OF BRITTANY

We must distinguish between two major categories of events that could slow down the advent of the energy transition in Brittany.

- On the one hand, there are the external causes, caused by the global consequences of the upheavals due to climate change and by the uncontrolled development of the six factors set out in the fiftieth anniversary report of the Club of Rome: "the limits to growth". As a reminder, these factors are the demographic evolution, the natural resource reserves, the per capita availability of the three basic productions: food, industry and services and finally the evolution of the global level of pollution.

- On the other hand, the internal causes that will reveal the endogenous obstacles to the energy transition in Brittany and that will be related to the regulatory, legal, fiscal and financial aspects at the hexagonal and/or European level as well as to the social and cultural contexts that will be in place in Brittany over the next few decades.

The need for action

However, just because the situation is difficult does not mean that nothing should be done, and following the example of the three countries mentioned in the previous paragraph and of many others that are acting locally, it is vital to implement the necessary policies.

It is important to bear in mind that since the problem is global, the response can only be one of solidarity, and this on a global scale. It is illusory to want to create comfortable and fortified havens in the West if chaos reigns elsewhere.

But we must start somewhere, while reserving resources to be able to act where financial, technological and human means are lacking, for concerted development aid actions.

In order to mobilise citizens, companies, associations and local authorities, it will be necessary to develop a joint Breton energy project that is understood and shared by all the players. The validation by the greatest number of people of the different energy production sectors will certainly require negotiations, arbitrations and concessions between the different professional branches, between the citizens and users and between the communities, but ensuring the development of these sectors is essential to achieve an efficient energy mix, resulting from the exploitation of all the resources available to us, without exception: wind, currents, waves, sun, waste and biomass, everything will have to be exploited.

The planning of this global project will have to be ensured at the Breton level by an assembly yet to be created, as the current community does not have the necessary powers and budgets. This new body will be the only one capable of articulating energy planning between the local and European levels. It alone will be able to establish the hierarchy of energy uses at regional level and therefore close to the citizens on the ground.

This implies that the economic and societal transition cannot take place in a hyper-centralised state of 67 million inhabitants which takes all the advantages for its capital region (Gross Paris = 812 km², i.e. 0.15% of the surface of the hexagon).

The future will be played out as close to the ground as possible, in those territories that have been able to attract or retain local grey matter oriented towards a culture of resilience and solidarity.

We have a choice to make:

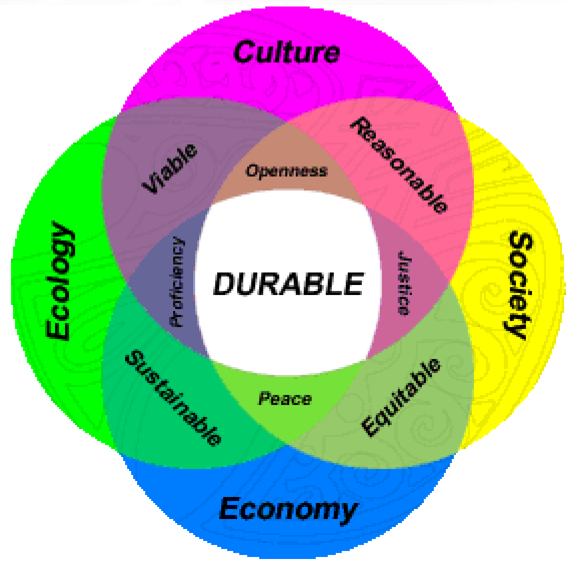
- either democratic resilience with a normative power devolved to an assembly in Brittany
- or catabolic collapse with the Jacobin nuclear power of the Parisian ultra-liberal bourgeoisie.

A real "historical break" also presupposes a lasting change in behaviour, a radical change in the individual and collective "software of thought and action", as well as a very strong mobilisation of all Bretons.

Local energies make it possible to combine local development, creation of local jobs, reduction of the energy bill and security of supply.

The solution to the problem is political. The interest of the NEW ALTER BRETON PROJECT is to give elements of reflection for a wider debate on the concrete realisation of a self-managing, ecological and Breton society.

We have the feeling that Brittany benefits from an exceptional situation to change course. But it will be necessary for a popular movement to take charge of the problem in all its dimensions.



Would we only have succeeded in making them aware that it is urgent to act? … That we would have achieved our goal!

No property is claimed on the content of this document, whose usefulness will be increased tenfold if the themes and objectives presented are widely discussed within various professional, academic and trade union bodies or within groups of citizens simply interested in achieving the energetic objective (a neologism borrowed from Marc Thery).

All the subjects presented are obviously open to amendment and will require argued contributions that will enrich, increase, clarify, improve or even correct this initial document.

ANNEXES & LINKS

- ***Diskrivañ diwar unañ a zo skrap ; diwar daou imbouc'h.***

- ***Copy from one, it's plagiarism; copy from two, it's research.***

Many of the links lead to documents in French

The links highlighted in yellow are already integrated in the document, the others only appear here in addition.

Some sources related to the themes presented in the pages of the document

Page i Preamble
https://www.pressespopulaires.bzh/produit/semanciper-un-projet-de-societe-vu-de-bretagne/
http://www.legislation.gov.uk/ukpga/2006/32/pdfs/ukpga_20060032_en.pdf

Page 1
www.yes-brittany.eu/pellgargan/RANB2022/data/p01_data_2020_Limits-2-Growth.xls
The curves are reconstructed from data gleaned from the Web. The titles in bold are the labels of the queries launched in QWANT.
https://www.theguardian.com/commentisfree/2014/sep/02/limits-to-growth-was-right-new-research-shows-were-nearing-collapse
WORLD DATA RESEARCH
http://www.worldometers.info/
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http://3.bp.blogspot.com/-DFWutnglJrQ/UbYgDBifOmI/AAAAAAAAA5Y/TjotBx63DlY/s1600/limits+to+growth.jpg
1 - NON RENEWABLE RESOURCES REMAINING
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https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/energy-outlook/bp-energy-outlook-2018.pdf

2 - POPULATION
http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=97
http://www.worldometers.info/fr/population-mondiale/
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https://ourworldindata.org/wp-content/uploads/2013/05/updated-World-Population-Growth-1750-2100.png
https://www.planetoscope.com/natalite/5-croissance-de-la-population-mondiale-naissances---deces-.html
3 - FOOD
https://ourworldindata.org/food-per-person
Food supply by region in kilocalories per person per day, 1961-2013
http://www.fao.org/faostat/en/#data/FBS
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http://www.greenfacts.org/en/diet-nutrition/figtableboxes/table-1.htm
https://www.ers.usda.gov/data-products/
4 - WORLD AVERAGE SERVICE
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WORLD AVERAGE GDP PER CAPITA
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http://cdiac.ess-dive.lbl.gov/trends/emis/graphics/global.total.jpg
http://cdiac.ess-dive.lbl.gov/trends/emis/glo_2014.html
The file linked below was compiled from data extracted from the files retrieved above
www.yes-brittany.eu/pellgargan/RANB2022/data/p01_data_2020_Limits-2-Growth.xls

A - The lessons of the Meadows report

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Anticipate these next systemic crises!
https://fred.stlouisfed.org/graph/?id=MCOILBRENTEU

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What alternative after the next financial crisis?
https://fred.stlouisfed.org/series/MVLOAS
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https://www.project-syndicate.org/commentary/financial-system-migrating-risks-by-mohamed-a--el-erian-2017-07/french
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https://www.eiu.com/n/democracy-index-2021-less-than-half-the-world-lives-in-a-democracy/
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No oil, no nuclear power,
An Alter project for the planet is necessary
https://www.planetoscope.com/petrole/559-production-mondiale-de-petrole.html
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