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France: The Future of Fuel

France, home to the "city of love" and scenic southern regions, has an issue casting a haze over the foreseeable future. As renewable energy becomes increasingly essential, France falls short of reaching targeted goals in the arms race to reach net 0 carbon emissions. Not only is France known for its stunning tourist destinations, but the country is also known for its vast farmlands. Taking up 28 hectares, or roughly 50% of France's total land area, each farm, on average, takes up the same amount of space as about 170 football fields (European Commission). France is the 3rd largest country in Europe, with a consistently growing population of 68.04 million as of 2023 (Statista Research Department). 18.76% of this population lives in rural areas, and 81.24% in urban areas (Statista Research Department). Responsible for over 17% of Europe's agricultural output, France's farmland is irreplaceable when considering food security in Europe (Eurostat). So the question is, as the usage of renewable energy becomes increasingly important, how are these changes impacting the farming industry, and how can France continue to provide food for the ever-increasing population while staying on the road to net 0 carbon emissions?

With an increasing population of about 68.04 million as of 2023, France is Europe's second most populated country (Statista Research Department). Additionally, France ranks among the highest fertility rates in Europe, with roughly two children per woman (Statista Research Department). About 65% of the population aged 15-64 has a paying job, with an average income of €41,706 and a combined household income of €275,458 (OECD; Statista Research Department). Average houses have somewhat affordable rates, ranging from €3,000 to €11,000 depending on the region and population density, and are commonly built using concrete or brick to provide sufficient insulation and reduce the need for heating or cooling systems(Meilleurs Agents; Schwartz).

France is a semi-presidential state containing a President of the Republic, The Constitutional Council, The Prime Minister and its government, and the Parliament (Élysée). The president has powers like appointing the Prime Minister and shared powers that need approval from the ministry (Élysée). The President appoints the Prime Minister, who directs the government through implementing legislation (Élysée). The Parliament consists of the Senate and the National Assembly, which are full of elected senators or deputies who vote on legislation (Élysée). Lastly, the government contains ministries, each entrusted with observing specific regions of the government concerning things like Ecological transition or Foreign Affairs (Élysée).

Education is free, compulsory, and high quality, with grants provided to school systems allowing primary and secondary education to be accessible to every adolescent(Britannica). Along with excellent education, France also ranks high in concern for health compared to other European countries, with a health index of 80.5, which assesses various factors that impact the health of a population(Vankar). Largely contributing

is the widely accessible and affordable healthcare, free preventative care, and low-cost treatments when needed (InterNations).

French families eat well-balanced meals, with each meal having a component containing bread and cheese (Gray). Meals are served in three courses, and many view this moment as an essential time for reflecting on the day's events, placing a high value on enjoying the meal rather than rushing to finish (Recor). French culture differs from that of many other regions not only because of the significance placed on mealtime but also due to the importance of local shops and the walkability of these areas. Taking note of the alarming rates of illness in the United States found from living in a sedentary state, many cities in France began to create a standard for what is "walkable" (Nikolova et al.). They place a high value on the compactness of shops, the comfort of pedestrians concerning moving vehicles, and urban ambiance, changing views on urban design, and creating standards for urban development (Nikolova et al.). Due to the walkable nature of these metropolitan areas, many citizens have access to various local produce stands, specialty shops, and general stores containing fresh produce, delis, and other products (Ulland). The importance of fresh produce makes it imperative that most of the produce bought is locally grown and seasonal (Lang).

Having a total land area of 547,557 km², France is the third largest country in Europe (WiseVoter). Approximately 50% of this land area is cultivated farmland, which supports over 700,000 farmers and over 450,000 farms economically (European Commission). Growing major crops like sugar beet, wheat, barley, and potatoes, France's agricultural exports support over 17% of Europe, making them one of the top producers in Europe (Crop Trust; Eurostat). The cool winters varying from 32-46°F, hot and sunny summers ranging from 61-75°F, and heavy spring rainfall allow agriculture to flourish (International Living). Depending on the region, elevation and heat severity fluctuate, with higher elevation towards the south and increasingly hot and windy conditions closer to the Mediterranean (NASA; International Living). An excellent opportunity for many types of produce to grow and flourish is due to this extensive variety of climates and landscapes throughout the country. France exports agricultural goods and products and is a significant exporter of machinery, vehicles, and pharmaceuticals, broadly supporting France's growing economy (AGI Global Logistics).

As shown, the living standards in France are generally high, and so is the quality of life, Though there is still a major issue plaguing the future: climate change. Countries throughout Europe strive to reach net 0 carbon emissions by 2050, setting reasonable targets for each year, most of which concern renewable energy (IEA). In 2020, France could not reach the European renewable energy targets, with only 19.1% of energy being renewable, well below the goal of 23% (Mouterde). Though many other countries are also struggling to reach these targets, France has fallen noticeably behind the net zero goals by 2050, and increased implementation is now critical (IEA).

In response to implementing these targets, most countries turn to onshore wind projects when possible, as seen in Europe's increasing wind power capacity (Fernández). Though falling short of the targeted 1.9 GW of new capacity to be installed by 2022, France had added only 1.2 GW of new capacity, adding to a cumulative capacity of only 20.3 GW in 2022, short of the targeted goal of 24 GW (Mouterde).

Failing to meet these targets shows a poor outlook on the future of climate and energy in France, costing the nation €500 million in fines (Mouterde). Government attention on these topics is increasing, and localized targets in smaller regions are being established; even so, there is a lack of administrative staff

looking over these processes, and there is little known for the future of low-carbon technology heading towards 2035 (Mouterde). Due to the positive contributions of increased government attention and localized targets, there are increased trends towards reduced carbon emissions. However, they do not necessarily align with the timeline agreed upon with the targeted net-zero goals.

In urban areas, large businesses are beginning to notice how efforts in reducing carbon emissions could provide economic and operational benefits by using and increasing solar power integration, energy-efficient building styles, government incentives, and Corporate Social Responsibility (Steimlé and Goossens). As renewable energy becomes increasingly important, businesses are beginning to recognize its benefits by harnessing these methods to their best advantage. Renewable energy positively impacts businesses in the areas and leads the nation on a quicker path towards net zero emissions.

More important, though, in concern for the impact on agricultural practices is the effect of these renewable resources on rural communities. Due to the large amounts of renewable resources in rural areas, the increase in renewable energy is allowing for further development of these areas (European Court of Auditors). Harnessing resources such as solar, wind, hydro, geothermal, and bioenergy creates opportunities for economic growth and job creation (European Court of Auditors). What is essential to consider is that although renewable energy can provide new economic opportunities for rural communities, how is the increased usage of renewable energy and decrease in fossil fuel usage impacting agricultural production in the present, and how will these changes impact the future of food production?

When analyzing the public opinion on the increased usage of renewable energy, it becomes clear that there is ever-growing support for these changes. As shown in a survey given to over 1000 people representing the general public's opinions on the energy systems in France, 77% of those surveyed supported renewable energy usage in 2023, compared to only 65% agreeing in 2021 (Messad). Though the majority feels this way, a very pivotal population disagrees.

Due to new environmental regulations and rising fuel prices, which have reduced fossil fuel usage, farmers across France have shown strong opposition to the impacts of these changes (Trompiz and Levaux). In conjunction with European farmers, French farmers specifically protest environmental policies that limit greenhouse gas emissions and chemical usage, as seen in initiatives such as the Green Deal (Corbet). These changes have caused economic backfire and unfair competition as local produce has become more expensive than imports, affecting the French farming business (Corbet). In protest, these farmers have joined together to form blockades on and around highways and significant markets to demand change from the government(Trompiz and Levaux). These blockaded markets use cheap imports instead of French produce, impacting the economic livelihood of French farmers and the produce marketed to citizens.(Trompiz and Levaux). Protests similar to such can be seen across the globe, differing in protest tactics but similar in the demands for relief against a crisis field by climate change policies (Rogin and Mufson). Though an average bystander can understand governmental and agricultural ends, it is fair to say that a compromise must be made between the agricultural producers and policymakers, as agricultural processes account for nearly 10% of Europe's Greenhouse Gas Emissions (Rogin and Mufson).

This issue concerning the switch to renewable energy is significant and presses for change regarding Earth's future climate and the security of citizens all over Europe. The need for food is ever-increasing,

along with socioeconomic issues regarding production. Therefore, it is vital to plan solutions that satisfy the need for affordable, renewable, and sustainable energy.

Adopting new energy harvesting methods to power machinery without purchasing new equipment could resolve the current issues. By increasing the number of biofuels used and produced, fossil fuel dependence would decrease along with operation costs. Specifically, collecting food waste and fermenting it into biofuel could provide renewable energy to power farm machinery instead of growing crops specifically for this purpose while also combatting the large amount of food waste that France faces. By adopting this new method of creating biofuels, the nation's food waste could decrease dramatically. A portion of the 10 tons of food annually wasted in France could be collected and fermented into biofuel instead of discarded(Permanent Representation of France to the United Nations in Rome). Additionally, the product of such fermentation, Ethanol, is biodegradable (Rumbero). Unlike other nonrenewable resources, it causes little environmental harm if spilled and produces less greenhouse gas emissions (Rumbero). Similar to the United States, the largest producer and user of biofuels globally, governmental branches like the Ministry of Energy Transition led by Agnès Pannier-Runacher could lead this project(Sönnichsen; Ministry of Ecological Transition and Territorial Cohesion).

Approximately 4 million French citizens currently sort their food waste in their homes, which is gathered according to local authority standards (Zero Waste France). However, since 2010, bio-waste in Paris has yet to be collected, though public composting sites run by municipalities are available to all people and businesses in and surrounding the city (Copenhagen Resource Institute). Governmental branches similar to the above must implement and establish policies enforcing the collection of agricultural waste from corporations, farms, and companies to ensure that any product going to "waste" is collected and fermented into fuel. One concern, however, is what farmers could currently be doing with any produce that is not up to standard to be sold. For example, unmarketable produce might be used as livestock feed. This issue may vary among farmers depending on their practices and must be resolved by those in charge as they arise.

To produce such large quantities of fuel, a large-scale biofuel plant would need to be manufactured, costing well over €10 million (Ryzhkov). For the plants to be built, there must be cooperation between the community and government concerning funding, though there are ways to minimize expenses. Various organizations and companies, like Total Energies, have a history of funding large-scale biofuel manufacturing projects; for example, investing €200 million into transforming the La Mède refinery into a biorefinery and investing €400 million in upgrades to the Donges refinery (TotalEnergies). If an organization, or many, were willing to collaborate financially on this innovative project, the total cost could be reduced relatively, and the French public could pay the residual expenses.

As of 2021, there were 39.89 million tax-paying citizens, with approximately 2.5% of their tax money spent on scientific research (Statista Research Department; Let's Live In France). A moderate increase of \notin 2-5 could allow for a substantial increase in the portion of funds for manufacturing these refineries.

Another solution that could satisfy the need for renewable energy involves installing onsite energy production methods at farms across France and switching to electric machinery. As technology improves, new machinery forms are being developed and released, such as the e25G tractor produced by Solectrac. With a single moving part in the motor, the e25G tractor requires very little maintenance, no oil changes, and no fuel purchases(Solectrac). Not only this, but these tractors "deliver maximum torque at zero RPM,

surpassing diesel tractors" (Solectrac). Due to the open nature of farms, solar panels could be installed and would receive adequate sunlight on the roofs of barns and other buildings (Penn State Extension). Installing windmills could harness sufficient wind due to the lower elevations and flat lands in farmlands of the north (Penn State Extension).

Using methods similar to the ones mentioned above, these electric tractors and power-producing plants could also be powered by collected waste turned into biofuel. These methods would help resolve the issues around waste in France and allow for a significant decrease in carbon emissions.

One setback is that biofuel is less energy-dense than other nonrenewable resources, meaning more fuel would be used to compensate for this (Rumbero). However, due to lower prices and fewer greenhouse gas emissions in comparison, it may pose little of a problem (Rumbero). Using biofuel could be cost-effective, as farmers would no longer rely on fluctuating fuel prices, allowing for a high produce yield. Although this is a possible solution, it may not be the most probable due to the expensive and wasteful nature of replacing old tractors with new ones.

Lastly, a solution exists where farmers implement no-till agricultural methods to reduce the fuel needed. By not using machinery for tilling the land, "approximately three fewer gallons of fuel per acre" is used, leading to substantial economic benefits (Creech). No-till increases soil health as there is an increase in organic matter and a decline in erosion, resulting in both high fertility and more plentiful yields (Fairfax County). To implement this nationwide, policies promoting no-till methods could be implemented, with economic incentives for those who adopt these methods. As machinery usage decreases, farms could switch to more manual ways of harvesting agriculture, leaving openings for jobs. Though this solution does not directly resolve the need for increased renewable energy usage to reach net zero, it allows for a decrease in fuel consumption by farmers and an economic benefit, along with a maintained yield of produce.

In total, increasing the usage of biofuel created from food waste could ensure a steady energy supply to farmers while allowing France to continue serving as a significant exporter of agricultural products to Europe. Not only could this solution be cost-effective, but it could also be sustainable by using waste and turning it into fuel. Climate change is a pressing, rapidly increasing issue that must be addressed immediately. Enforcing these solutions would ensure a continued food supply for the ever-increasing population while staying on the road to net 0 carbon emissions.

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