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Abstract

As a looming climate crisis continues to overwhelm the global community and Europe grips with fluctuating fossil fuel prices due to geopolitical tensions, the European Union appears to be rushing to forge a path to renewable energy to forgo dependence on nonrenewable energy sources. Decades ahead of the global community, the European Union has succeeded in its 2020 goals by increasing the share of renewable energy to 20% of overall consumption. Heading towards their strikingly ambitious goals for 2030, this great transition provides a case study that other states should be watching closely. This article analyzes the effects of several different European Union public policy strategies and instruments concerning the energy sector. By studying their approach and the mistakes they made, the global community is presented with valuable lessons and principles that provide strategies and specific policy instruments to mimic or adapt to their own regions.

Keywords

energy transition, energy policy, renewable energy, energy security

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1. INTRODUCTION

In the middle of a climate crisis and geopolitical events that threaten energy security, the European Union (EU) appears to be in the midst of a great energy transition. The EU represents a new case study where a union of 27 Member States joins together in cohesive and interconnected energy policy to try and decarbonize their energy system. So far, the EU has made stunning progress as the European bloc recently met its 2020 energy goals with a 20% reduction in greenhouse gas emissions, increasing share of renewable energy use to 20%, and improving energy efficiency by 20%. While energy transition has been discussed as an engineering problem for decades, the success in meeting these targets alludes to the feats in public policy crafting from the European Commission (EC). A decade ahead of most states, this tremendous energy transition provides great insight into how states can begin the switch from fossil fuels to renewable energy and what pitfalls to avoid from a public policy perspective. The EU proves that it is not only possible to successfully navigate the early stages of energy transition, but that the transition can continue to be successful with innovative and scientifically-backed public policy that aims to solve inherent issues with renewable energy sources.

2. INTERNATIONAL CLIMATE COMMITMENTS: ORIGINS OF ENERGY TRANSITION

Energy transition in light of climate change is a comparatively new policy area that has emerged largely out of the commitments made at the international level in the 1990s. In 1992, the signatories of the United Nations Conference on Environment and Development agreed on the vague goal of "developing methodologies and identifying thresholds levels of atmospheric pollutants… that would cause dangerous anthropogenic interference" (Rio Declaration, 1992). More direction was soon needed and in 1998 the Kyoto Protocol agreed that industrialized countries would have the responsibility of reducing their emissions by 5.2%. This international discussion bore witness to the principle of Common but Differentiated Responsibilities and Respective Capabilities. In this respect, the EU agreed to an 8% reduction in emissions (from the 1990s levels) but only if the EU countries could meet their target together as a "regional economic integration organization" (Kyoto Protocol, 1998). This measure ensured that the European Community considered the diverse level of comparative wealth between its members and ensured that no unfair pressure was put on vulnerable states. This principle of fairness is what continues to drive energy policy in the EU and ensures continued compliance.

Since the Kyoto Protocol, the EC has drafted and passed with the help of the European Parliament numerous directives and energy policy packages that address a wide array of areas such as research, development, transport, energy efficiency, industry, and infrastructure. These policy measures include economic instruments and regulatory standards as well "soft" policy instruments like regulating the information on labels on consumer appliances. International treaties spurred the actions of the EU to meet their commitments by employing domestic policy strategies across the region. The EU case study holds a wealth of knowledge and in the next section key lessons will be taken from policy scenarios on how other states can implement their own energy transition towards renewable sources.

3. DRIVING CHANGE AND OVERCOMING BARRIERS: EU ENERGY POLICY

As the third-largest emitter of greenhouse gasses, the European Union faces the monumental challenge of switching from a historically large dependence on fossil fuels to a transnational system of renewable energy sharing (Welsch, 2017). While this energy transi-

tion is technically achievable, the unpreparedness of Member States concerning the needed infrastructure, market incentives, and regional interconnection to make the transition, made it quite difficult in practice and was an issue the EU needed to address head-on (Vahlenkamp & Feldhaus, 2010). The EU's success in overcoming these obstacles is ruly remarkable, especially when one considers the massive challenges that confront a state when crafting energy legislation.

For the last two decades, energy policy in the EU has been constantly evolving into the behemoth that is seen today. There are policies for energy system integration, offshore renewable energy strategy, hydrogen advancements, trans-European electrical grid projects, energy market reformation, and strategies for decarbonizing sectors like industry and transport, just to name a few. This is a massive and ongoing public policy undertaking of the European Commission, and as a result, this research paper does not have the space required for an exhaustive list of all policy initiatives.[1] Instead, the analysis below will provide a gateway into energy transition policy at the EU level and break down some of the most impactful policy instruments and strategies that could provide other states and regional coalitions with recognizable frameworks for their own transition to renewable energy sources.

4. Guiding Principles, Targets and Goals

To begin this exploration, this paper will divide the relevant policies into organizational themes, beginning with policies that establish guiding targets and goals for the EU. This category of public policy doesn't particularly lay out specific blueprints or binding techniques for each state to follow. Instead, the EU has used numerous guiding frameworks to set goals and provide a visionary path for future policies to follow. The first of these guiding frameworks have already been discussed and includes international commitments as seen in the Rio Declaration (1992) and the Kyoto Protocol (1998). These climate commitments have acted as a catalyst for energy transition policy at the EU level and have enacted a standard of setting goals for future regulatory structures.

Following the international commitments of 1992 and 1997, the EU took matters into their own hands. In 2005, EU leaders agreed to three guiding pillars of energy transition: sustainability, competitiveness, and security. After a few years of dialogue, the EU made these pillars legally binding for all Member States as part of the Lisbon Treaty (EC, 2006; Treaty of Lisbon, 2007). Along with guiding pillars, the EU has set comprehensive goals for cutting emissions, increasing renewable energy generation, and energy efficiency improvement for the last few decades. For example, in the 2009 Climate and Energy Package, the EU enacted legislation that set three specific targets for the community to reach as a collective: 20% cut in greenhouse gas emissions, 20% renewable energy in final consumption, and a 20% improvement in energy efficiency (EU, 2009b). This target-setting strategy made later energy policies digestible and kept EU leaders and national governments on the same track. Arbitrary to some, this strategy became increasingly successful as just recently the EU surpassed the 2020 goals with a 22% final energy consumption of renewable energy (EC, 2022c). Breaking the goals down by decade allowed stakeholders to not become overwhelmed and overburdened with future initiatives. In 2014, this strategy was implemented

1 Other energy policies that are noteworthy: EC's Energy System Integration Strategy, Hydrogen Strategy for a Climate Neutral Europe, revision of the TEN-E policy (COM(2020) 924), directive to reduce indirect land use change for biofuels and bioliquids (EU 2015/1513), Strategic Energy Technology (SET) Plan, EU's Biodiversity Strategy for 2030 (in relation to Biomass energy), the North Seas Energy Cooperation, and the Baltic Energy Market Interconnection Plan.

again to create the 2030 Climate & Energy Framework, in which the EU agreed to the ambitious targets for 2030: 40% cut in greenhouse gas emissions, 32% renewable energy in final consumption, and 32.5% improvement in energy efficiency (EC, 2014). Finally, in 2019, the European Green Deal set the target of having no net emission of greenhouse gasses by 2050 (EC, 2019). This target was consistent with commitments made in the Paris Agreement and was additionally set into binding law with the European Climate Law (EU, 2021).

5. Three Pillars of EU Energy Policy

The following sections will discuss in more detail the EU energy policy's three pillars: sustainability, competitiveness, and security. This will be used to show how specific public policies were used to overachieve 2020 targets and help solve the inherent issues with renewable energy sources. In each section, barriers will be presented to demonstrate the complexity of these goals and how the EU has innovated policy instruments to overcome them.

5.1. Sustainability

Unfortunately, energy transition is not as simple as slowly replacing fossil-fuel-burning power generation facilities with an equal number of solar panels and wind turbines. Introducing renewable energy sources into an economy comes with certain risks. For example, the volatility of renewable energy sources introduces a barrier of intermittent supply versus fluctuating demand. Fossil-fuel-burning generators, on the other hand, can provide energy and change the output of electricity as needed on a given electrical grid. As long as the source of fossil fuels is available, this facility can ramp up or down the production of electricity to follow grid operator signals. This dynamic changes when renewable energy generation enters a system. A solar farm can output a generous amount of energy to help meet local electricity demand, but seasonal, day-to-day, and intra-day variability of the weather affects the supply of electricity (Mackay, 2016). In order to combat the volatility of renewable energy, a system must have a large supply of renewable energy as well as have it coming from a diverse mix of sources.

To promote the overall supply of clean energy, the EC has strategically used a carrot and stick[2] approach to simultaneously incentivize renewable energy production, increase diversity, and improve energy efficiency. In this approach, the EC has set careful targets, as shown above, but this has become a strategic component in itself. Instead of telling the entire region what to invest in or how to do a proper transition, the EC recognizes the great diversity and socioeconomic differences between the Member States. The strategy for an energy transition in Germany will not be the same as in Poland. Setting these overarching goals allows for the flexibility of individual Member States to meet their goals with national policies. This balance between EU governance and individual sovereignty is crucial. It does not stop here: to further support Member States, the Regulation on the Governance of the Energy Union and Climate Action requires each member to submit a draft National Energy and Climate Plan (NECP) to the EC for each decade. The commission will then assess each document and issue country-specific recommendations backed by the academic community, which can all be found on the NECP repository for other stakeholders to analyze and prepare for coming policy adjustments (International Energy Agency, 2020).

To further increase production and the diversification of clean energy, the EU has set aside billions of euros in financial aid to incentivize this transition. First, the EU has com-

2 In public policy, "carrot and stick" approaches refer to instruments that both incentivize people/organizations to comply with a policy as well offer punishment if they refuse to comply.

mitted 25% of its budget towards climate change, which amounts to an outstanding €503 billion over 2021–2030. This goal is also expected to activate further national co-financing amounting to €114 billion across the same time period (Hafner & Raimondi, 2020). Along with the passage of the Green Deal, the Sustainable Europe Investment Plan aims to mobilize at least €1 trillion of combined private and public sustainable investments for the 2021-2030 period as well (EC, 2020). This money will "provide incentives to unlock and redirect public and private investment, and provide support to public authorities and project promoters in planning, designing and executing sustainable projects" (International Energy Agency, 2021). It is also widely recognized within the EC that the socioeconomic differences of Member States will greatly impact the speed of energy transition. For this reason, the Commission created the Just Transition Mechanism which will help mobilize around €100 billion to ensure the cost of transitioning to sustainable energy sources does not fall on the economically disadvantaged (Hafner & Raimondi, 2020).

The EC has set targets to guide states, established country specific plans to assist them, and even offered financial support in meeting energy transition visions. These "carrots" provide many incentives to Member States, but the EC has also established regulations to punish industries that are resisting the transition. One of the earliest instruments established was the EU's Emissions Trading System (EU ETS). Officially operational in 2005[3], this was the first multi-country greenhouse gas emission trading scheme (Delbeke & Vis, 2019). Foundationally, it operates on the Polluter Pays Principle by capping companies' carbon dioxide (CO_2) emissions and allowing businesses that are more energy efficient to trade their leftover CO_2 allowances (Nagy & Varga, 2009). Having companies be responsible for their allowances has created a policy instrument that enforces lowering greenhouse gas emissions as well as makes electricity production from burning fossil fuels more expensive, which in turn incentivizes clean power sources. If a company does not purchase enough allowances for their overall emissions, they can be heavily fined. This instrument also incentivizes companies to invest in energy-efficient practices and technologies to allow them to sell their leftover emissions allowances in the EU market. Given how new this policy area was when first created, the EU ETS suffered from unforeseen issues with over-supply of CO_2 allowances during crises like the economic recession in 2008 (Delbeke & Vis, 2019). But the EC has been active in revisiting, analyzing, and fixing structural deficiencies in the program. These efforts can be seen in the recent price of CO_2 increasing, which allows for a renewed surge in investments for clean energy and efficiency standards (EC, 2021b). Introduced in 2021, the EC's "Fit for 55" package will continue to update the EU ETS with new linear reduction factors, including new industries, as well as including a market stability reserve reform (Council of the European Union, 2021). As the price for CO_2 rises, it will continually redirect public and private investment towards more efficient production models. The numbers back up these claims—from 2005 to 2021 the industries included in the EU ETS have brought down emissions by 42.8% (EC, 2021b). Finally, the EU ETS also funds the Innovation and Modernization program for energy transition with an additional €25 billion of revenue from auctioning carbon allowances (Hafner & Raimondi, 2020).

5.2. Competitiveness

The EU has made tremendous progress towards early goals of energy transition by not only financially assisting and incentivizing sustainable energy practices but also employing

3 The EU Emissions Trading System had a pilot phase of 3 years from 2005-2007.

the use of regulatory instruments to curtail harmful consumption models. This has helped partially overcome the barrier of volatility when it comes to renewable energy sources. Public policy strategies outlined above have worked to increase the overall clean energy supply, but the diversification of clean energy sources is still a barrier that needs to be solved in order to make clean energy reliable. The EC has overcome this challenge through crafting policy that relies on competitive market forces to increase the diversification of energy suppliers and producers for the entirety of the European community.

To truly be self-sustaining, the EU must diversify clean energy sources it can tap into to make up for the drastic intraday variabilities in certain clean energy supply. For example, solar energy in one country might be overproduced during the day but at night falls off. This can have devastating effects on the energy market and its consumers. If solar energy falls suddenly, consumers may be faced with rapidly increased energy prices as the demand for electricity will be higher than the current supply. Luckily, the EU is home to some of the most geographically diverse states. From the mountains of France to the rolling plains of Hungary, the geography of the EU is highly varied and offers a diversification of resources. These geological differences become of great importance when discussing and planning renewable energy projects. For example, Denmark has an abundance of shallow-water sea territory that is optimal for offshore wind power production, while Spain has optimal weather and surface tilt for solar energy production (Mackay, 2016). These advantages are of great importance, but they still suffer from volatility. Spain might be an optimal place for solar energy production but at night it would lose a huge percentage of renewable energy supply. The EU represents a unique opportunity to share the burden and responsibility of diversifying renewable energy for the entire region. In this model, each state can utilize its own comparative advantage to invest in the renewable energy options that lead to the best utilization of the landscape, increasing overall efficiency and yield of energy production.

Diverse energy sources are present, but how does a region that spans nearly 4 million km^2 tap into more than twenty-seven national energy market structures and where would the physical infrastructure for energy flow exist that could carry such a capacity (World Bank, 2022)? For the last three decades, the EU has taken on this challenge of integration by adopting a series of important public policy decisions which ultimately led to the creation of a single internal market for electricity and the most interconnected continental power grid in the world (Liu et al., 2020). Steps to launch this behemoth of a public policy project began in the 1990s and market reforms occurred through three energy legislative designs. The First Energy Package developed common rules for the European internal electricity market and began the steps of unbundling energy monopolies (EU, 1996). Then in 2003, the Second Energy Package sought to liberalize existing national markets by allowing new electricity suppliers to enter the market as well as ensuring customer protection by letting consumers choose their supplier (EU, 2003). This package was crafted to limit the inherent risks of "systemic conflict of interest deemed inherent in the vertical integration of production, networks, and supply activities" (Faure-Schuyer & Pye, 2017). Further attempts to liberalize the market were addressed in the 2009 Third Energy Package, which unbundled supply, generation, and transmission networks and increased transparency with third parties and retail markets (EU, 2009a). This package also formed the legal basis for a single electricity market as well as created the Agency for Cooperation of Energy Regulators (ACER) and the European Network of Transmission System Operators (ENTSO) in order to supervise the integration of a single market (Faure-Schuyer & Pye, 2017).

This integrated single market is still evolving today as the EC is taking its time rolling out new policies and regulations to ensure the market does not crash due to its infancy. To fully integrate this market into the region, the EC has set its sights on improving cross-border electricity interconnections. Cross-border interconnections are physical infrastructure projects that connect one state's electricity grid to another country's grid. For example, the Celtic Interconnector is a series of underwater cables that physically connect Ireland with the continental Europe's grid through France's network with a capacity of 700 Megawatts (enough to power 450,000 European homes). To incentivize these connections, the EC is using large sums of money out of its budget, with the Celtic Interconnector project receiving €530 million of public funds (Newbery, 2021). The EC has also added interconnection to their list of goals for 2030, requiring states to have in place cables that will be able to send at least 15% of its produced electricity capacity (EU, 2018).This physical connection in tandem with the integrated market will allow Member States to seamlessly buy and sell energy as needed (Directorate-General for Energy, 2019).

The investment in interconneced infastructre is critical considering the effects it has on the reliability of renewable resources and the market value for them. First, the integrated market and electrical grid allow for the EU to become physically connected and utilize the diverse renewable energy sources available throughout the landscape. Second, diversifying renewable energy sources makes them more reliable. If there are extreme weather conditions in one Member State, they are able to import electricity from their neighbors as needed. This also makes the process more efficient. For example, Denmark's wind farms regularly overproduce electricity in comparison to the demand in their country. Instead of Denmark slowing down the production of wind energy, they can sell it to neighbors like Sweden. Taking advantage of their mountainous landscape and the cheap energy, Sweden can then fill up pumped hydro reservoirs that they will then release when demand for energy is high and sell the surplus elsewhere (Newbery, 2021).

Pairing market conformity with adequate physical infrastructure not only ensures the security of energy supply across the EU, but can also increase the incentives for renewable energy. In this system, each state can use its geographic advantages and connect isolated electrical networks in order to make possible the buying and selling of electricity across borders, while the EC can established other policy initiatives to ensure the market rewards clean energy production and transmission. For instance, the Renewable Directive of the Third Energy Package creates priority dispatch for renewable energy in the grid resulting in transmission system operators dispatching energy from clean sources ahead of other generators (EU, 2009a). Importantly, both of these steps—increasing interconnectedness and incentivizing renewable energy productionv—will be beneficial for the economy as well as energy security, as the spending on energy imports will decrease. According to the European Parliament's Cost of non-Europe report, annual efficiency gains will be at least €250 billion with a more physically integrated internal energy market (Erbach, 2019).

5.3. Security

The goals of sustainable and competitive energy in Europe are inherently interlaced with the EC's goal of a secure energy network. The international energy market has continued to be anything but reliable in the last few decades. The EU 2009 and 2014 gas crises, the 2014 global oil price collapse, and even the decline in global coal demand in 2015 are all events that compromised the security of energy for the EU. These issues with the international market are only exacerbated with rising geopolitical tensions, making the "business

of relationships" of the gas and fossil fuels industries increasingly volatile (Gustafson, 2020). This can be seen with the current Russian invasion of Ukraine and the subsequent shock to European energy reserves, as Russia supplies 41% of natural gas and 27% of crude oil imports to the region (EC, 2021a). These crises have proved to the EC that being dependent on foreign imports creates a barrier to achieving energy stability (Dutta et al., 2022).

Taking these issues and possible future geopolitical conflicts into account, the EC proposed the Energy Union Package in 2015. This package works to highlight how the security of energy supply ties into other goals of sustainability and competitiveness in markets. It casts a bold vision of "an Energy Union where Member States see that they depend on each other to deliver secure energy to their citizens, based on true solidarity and trust, and of an Energy Union that speaks with one voice in global affairs" (EC, 2015). This goal highlights the importance of the internal energy market and demonstrates that the EU needs more energy efficiency in order to rely less on foreign fossil fuels. It also encourages Member States to diversify all aspects of supply such as energy sources, suppliers, and routes in order to reduce external shocks on the EU when crises do occur. While this transition to a fully integrated and secure energy market takes place, the Energy Union strategy also includes crisis management plans to offset the effects of short-term energy shortages from outside suppliers (EC, 2015).

If the first two decades of the European energy transition were spurred by climate action, the energy policy of the last decade has been catalyzed by pressing issues of security. Most recently, current EC President Ursula von der Leyen announced in a press statement a "focused acceleration of the European Green Deal" due to the Russian invasion of Ukraine (EC, 2022a). Shortly after the press statement, the EC sent communication about its reactive policy strategy entitled REPowerEU. Policies within this plan were designed to phase out all dependence on fossil fuels from Russia by 2030. This strategy accelerates the Green Deal so much that it claims to be able to cut nearly two-thirds of energy imports from Russia within a year. To achieve this, policies include diversifying gas supplies, importing large volumes of biomethane and renewable hydrogen production, boosting energy efficiencies in sectors that use fossil fuels, increasing renewables, and addressing infrastructure bottlenecks (EC, 2022b). Thus, the energy transition in the EU is not only about going green but it is also about creating a regional network that is self-reliant and free from the demands of fossil fuel-rich states. If the Energy Union is successful in its 2050 goals, this will create the first region to essentially overcome the barrier of having to import energy.

5.4. Lessons

There are a few key lessons that can be learned from the various policies and strategies noted above for each pillar of the EU energy transition. For the issue of lacking a large supply of renewable energy, the EU has created policy instruments to incentivize production of clean energy and deterrents to harmful consumption models. In practical terms, the EU sets clear targets that allow for flexibility from state to state, requires states to make public their plans, offers scientifically-backed recommendations to those plans, and to top it all off, sets aside a large budget to support new projects. To deter activity that would be harmful to these goals, the EU has created the EU ETS, which incentivizes energy efficiency and adds a market deterrent for industries producing non-renewable energy or those engaging in outdated consumption practices. If other states want to achieve success in spurring the production of clean energy, they must be willing to similarily give out financial incentives and use a stronger approach to put pressure on the more stubborn industries.

To help solve the barrier of volatility, the EU created the internal electricity market and the regional interconnected electrical grid to diversify energy sources. This, in turn, has created a space for a large amount of efficient energy sharing that incentivizes renewable energy market exchanges and allows for states to use their comparative advantage in energy production. To solve this barrier in other regions, states will need to effectively utilize geographical space for renewable energy production and create market incentives that drive energy sharing.

Finally, even if a state does not have the motivation to transition to clean energy to stop climate change, it is likely to recognize the benefits of renewable energy through a lens of national security. Energy transitions to renewable energy allow states or regions to become more self-sustaining and less vulerable to external pressures. The need for energy independence should be especially clear in light of the recent Russian invasion of Ukraine and Russia's increasing use of energy blackmail as a political tool. Just as the Energy Union strategy has allowed the EU to focus on the internal market to avoid foreign control of their domestic supply of raw energy, other states might find this approach helpful in transitioning for security purposes.

6. Conclusion — Principles of Success

The EU is providing the rest of the world with many lessons on how specific policy instruments can help with advancing goals of sustainability, competitiveness, and security. In addition to the lessons learned above, there are three overarching principles that can be derived from this case study. First, in order to have an effective energy transition, a principle of fairness must be embedded in public policy crafting. To ensure energy policy is inclusive of the entirety of the EU, the union embraces the Common but Differentiated Responsibilities and Respective Capabilities strategy. It is largely understood that some of the least energy-efficient states are also those with a comparatively lower GDP per capita. To maintain fairness in regional regulations, it is imperative that policies be enacted that provide flexibility to the rules or funds to redistribute financial investments. The EU has maintained this principle through differentiated energy targets based on each state and the Just Transition Mechanism fund. This also means allowing states to tackle the problem in the best way possible for their own situation and not providing a blanket fix. This is EU technocracy at its finest. It hasn't implemented a bar that everyone must jump over at once but looks at everyone's strengths to accomplish a shared goal.

In order for any region or state to craft public policy for a successful energy transition, principles of science must also be interwoven with policy. Energy policy involves complexities that relate to many facets of academic thought. To craft comprehensive policy, the EU has relied on INSIGHT_E, a think tank financed by the EU that provides unbiased policy insights. This think tank is comprised of experts from a total of twelve European academic institutions as well as a network of over nine hundred stakeholders from over thirty countries (Welsch, 2017). Other states that seek to mimic the EU's success must trust academic institutions to provide up-to-date science on a constantly evolving and complex issue area.

Even with all the research and planning put into the relevant policies, it is still a new area of policy, and that has led the EU to embrace a third principle: learn-by-doing. States must not be afraid to learn through experience and alter policies when needed. This can be seen in the rapid learning and response to the EU ETS and the subsequent policies that amended worrisome exogenous variables. Along with the academic community, states must create agencies to monitor and analyze developments within energy policy. And when prob-

lems arise, be swift to take action.

A decade ahead of most states, the EU represents a unique case where the transition to renewable energy sources and a decarbonized energy system has already reached unprecedented levels. By studying their approach and the mistakes they made, the global community is presented with valuable lessons and principles: lessons that provide strategies and specific policy instruments to mimic or adapt to their own region, and principles to guide the overall crafting of public policy in this field. The EU's "many carrots with a few sticks" approach has led the region to succeed in its 2020 goals and be on track for ambitious 2030 targets. It is clear that any state or regional coalition wanting to make this transition will need to make serious investments into physical, digital, and theoretical frameworks that will pay off decades later. The EU is leading the charge on this front and renews hopes that maybe one day, the global community can turn its back on the harmful consumption of fossil fuels.

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