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Feed-in Tariffs and Sustainable Energy: Why Different OECD Governments Support Sustainable Energy at Different Rates Through Feed-in Tariffs

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Abstract

The global push for sustainable energy is a point of focus for every industrial economy on the planet; with the threat of global warming growing by the year, the need for a shift away from fossil fuels to renewable energy has become a must. However, this shift does not come without a significant financial burden. While countless advances in science and technology have driven down the cost of producing renewable energy, it remains more expensive due to the inconsistency in power generation and its delivery. This paper aims to look into the different policies used to ease this financial burden of converting to renewable energy, with a Specific focus on Feed-in Tariffs and the factors that go into governments pricing out FiTs. To measure Feed-in Tariff prices more accurately among countries, this paper focuses on OECD countries. This is due to them all being democracies and possessing stronger, more established, and robust economies. To try and account for FiT price differences within and between countries, explanatory variables include malapportionment, renewable energy usage, the price of crude oil imported, the amount of crude oil produced, oil price volatility, GDP per capita, government deficit, Green party participation in government, will be utilized in series of regression analyses to examine the effects on FiT prices between and within countries. Renewable energy usage and Government deficit are found to have significant adverse impacts on FiT price both within and between countries. Meanwhile, oil price volatility and the price of oil imported have a significant positive impact on FiT price between and within countries. This brings about broad incite behind countries' reasoning to support the adoption and growth of renewable energies, suggesting it has less to do with views on climate change and more do to do with insulating countries from the volatility of oil prices due to their dependency on oil. This may provide more support to suggest that governments' motives to push for renewable energy now have not changed from their original reasons dating back to 1973.

Since the 1970s, countries have tried to shift away from oil reliance, in favor of cleaner, more renewable forms. This global reliance on oil has been recently brought to back to light with the sanctions imposed on Russia after the invasion of Ukraine, driving up oil prices through the roof. Once again, creating another case for governments to push for renewable energy. This push for renewable energy is not a new fight, but through various past policies and directives is one that is growing rapidly. Countries are looking for ways to promote the development of clean energy sites, which has led to the creation of various policies. As we enter 2022, we have seen what approaches have worked thus far and the results. But as countries aim to reach ambitious targets for renewable energy deployment, the question arises of why do different governments support sustainable energy at different rates? A question that becomes more intriguing as we look at OECD countries and their variance in using Feed-in Tariffs, the most efficient and effective policy we have seen this far, in achieving the OECD’s goal of reducing net emission by 40% and having 50% of all electricity coming from renewable sources by 2030 (Aklin & Urpelainen, 2018).

Renewable energy and the use of cleaner, greener sources of energy are nothing new. For centuries, we have turned to renewable sources to provide energy. From early water wheels dating back to 4000 BCE, they took the potential energy of a flowing river and turned it into useable mechanical energy. That energy later became one of the drivers of the industrial revolution as flowing rivers could now power whole factories. This industrialization led to many advancements, including but not limited to electricity generation, which spawned the second industrial revolution, as now factories could stay open longer and produce more. As production increased, so did the need for electricity. As electrical grids grew and the demand for electrical energy to power these grids grew, the world looked to fossil fuels to answer our electricity demands, not renewable alternatives. Renewable energy as a source of electricity was dwarfed by the economic efficiency of using fossil fuels, so much so that the contribution of renewable energy to modern industrial economies was seen as a negligible (Aklin & Urpelainen, 2018). In 2000, the International Energy Agency (IEA) reported that upwards of 90% of the global energy mix came from oil, natural gas, and coal. This led to their *World Energy Outlook* predicting that non-hydroelectric renewables would continue to be irrelevant. Its predictions from 2000 to 2020 only saw non-hydroelectric renewables climb from a 2% share to a 3% share of electricity generation (IEA, 2000) - with much of this growth coming from OECD countries.

However, those predictions have since proven to underestimate the expansion and growth of renewable energy regarding electricity generation. This is thanks to economic and political factors that have aided in developing renewable energy. While renewable energy is growing, it is growing at different rates in different countries around the globe. The majority of the growth continues to come from OECD countries. However, various factors such as GDP, government budget, renewable energy targets, and present production rates of renewable energy all continue to contribute to variation within the continued growth of renewable energy, specifically in the OECD. This brings in my research question of why is it that different governments in the OECD support sustainable energy at different rates. In particular, through feed-in tariffs, which is the focus of this thesis of what factors explain the different levels at which OECD governments support renewable energy through feed-in tariffs?

This thesis proceeds as follows. Section 1 explains the history of renewable energy growth, followed by Section 2, which looks at climate change and its roles in expanding the use of renewable energy globally. Section 3 explains renewable energy and examines the primary forms of renewable electricity. Section 4 outlines the disadvantages and issues of using renewable energy, followed by section 5, which includes a detailed discussion of renewable energy policies with a particular focus on feed-in tariffs (FiTs). Section 6 presents my theoretical model through both a political and economic lens in an attempt to explain the variation seen among FiT prices across OECD countries. Section 7 lays out my research design and the variables used, followed by Section 8, which will present the empirical results.

History of Renewable Energy: The Need for a New Energy Source

The push for renewable energy we see today, in the form of wind and solar, got a significant push from the energy crisis in the early 1970s. This was when the world was experiencing incredibly high prices for fossil fuels, which later continued with Saudi Arabia and its fellow members of the Organization of Arab Petroleum Exporting Countries (OAPEC) placing an oil embargo on the United States and other countries that supported Israel during the Yom Kippur War. This caused continued fuel shortages and record-high prices throughout the decade. By the time the embargo was lifted in 1974, the oil price had grown by nearly 300%, from $3 per barrel to $12 per barrel. This forced the hand of policymakers to push for alternative energy forms which could be scaled up to help replace fossil fuels and ultimately reduce the dependency countries had on fossil fuels (Keohane & Nye 1977). The shocks in oil prices from 1973 continued with the second oil crisis of 1979. This saw oil prices more than double again to upwards of $35 per barrel even though total oil production only fell by an estimated 4% during that same time. This volatility in oil price, as well as the public concern about nuclear energy stemming from the accidents such as Chernobyl (1986) and Three-mile Island (1979), served as the catalyst for policymakers all over the globe to look favorably toward new sources, as a way of powering the world into the new millennium. This led to countries adopting new energy policies with a two-pronged approach. The first is a way of being less dependent on fossil fuels, and the other is heavy investment into new technology for use with alternative sources. Preferably these sources would be available domestically. This meant sources other than oil for much of the western world, which they lacked. At the same time, environmental concerns began to grow, which put pressure on governments to not simply just explore the technology used in harnessing coal or natural gas. This led them to focus on the technology investment to harness wind and solar energy. The new source looked to reduce the dependency on fossil fuel for energy generation and serve as a cleaner, greener alternative.

Climate Change and Treaties: The Catalyst for Renewable Energy?

The concern over CO2 emissions and their negative externalities, such as global warming, has led countries to focus on more environmentally friendly energy policies. To put this in economic terms, energy scholars of the Swedish Energy Agency T Sundqvist and S. Soderholm (2002) estimate there are 132 unpriced externalities associated with varying sources of electricity generation, with negative externalities exceeding any positives ones. These unpriced externalities range from the effects of CO2 emissions on both the environment and human health and overall environmental damage done to the earth. Often these externalities are not put in monetary terms. However when it is, this equates to a total average unpriced negative externality of roughly 13.46 cents for every kilowatt-hour (kWh) of electricity generated. Table 1 below shows the average negative unpriced externality associated with each energy source. Wind and solar energy yield a substantially lower negative externality than their fossil fuel counterparts. Dr. Benjamin K. Sovacool (2010) of the University of Sussex and the director of the Danish Center of Energy Technology at Aarhus University estimated that just in the countries of Southeast Asia[1], unpriced non-climate related externalities would amount to over 69 billion in damages per year. If you factored in CO2 emissions, at a conservative $20 per ton, that would add another estimated $20 billion, bringing the total to 90 billion dollars in negative unpriced externalities for electricity generation in Southeast Asia alone.

	Coal	Oil	Gas	Nuclear	Hydro	Wind	Solar	Biomass
Min	0.06	0.03	0.003	0.0003	0.02	0	0	0
Max	72.42	39.93	13.22	64.45	26.26	0.80	1.69	22.09
Mean	**14.87**	**13.57**	**5.02**	**8.63**	**3.84**	**0.29**	**0.69**	**5.20**
SD	16.89	12.51	4.73	18.62	8.40	0.20	0.57	6.11
N	29	15	24	16	11	14	7	16

Table 1. *Chart of Estimated Negative Externalities Associated With Each Different Source of Electricity Supply as Seen in Sovacool's estimated model, $1998 (US Cents/kWh). Mean numbers have been bolded. (Sovacool 2010)*

The negative externalities measured in Southeast Asia are ones we have come to endure all over the globe, and they have been at the forefront of the recent global conversation. Co2 emissions have been a significant area of concern due to the relationship with climate change, a concept that is not radically new. This relationship has further invigorated governments to look for sources that can help reduce Co2 emissions and ultimately help slow climate change. Energy scholars emphasize that renewables can be a cornerstone of a comprehensive strategy to solve the problems of climate change and, in the process, help with energy poverty, arguing that obstacles to increasing the use of renewable energy can be surmounted (Aklin & Urpelainen, 2018). This has led to many summits and the adoption of global agreements to help reduce the globe's emissions, with the first notable one being the Kyoto Protocol.

[1] The countries comprising Southeast Asia in Sovacool's calculations are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

The Kyoto protocol of 1992 originally agreed to reduce emissions by 8% between 1990 and 2012 but ultimately achieved a reduction of 19% of total emissions among the countries in the agreement to the protocol (Dupont and Oberthür 2015). This then spurred a more significant, more comprehensive agreement with the signing of the Paris Climate accord of 2015. With the signing of the Paris Climate Accords in 2015, the push for a cleaner, greener future became a point of formal focus for policymakers all over the globe. In total, 150 countries signed the accords, with 196 countries choosing to adopt the legally binding international treaty on climate change. The goal set by the Paris Climate Accords is to reign in greenhouse gas emissions and keep global warming below 2 degrees Celsius of preindustrial levels, with the preferable target of it being 1.5 degrees Celsius. The accords became the first multilateral binding agreement, bringing all nations into a common cause to have global emissions peak as soon as possible so a climate-neutral world can be achieved by 2050. While the accords set forth an international commitment, the progress that will allow the goals to be met is individual. Under the agreements, countries had until 2020 to submit their plans for their action, known as nationally determined contributions (NDCs).

The push for sustainable energy by these accords is not the only one. Countries have set their targets beyond NDCs, and other formal organizations of countries like the European Union are looking to do their part in pushing for a more sustainable future. However, increased sustainability comes with increased expense. The push for greener energy has required establishing incentives to convince producers and consumers to turn away from cheaper fossil fuels in favor of more environmentally conscious options. These include, but are not limited to; tax credits for both producing and investing in renewable energy, feed-in tariffs, net metering, and more. All of this is designed to address the barriers to renewable energy by lowering upfront costs, lowering financing costs, creating new markets, and ultimately allowing for the growth of the renewable and sustainable energy sector. These goals, while ambitious, have become the global standard for what countries aim for in reducing Co2 emissions.

These standards have been reaffirmed and elevated by the COP 26 conference. This served as the follow-up conference to the Paris climate accords, which had original targets set during the COP 21 conference in 2015. The primary focus was to establish the goals for the end of this next decade and ultimately accelerate the goal initially set forth by the Paris Climate Accords. The COP 26 also expanded to include 153 countries, up from the 150 countries in the original accords, making up 90% of the world GDP. These 153 countries have now pledged net-zero commitments by 2030 as part of their new NDC for the next five years to keep the overall target of limiting global warming to 1.5 degrees Celsius and below by 2050.

Renewable Energy: Potential Solution and Economic Challenges

What is Renewable Energy?

These efforts to reign in climate change effects are based on lowering global emissions using sustainable energy. This is also interchangeable with the term renewable energy, and while there is considerable overlap with many sustainable options also being renewable, it becomes necessary to define what is sustainable. Sustainable states that something is sustainable if it can be maintained at a specific rate or level in its most basic definition. John Hopkins University defines sustainable energy as energy derived from resources that can support current operations without jeopardizing future generations' energy needs or climate. While this definition is valid, especially when it comes to energy, it falls short in considering the economic costs of sustainable energy. We have seen efficient and effective policies emerge in Germany and Spain, and many other countries, all of which were deemed economically unsustainable due to the financial burden they placed on governments and the debts they caused. In the case of Spain, their early renewable energy policies caused debts of over 26 billion euros to amass. This ultimately led to the end of those policies favoring less financially burdening ones. Today, we see this with many countries adopting feed-in tariffs funded through the consumer or country's taxpayers. For my research, it became apparent that the term sustainable needed to consider the economic side of energy production. This led to my working definition of sustainable energy as; renewable energy capable of maintaining current operations without jeopardizing the energy needs or climate of future generations while being cost-effective and fiscally responsible in its production and transportation. This allows for a more refined focus on what is genuinely sustainable energy for the future. Energy is not sustainable if the market and government incentives are unable to aid in its growth and if the cost to consumers is too much.

Wind and Solar: the solution for clean Energy?

With this criterion set for what is sustainable energy beyond just the planet's needs but countries' economic needs as well, the point of focus was solar or photovoltaics and wind energy. During the oil crisis, these forms of energy saw huge government investment to develop the technology to harness the potential energy they had to offer more efficiently. In 1973 the world saw increased investment in wind technology due to the oil crisis at the time, and then in 1991, the world saw the first offshore wind farm in Vineby Denmark, with the United Kingdom following second off the coast of Cornwall (Aklin & Urpelainen, 2018). The investment in solar technology came later with The Solar Project in 1996, proving to aid in the significant leap of solar energy as an energy source. This investment in development pushed solar and wind energy to become the two primary sources that are widely viewed as the "first modern renewable sources of energy that are commercially viable," with onshore wind in the lead and now photovoltaics (Aklin & Urpelainen, 2018). This commercial viability comes from the increased efficiency in this technology due to investment in research and development of wind turbines and solar panels. In 1989, a single wind turbine was able to generate at most 300 kilowatts (kW) of power; by 1999, that had increased to 1.5 megawatts (MW) of power, and then in 2012, some of the largest turbines could each generate 7.5 MW of energy. In comparison, the average nuclear powerplant today (2017) can only produce 1,000 MW of power.

As for costs, these also decreased as efficiency went up. In the United States, the cost of wind energy fell from $4.30 per watt in 1984 to $1.90 per watt in 2009 (IPCC, 2011). Similar trends are being reported all over the globe. As for solar photovoltaic energy, the costs decreased by an even greater margin, with large solar parks producing electricity for less than $1.00 per watt in 2011 (Quigin 2012). Some estimates suggest that solar prices dropped from $76.00 per watt in 1977 to $0.74 per watt in 2013. It is also predicted that solar energy's production cost will continue to fall by 13% year on year and wind production by 9% yearly. These price decreases come from extensive investment in this technology from developmental strategies laid out by countries under the Kyoto Protocol and in their NDCs under the Paris agreement. The chief developmental strategies of the European Union and China are seen as the key catalysts in driving down the cost of wind and solar photovoltaics internationally (Dupont and Oberthür, 2015). With these now lower costs, these sources became more economically viable for more countries that once struggled to afford the extensive investment in switching to renewables.

Clean Energy is the Solution: Not so Fast

Clean energy has long been seen as the more expensive option in terms of finances when compared to its fossil fuel alternatives. When renewable energy started becoming more of a focal point in terms of a source for energy production, power produced from renewable sources such as wind cost five times as much per kilowatt than compared to its fossil fuel counterpart. The Imperial College Centre for Energy Policy and Technology (ICCEPT) reported that the production and delivery of electricity from coal in 2002 was 3-5 Eurocents per kilowatt-hour, whereas electricity from solar and other renewable energy costs upwards of 15-25 Eurocents per kilowatt-hour to be produced and delivered to consumers. Thanks to the massive growth of renewable energy and increased efficiency, we now see that renewable energy follows a similar cost structure as fossil fuels do. As of 2019, the International Renewable Energy Agency (IRENA) estimates that the cost of producing renewable and sustainable energy is comparable to that of fossil fuels, ranging anywhere from 5 to 15 cents per kilowatt-hour in terms of developing new plants and producing electricity. However, this does not consider additional costs associated with the delivery to the grid and infrastructure enhancements.

Unlike fossil fuels, renewable energy cannot deliver a constant level of production around the clock as existing energy sources can. Baker et al. (2013) show that current cost estimates for renewable energy may prove too optimistic because they do not account for the needed changes to accommodate intermittency in power supply and decentralized power generation. A complete renewable energy sourced grid would require storage facilities and optimized power grids that would allow for easy switching of energy between sources. This will remain unobtainable until changes are made, and these changes would come at a high cost, hence why most of the world relies on a hybrid grid. This means that renewable energy works in tandem with fossil fuels. Energy from fossil fuels would pick the slack when renewable energy is not being produced. But this too creates an issue due to how electricity is priced, and the effects renewable energy has on prices. Currently, electricity markets are spot prices based on energy demand and the average cost of energy per unit supplied to the grid from all the suppliers. What renewable energy does is it drives down the prices in the market and the demand for renewable energy. This is because renewable power now costs less per unit to produce than forms such as nuclear, but it also costs less than fossil fuels when they aren't at peak production levels. Due to the emergence of renewable energy onto energy grids, fossil fuel power plants only need to work at optimal levels during peak power usage times. This means that their marginal cost of producing electricity is higher than where it should be, and if enough renewable sources are attached to the grid, then the marginal cost exceeds the price producers are being paid for energy under spot pricing. This only then raises electricity costs for the consumer.

As for delivery costs, these costs include the amount of energy needed to get the electricity to the grid and the cost of the infrastructure itself. All electricity transportation requires a percentage of electricity to be lost as energy flows through powerlines from producer to consumer. With fossil fuel grids, the main producers aren't generally far from consumers meaning they have a lower Energy Return on Investment (EROI) and cost less in infrastructure to transport energy[2]. Energy output from fossil fuel using producers is also more constant, contributing to a lower EROI. As for renewable energy, their EROI sits higher than fossil fuels. This is due to where renewable energy sites are located, and their intermittency issue measured above. Large-scale wind and solar farms are often situated at rural sites due to the space they need and the requirement for optimal location if they want to produce at rates that can rival fossil fuels. This means they need significant infrastructure in the form of extended power line networks and more. All of which require a percentage of energy produced to operate, thus lowering the EROI. Then there's intermittency issue, because renewable energy is not constant,

[2] EROI stands for the Energy Return on Investment. The more energy that it takes to supply energy to the consumer the lower EROI will be.

like wind turbines that have a minimum speed and a maximum speed, EROI will decline due to energy still having to power the power lines to the grid, thus raising the percent of Energy invested in just simply getting power to the grid from the turbine farm. There is also the issue of inefficiency as renewable energy sites age. In Europe, the average output from a wind turbine declines by over 12% in a 20-year lifetime, thus lowering EROI. This then raises the issue of if renewable energy is economically viable when factoring in the costs outside of simply producing renewable energy.

Leveling the Playing Field: Renewable Energy Subsidies

What are the Subsidies used?

Clean energy faces and promises a brighter future for consumers and producers but is hampered by its costs and the volatility of the energy market, which scares off investors into renewable energy. Governments have tried to level the playing field, artificially making renewable energy more attractive from an economic point of view, but this has relied on policies such as taxes on carbon consumption and incentives to use cleaner fuels through policies like feed-in-tariffs and other subsidies which aim to offset the increased costs of transporting and storing clean energy. Table 2 highlights eight of the main policies used to promote renewable energy expansion. Of those eight, we will be examining the effects of Renewable Portfolio Standard (RPS), Renewable Energy Certificates (RECs) or the Green Certificate programs, competitive bidding schemes, followed by a deep dive into FiTs. While all these policies do appear to work, FiTs prove to be the most dominant subsidy used. This is as governments aim at striking the balance of promoting renewable energy but at a cost that is not just sustainable to just them but consumers as well. They must break the Carbon Lock-in[3] associated with fossil fuels and promote the adaptation and investment in the cleaner greener technology of renewable sources such as wind and solar/photovoltaic power. This requires providing stability in energy markets and an incentive to invest in renewable technology, which while they cost the same in terms of energy production, in comparison with fossil fuels using producers, is more capital intensive upfront.

Mechanism	Advantages	Disadvantages
Renewable Portfolio Standards	Diversifies investment risk Creates continuous pressure for lower electricity prices Minimizes government intervention Provides flexibility when coupled with a Renewable Energy Credit market	Will not initially support higher cost renewable energy Does not support off-grid systems Renewable Energy Credit prices will perpetually fluctuate
Green Power Programs	Allows consumers in areas without plentiful renewable resources to support them Does not impose the cost of renewable energy on those that do not wish to pay for it	Voluntary nature means no guarantee that new projects get built Does not uniformly promote renewable energy projects Inflated costs of renewable energy may create little incentive to improve efficiency among providers
Research & Development	Easily controlled by government Provides support to specific technologies	Concentrates investment risk with no guarantee of success At risk to declining public and private budgets
System Benefit Funds	Socializes the cost of renewable energy Can be used to promote other policy goals	Narrow geographic focus Modest funding Regulatory uncertainty
Investment Tax Credit	Directly promotes R&D Distributes risk to private companies	Can send false price signals Benefits investors, not electricity customers Can inflate vendor prices May have no effect on behavior
Production Tax Credit	Wide in scope Socializes the costs of renewable energy	Can be insufficient to attract new investment Significant budget must be available Must be known by producers Producers must have significant income stream Exclusionary to individuals and small firms
Tendering System	Government can control level of renewable penetration Provides an incentive to keep costs low Distributes savings to consumers	Fixed price distorts the market Reduces investor margins and can hurt R&D Tends to hurt domestic manufacturing, as investors seek least cost international suppliers
Feed-In Tariffs	Provides stable investment stream to developers Suppliers receive payments immediately Puts pressure on lower equipment prices More consistent than many unclear RPS	Little incentive may exist to drive electricity rates down or to innovate without degression Initially inflates the cost of electricity until significant amounts of renewable energy are deployed

Table 2. *Advantages and Disadvantages of Eight Renewable Energy Policy Mechanisms. (Sovacool 2010)*

Government subsidies for energy are not a new phenomenon. The IMF reports that as of 2015, subsidies for all forms of energy totals over 6.3 trillion USD or roughly 6.5% of the worlds GDP. In terms of subsidies devoted to purely energy production, not taking into account other factors[4], the International Renewable Energy Agency estimates that 638 billion USD is allocated

[3] Carbon Lock-in is the delay/prevention of adopting low-carbon renewable alternatives, from various factors all of which make it difficult to move away from carbon energy.
[4] These factors include climate costs and air pollution which are also subsidized

to these subsidies. Further analysis estimates that of that 638 billion 70% (447 billion USD) are allocated to fossil fuels, with subsidies for renewable power generation only totaling around 20% of all subsidies (128 billion USD). Many of these subsidies are grandfathered in with aging tax codes. These come from the historical efforts to promote cheap and abundant energy sources, many of which were fossil fuel-based.

Renewable Portfolio Standards

Renewable Portfolio Standards or RPS are regulatory mandates, that only apply to electric utility companies, with the goal to increase the production of energy from renewable sources. These renewable sources include but are not limited to wind, solar, biomass and other alternatives to fossil fuels and nuclear energy. Most RPS mandate that a certain amount of energy must come from renewable sources, with some RPS policies mandating which sources. RPS systems are good at promoting renewable energy by creating a demand for renewables but does not encourage renewable energy generation by new entrants. The RPS mandate is focused on existing utilities and fail to offer any incentive to lower entry barriers for outsiders to the current utility network. The RPS focuses on regulating the behavior of existing players without guaranteeing grid access to third parties (Bayer & Urpelainen 2016). What this means is while it does promote renewable energy it does little to shift the energy market from current investors to outside investors. It is also limited in the energy it promotes as it promotes the cheapest form of renewable energy in terms of investment, as companies are looking to satisfy the mandate at a cost that is cheapest to them (Sovacool, 2009). Renewable portfolio standard programs usually work in conjunction with another policy such as Renewable Energy Certificates of Green Certificates.

Renewable Energy Certificates (RECs)

Renewable Energy Certificates (RECs), also referred to as Green Certificates, are government programs to promote renewable energy development, allowing utilities to meet the mandate for a certain percentage of energy to be renewable under the RPS policies. The RPS requirement established by the government is a set percentage of electricity generated that needs to be from a renewable source. Since RPS standards usually only promote the cheapest form of energy and does not encourage new entrants into the market RECs aim to fix that. RECs or Green Certificates create a market for which renewable energy can be sold to utility companies along with a certificate which says the energy came from a renewable source. It is up to utility companies to then buy enough renewable energy and obtain enough certificates to fall in compliance with a set percentage of their electricity sold to consumers coming from renewable sources, as set forth by the RPS policy in place. These certificates are issued by the government to renewable energy producers at a rate of x certificates per unit of energy and their value comes from supply and demand in the market the REC policy creates. This raises the concern of possible overinvestment in renewable energy since they operate under the premise of supply and demand, if too much renewable energy is produced then the certificates will drop in value as utility companies will only pay for the number of certificates, they need to fall in compliance with RPS standards. This drop in value of the certificates does not entice newcomers into the market as they only now receive payment for producing electricity and are now without the added premium of selling the certificates to the utility company.

Shortcomings of RECs

While Green Certificates or RECs have been proven to be effective at promoting an increased capacity of Renewable Energy as a percentage of the total energy produced, there are shortcomings to the policy. The main issue mentioned earlier is if RPS requirements do not increase at the same rate as renewable energy is being produced, in terms of the amount of renewable energy being produced as a percentage of total energy being produced. For the REC market to remain at equilibrium the amount of renewable energy, as a percentage of total energy being produced, must remain equal to the amount of renewable energy, as a percentage, that is required to be bought under RPS policies. If there was disequilibrium and the percentage of RE being produced exceeds the percentage that is to be bought, then the value of the certificates decreases. To stop that happening governments have had to manage the market and effectively establish a price floor by buying up unsold certificates in the market to keep the price of the certificates at a certain price point. A price point, which entices further production and investment into renewable energy technology. There also remains the issue of RECs continuing to favor the cheapest form of Renewable energy technology. This is an issue as it does not promote research and development into newer more expensive forms of renewable energy, which could become cheaper if investments were made into them.

Competitive Bidding

Another policy implemented to try and expand the use of renewables as an energy source is the competitive bidding scheme among investors, where government contracts are put up for auction to the lowest bidder. This is a policy that allows for the costs of investment to be controlled as now the government can set what requirements they want from a site. This can be in terms of technology used and the amount of electricity supplied. Then companies bid for the contract to achieve the lowest cost per kilowatt-hour, with the contract going to the lowest bidder. This in essence makes producers price takers as they must work to reduce costs in such a way, that they win the contract and can still turn a profit. Most contracts are auctioned in phases and as interest grows from one phase to another, the next phases are then proposed. From that competitors then bid for the contract and try to undercut each other. This has resulted in seeing auction prices for electricity fall by 30 percent to 50 percent per kilowatt-hour of what the lowest feed-in tariff was set at. The competitive bidding scheme is ideal for saving money, as it brings to the surface the issue of price vs quantity. Under competitive bidding schemes countries achieve the low cost of energy production, but the issue arises of expanding the installed capacity of renewable energy beyond these contracts. This is as there is no incentive to produce more energy than what is awarded in the contract. Due to the competitive bidding scheme enabling the marginal production costs of all the producers to be identified. The overall cost of reaching the target is then given by the area situated under the marginal cost curve (Menanteau et al, 2003). This allows for governments to more accurately assign costs associated with units of production. It also stops any extra energy from being produced from these contracts as producers do not want to raise their marginal cost curve in order to remain profitable and earn a return on investment similar to what they would find in the fossil fuels side of the market, roughly 5 %to 6%. Under the competitive bidding scheme, some 61 countries have issued and closed 800 renewable energy auctions since 2003. These include 50 in China, 63 in Brazil, and 257 in India (Aklin &Urpelainen, 2018).

It becomes important to mention that while the competitive bidding system in theory allows for the introduction and use of selection criteria for what renewable energy is used and is better at allowing for a country to fulfill its set objectives. It is not able to compete in terms of efficiency with countries operating under a feed-in tariff system (Menanteau et al, 2003). It has been seen in examples of Germany and France, where a competitive bidding scheme has been introduced and later replaced with FiTs to encourage projects at less attractive sites or with less attractive technology (more costly). Feed-in tariffs serve as an effective tool in achieving the quantity component of renewable energy quotas outlined in Res-E portfolios for countries.

Feed-in-Tariffs: What they are and Their effect on Renewable Energy

Feed-in Tariffs, also known as FiTs, are one of the many incentives governments use to increase the amount of renewable energy that is produced and consumed. This is in effort to meet environmental goals set forth by coalitions like the UN and the Paris Climate Accords. FiTs are special guaranteed rates, per unit of electricity, that governments establish for certain renewable sources of energy. These rates are generally higher than rates otherwise available to other electricity generators using non-renewable sources. FiTs don't just provide producers with a price per unit higher than the spot rate of electricity, but they also guarantee grid access for 15 to 25 years. The average life of these contracts is about 20 years. This means that investors have a stable foundation to invest in renewable energy, as they not only get a rate exceeding their marginal cost but are also guaranteed long-term purchasing agreements for the electricity generated. This means FiTs to not only cover the high initial investment costs but also yield a 5 to 6 percent return on investment over the life of their contract. Many FiT policies also have priority dispatch clauses. A priority dispatch cause means that the energy produced from renewable sources, under these contracts, must be bought before you can get energy from another source. This includes sources like fossil fuels and is irrespective of if the cost per unit of energy is more expensive. The additional costs associated with FiTs are often passed onto the consumer in the form of the price of electricity being a couple of cents more per kilowatt-hour. This leads to two things happening. First, is that now investors have an incentive to build larger wind farms and solar farms as they know their energy will get bought at a premium. This is because they now can supply whatever amount of energy they wish, irrespective of the price of electricity in the market, knowing that is now guaranteed to be bought at a better rate under a FiT (Andor et al., 2010). This then creates the issue of cost containment for governments who issue the FiTs, as they must purchase the energy generated at an even higher rate in comparison to other cheaper sources. This leads to a welfare loss due to an allocative inefficiency under the FiT scheme with priority dispatch.

FiT policies have been seen as favorable to investors in renewable energy due to the guaranteeing of a more stable and secure market, one that is isolated from the typical volatility of electricity prices, that has been seen in the fossil fuel market. FiTs have not only been seen to increase the number of investors, but also a diversification in who's investing. FiTs are guaranteed to anyone and promote decentralizing the grid in the process due to allowing anyone to become a renewable energy producer. In Germany, for example, many farmers reap generous profits from solar electricity generation under the feed-in tariff (Vasagar 2013). This is due to it being available to anyone. It promotes independent power producers and helps redistribute the wealth from large utilities to a much larger population, especially in rural areas, where the potential for renewable energy generation is highest. This is effectively a redistribution of wealth and is a positive for governments trying to push forth new energy policies. Since it also allows for the premium to be paid to anyone, it expands the competitiveness of the sector as a whole.

The advantages offered by feed-in tariffs have led to them being the most widely adopted renewable power generation policy employed at both the national and state level. As of 2014, 73 countries and 28 states/provinces had adopted some form of feed-in tariff/feed-in premium.

Many of the countries employing FiTs are generally wealthier and can be classified as a developed country. The policy of using FiTs is not limited to these wealthier countries, as countries such as the Philippines, Uganda, Kenya, and South Africa have all turned to the use of FiTs to increase renewable energy generation. However, unlike other wealthier countries, these countries have learned from previous FiT schemes and placed a cap on the amount of energy each producer can generate in their contract, and if they exceed that amount, they must renegotiate a new FiT price (Guild, 2019). This is in response to the negatives that have been associated with FiTs.

FiTs, while widely adopted, are not perfect in promoting the expansion of renewable energy generation. Due to their nature of guaranteeing a premium rate for electricity, it distorts the prices of the market, while also failing to combat the high up-front costs associated with renewable energy deployment in the form of grid modernization etc. It also does not encourage price competition between competitors as a guaranteed rate is being offered for electricity generation[5].

Feed-in premiums are very similar to FiTs but unlike the fixed rate of FiTs they offer money on top of the spot market price. What this means is there is a set premium offered to producers, that is more than market price. This means that like the regular electricity market there is volatility in the price producers receive, as the price of electricity is still dependent on the market and not a set rate like under a FiT. This therefore still allows for competition between suppliers but with the upside of being paid more for electricity than what a fossil fuel producer would get. Like FiTs they still suffer the same weaknesses in not being able to confront upfront

[5] With price competition the suppliers of renewable electricity are willing to produce the same amount, but at a lower cost. This would mean that the consumers would ultimately being paying less than under the current FiT schemes that don't promote competition amongst producers.

costs and prove to be expensive in the long run. With both FiTs and FiPs, accurate information is needed to efficiently and effectively needed by the government to adequately choose the right price point. Too low and investors will not expand renewable energy, too high and there will be inefficiencies and wasted public funds.

While FiTs are difficult to price out and can result in increased cost of electricity generation, they have been seen to be the most effective subsidy in promoting renewable energy expansion. The reason they are difficult to price out is due to establishing a rate that will entice investors into the market, but at the same time not become a burden to governments who implement FiTs. It is difficult to determine the rate that marginal cost is not definitive like it is under a competitive bidding scheme. However, even with this difficulty FiTs remain the most effective policy in promoting renewable energy growth compared to the other policies such as competitive bidding schemes. FiTs in Europe were seen to result in 20 times more generating capacity than any other policy used (Aklin &Urpelainen, 2018). This is due to not only the added premium energy producers received, but the decrease in volatility investors saw from this. As it stands in theory, FiTs and the electricity capacity they allow for, should allow for the overall cost of electricity generation to decrease with time and scale. This is only in tandem with increased investment in research and development. Bloomberg New Energy Finance cites that the FiTs adopted by more than 60 countries worldwide have driven up 64% of global wind and 87% of global photovoltaic capacity (UNEP 2012, 5). It is this growth that has ultimately allowed for the overall lower cost of environmental regulation for follower states in adopting other policies.

Main Design Elements of FiTs

In their most general form, feed-in Tariffs are bills that get signed into law mandating a subsidy per kWh of energy generated from renewable sources in excess of the wholesale amount.

This is along with a purchase obligation to utility companies to buy this energy. These laws often differ in what specific parameters they use from country to country and are often amended over time in response to the change they cause in the energy market. These amendments often come in an effort to revise FiT rates to better follow the lowering energy cost from the expansion in renewable energy these policies cause. In early FiT laws, especially Germany and Spain, the countries took on large FiT debts, as they were the ones to pay the difference between the established energy rate passed to consumers and the FiT price the government had set. In Spain its FiT laws had to be amended, as while they were highly effective, they were also seen as fiscally unsustainable due to the growing "Tariff Deficit" amounting to over 26 billion Euros (Davies & Allen 2014).

Today most FiTs are seen to follow a series of design elements that are considered when countries choose to adopt FiTs. The first of which is if the bill will state it is a fixed-premium or a fixed tariff. A tariff which is a total amount of compensation per kWh of energy, while a premium, is an addition amount on top of the market price for electricity. Another is the support tied to a certain technology. Nearly all FiTs have this specification often requiring energy from either wind or solar power. Another main element is if the FiT regresses with time, this is the element that was often added in the amending of early FiTs. Today most FiTs regress in payout with time typically in intervals of 5 to 10 years. This is to better allow the FiT to keep up with the lowering of energy cost to produce from renewables due to their expansion. Most FiT policies look to provide energy investors a return on investment of 5 to 6 percent over the life of the Tariff under which they invested. Other design elements of FiTs today include is, does the FiT become a cost to consumer or not, as well as what is the duration of support a FiT offer to renewable energy generators. The average life is seen to be 15-20 years but can range anywhere from 10 to the entire lifetime of the energy farm. These energy farms typically use solar or wind technology. Figure 3 highlights all the main design elements FiTs often consider.

Main design elements of FITs.

	Description
Fixed-premium vs. fixed-tariff	Tariff: a total amount of support is granted to RES-E generators per kWh. Premium: an additional amount to the electricity price is granted
Support tied to electricity price	Support may or may not be linked to the electricity price
Technology-specific FITs	Support is differentiated across technologies to reflect technology-specific generation costs
Cap price	Support is capped (electricity price + premium)
Floor price	A floor ensures a minimum support level (electricity price + premium)
Degression	Reductions over time in support levels for new plants. Degression rates: % reduction of support per year
Reduction of support for existing plants	Reductions of support over time for existing plants, compared to providing the same overall amount of support for the whole period, but constantly over time
Support paid by electricity consumers vs. paid by taxpayers	Support can be charged to consumers or taxpayers
Maximum size of plants	Only installations below a certain capacity threshold would receive the support
Duration of support	Support may be guaranteed for a longer or shorter time
Capacity limit per technology	Cap on technology deployment eligible for support (overall or for individual technologies)
Cost-containment mechanisms	Some elements may help to control costs: limits on generation eligible for support, capacity limits, cap on total costs, etc.

Table 3. *Main Design Elements seen in FITS (Del Rio 2012)*

While the design elements of FiTs can differ from country to country, many Feed in Tariff policies today contain the same design elements. Del Rio (2012) looked at the implementation of the design elements seen in table 3. across 22 European countries and various other non-European countries and found remarkable similarities, even though each country had chosen their own FiT policies. In terms of if countries had chosen a tariff or premium 18 countries had chosen a tariff while only four had strictly chosen a premium. A handful of countries were seen to offer both a tariff and premium. When it came to the elements of FiT support being tied to electricity price and specific technologies. In all the countries that chose

FiTs, these FiTs were linked to certain technologies and were irrespective of electricity price, in terms of support offered. As for the cost to consumers and how the FiT was funded, all countries but the Netherlands had passed on the cost to the consumer of electricity. The Netherlands had elected to pass on the cost of the FiT to all of its taxpayers[6]. No countries chose to include a cap price or floor price for the tariff/premium price. As for a capacity cap associated with a FiT, Spain was the only country to include one, but for solar photovoltaic energy only. As for duration of the FiT. This differed by country, with many electing 15 years. No country took on a FiT with a cost containment clause. As for the reduction of FiT support for existing plants, Denmark and Latvia chose to decrease their tariff after 10 years and Spain chose to do the same, but after 20 years. With the presence of many similarities in term of FiT design elements being the same, and almost standard since the first FiTs seen in Germany and Spain, it becomes reasonable to consider most modern FiT schemes, coming after the early German and Spanish ones, follow similar parameters.

Effects of FiTs

While the increased capacity for renewable energy can be attributed to FiTs, as they exceed any other policy, in terms of promoting installed capacities of renewable energy. Scholars still look to measure the true effectiveness of FiTs, as well as other factors that can play into this effectiveness. The payment of a just above market tariff is not guaranteed to drive growth in renewable energy installed capacities, poorly designed FiT schemes can impede growth (Aguirre & Ibikunle, 2014). It has been seen that FiTs that promote investment incentives have been linked to growth throughout the renewable energy market, irrespective of the technology it was applied to (Zhao, Tang, & Wang, 2013). This is as FiTs stop the producer from bearing the brunt

[6] In the case of Netherlands, them passing on cost of their FiT to all Taxpayers, it should be noted that over 50% of all energy used in the Netherlands from renewable sources.

of the cost, and spreads it to the consumer, the utility company that must purchase the electricity at that set rate. FiTs are also seen as the superior policy when paired with RPS policies when compared green certificates coupled with RPS policy. Mitchell et al (2006) concluded that FiTs were more effective in promoting the deployment of renewable energy as it reduces the risk of investment for generators in a more effective way, than compared with competitive bidding policies. Fagiani et al. (2013) concludes that feed-in tariffs are effective at relatively low additional costs to customers and are preferable to green certificates for the ease of implementation and lower administrative costs. Current evaluation of FiT policies in more than 60 countries show that they have positive effects in 95% of cases, along with FiTs being more generous and effective in democracies compared to autocracies. (Bayer & Urpelainen 2016). They also found that the generosity of tariffs varies across state and technology, but with OECD countries having higher FiT premiums ranging from 0.02 cents to 10.3 cents (US) per kilowatt-hour of electricity. It is also proposed that the FiT are better suited for rural constituencies due to their ability to redistribute wealth from large utilities, and this redistribution plays a role in them getting little public backlash.

Summary: Sections 1-5

The decrease in renewable energy costs, along with the worlds focus on renewable energy as a way of combating climate change, has led to the rapid growth and expansion in wind and solar photovoltaic technology. With the energy crisis of the 1970’s showing world leaders the issue of being dependent on fossil fuels for energy, alternative energy sources where invested in. This includes and is not limited to solar, wind, geothermal and nuclear energy. With the public concern that arose from nuclear disaster such as Three-mile Island and Chernobyl, and the lack of extensive investment in geothermal energy, solar and wind energy quickly became the favorite source. With increased investment it grew into becoming the commercially viable renewable source to replace coal and other fossil fuels. While the cost for solar and wind energy has dramatically fallen it remains the more expensive option when compared to fossil fuels in its production and delivery, when the market is left unaffected by taxes or subsidies. As it is seen FiTs remain the subsidy of choice for governments to promote renewable energy and increase investment across all types of renewable energy technology. FiTs are seen as both politically and economically friendly countries and remain the most effective policy in promoting Renewable energy.

Theoretical Model

The Political and Economic explanation for Variation in FiTs

In order to better understand why it is that different governments in the OECD support sustainable energy at different rates, feed-in tariffs are going to be looked at through both political and economic theories[7]. These theories have been formulated through the results of prior literature which looks at the effects of malapportionment within a country, the presence of green parties in government and their effects on renewable energy, and the economic effects of oil price volatility on the promotion of sustainable energy. This promotion of sustainable energy will be measured by the Feed-in Tariff price within countries, as a way or numerically indicating how much governments invest in renewable energy. Figure 1 displays some of the variation we see of Feed-in Tariffs for both Solar and Wind energy from the years 2000 to 2019, among OECD countries. What we see initially is that even though all these countries have a collective

[7] The OECD is the Organization for Economic Co-operation and Development. They are a group of 38 member countries that discuss and develop economic and social policy, The majority of its members are typically democratic countries that support free-market economies.

agreement to have 50% of all their power come from renewables by the year 2030, they are subsidizing them at different rates.

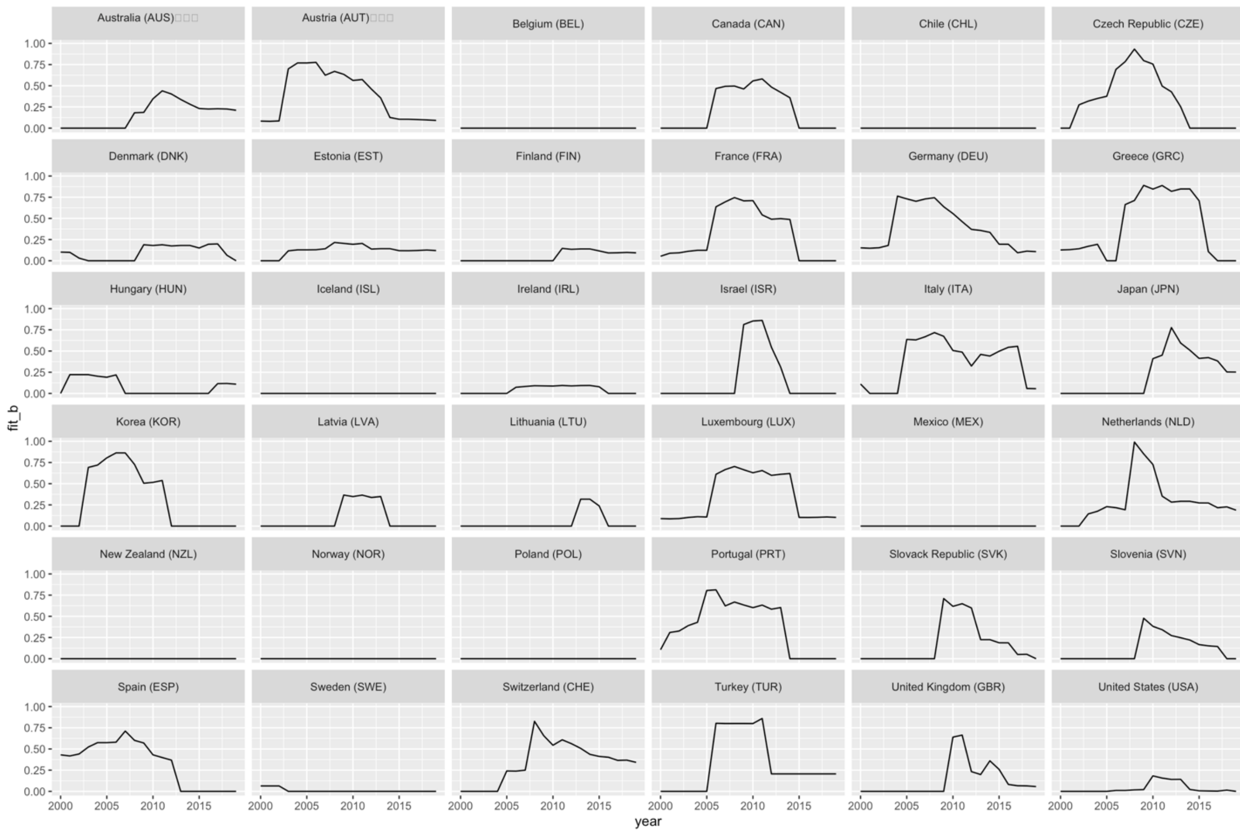

Figure 1*. Feed-in Tariff Variation over time (2000-2019), X-axis is years and Y-axis is Feed-in Tariff rate for Solar and Wind measured in U.S. Dollars (OECD Data).*

The existing literature of Bayer and Urpelainen (2016) established through their analysis of 112 countries, from 1990 to 2012, that political democratic institutions were 4.5 times more likely to adopt FiTs than autocracies. This is on top of the existing knowledge of FiTs being linked to a 64% increase in global wind and 87% increase in photovoltaic capacity (UNEP 2012). Having known this, my work looks to continue on from Bayer and Urpelainen and use a more contemporary data set that goes through 2020, with FiT data. My analysis will go beyond if a country has FiTs or not, but dive deeper into FiTs by looking to see what economic and political factors affect the presence of FiTs within countries and the amount these tariffs look to offer investors in renewable energy. I will be looking at the support for sustainable energy, measured through the average FiT price offered in a country from year to year amongst OECD countries. This is due to it being established that FiTs are arguably the best way of promoting renewable energy growth and are favorable to democratic governments. Since my data is from only OECD countries, I will be looking to better understand and dive deeper into the preliminary findings of Bayer and Urpelainen (2016). I am not looking at FiT adoption and if its dependent on if a country is democratic or not, like they did, but rather into the variation in Tariffs between OECD countries. I will also better be able to analyze the variance in FiT price, as while the countries have different attributes, they all have the same benchmark agreement to produce 50% of the power needed through renewable sources, as well as lower CO_2 emissions by 40%, by the year 2030. As for making this comparison between yearly average FiTs, many of the countries mentioned in section 5 are also OECD countries and their similar design and focus of FiT. Older research looking at the effectiveness of feed-in tariffs in their development of photovoltaic solar, Dijkgraaf et al. (2014) compared OECD FiTs and found that not only did the better the FiT price was, but the longer it was guaranteed, the greater investment in Photovoltaics.

Politics: FiTs Favor Rural Areas and the Effects of a Green party

I first develop a political theory of why governments spend more or less on FiTs. Bayer and Urpelainen (2016) state that FiTs are uniquely attractive to democratic countries, they explain how FiTs benefit rural constituencies because they encourage a decentralized power production system. This is beyond them also being the most effective single policy available to a government interested in promoting clean energy (Mendonca, 2007). As now rural areas that elect to install a wind farm or solar farm, can now take part in the energy production process, thus allowing them to reap the economic benefits of producing power. Which was once not accessible to these rural areas under the typical centralized fossil fuel dominant grids, that existed before the expansion of renewable energy. Bayer and Urpelainen also showed that while democratic institutions favor FiT implementation for both environmental and distributive reasons, the level of development, corruption, status of transitional democracy, or policy diffusion does not predict FiT adoption. With that being found, my theory looks to hone deeper in on the rural connection between FiTs and rural constituencies and their representation in government. Bayer and Urpelainen (2016) did not expect countries with large rural population to promote FiTs. This is because while generating renewable energy would benefit a vast amount of people, the cost of FiTs would also be vast. With this in mind, I will be looking at malapportionment within OECD countries, but unlike Bayer and Ureplainen, I will be studying its effects on FiT levels. While FiTs can further promote renewable energy, which offers a multitude of benefits. It has been seen that urban populations are less likely to see economic benefits in from producing renewable energy due to FiTs. This is due to the simple fact that renewable energy production through wind or solar power is less feasible in urban areas due to the resources like land they take up. But while urban areas may not see the production benefits that does not hinder rural populations form reaping the rewards. The urban population will better distribute the costs of sustaining FiTs, while rural populations that produce renewable energy will benefit from the incentives. With knowing this malapportionment becomes a point of focus. Malapportionment comes from the creation of electoral districts that differ in how many people they represent. If one district of 10,000 voters is represented by a single individual, and another district of 100,000 voters is represented by a single individual, this is malapportionment. The district with 10,000 is seen to have more political clout as they still receive one vote, the same as the district with 100,000 voters, thus the greater the malapportionment score. The more political clout rural constituents have is due to malapportionment. This greater level of malapportionment is likely to possibly allow for more FiTs policies to be implemented. If there is a statistically significant connection between rural constituencies and FiTs, I theorize *that the larger the malapportionment score of a country, which provides rural voters representative power, than urban voters, the higher the average FiT price will*.

Looking beyond the theorized relationship between rural constituencies and FiTs the effects of Green parties on FiTs could also be used to explain some of the variance we see in FiT price among OECD countries. This is as green parties generally believe that environmental protection is of supreme importance to the sustainable development of humans and all other animals. They look to tackle the issue of climate change and end the climate crisis through the replacement of fossil fuels with renewable energy. They aim to do this by making renewable energy cheaper and universally accessible to everyone. This is in line with the policy of FiTs, as they not only look to drive down the cost of turning to renewable energy through financial subsidies but also expand the number of producers of electricity to include communities beyond the centralized grid. This means expanding the ability to use and produce renewable energy to a wider audience. An audience that without FiTs would not be a part of the renewable energy production process. A presence of green parties would equate to more voice in government wanting policies that put the protection of the environment front and center. This would include energy policies such as FiTs, as they help with the expansion of renewable energy as an alternate to expanding the use of fossil fuels.

Focusing on the presence of green parties, Neumayer (2013) found in an analysis of 21 OECD countries from 1980 to 1999 that the presence of green or left libertarian parliamentary strength is associated with statistically significant lower levels of air pollutants across the board. Indicating that the rise of a green/left-libertarian parties in western democracies does have an effect on pollution levels. When measured, Neumayer (2013) found that one percentage point increase in share of legislative seats is associated with reduction in per capita pollutions levels of 0.7 percent (CO_2), 5 percent (SO_2), 1.3 percent (NO_2, CO) and 1.9 percent (VOC)[8]. Using these results and the understanding of the main environmental pillar of green parties, *I theorize that the greater the presence of a green party in a country, represented in parliament, than the greater mean FiT price for that country*, thus further explaining some of the variance seen between FiT prices among OECD countries.

Economics: Oil Cost and FiTS

Second, I develop a set of economic explanations for FiT levels. As first highlighted by the oil crisis of 1970s, most of the world relies heavily on the production and consumption of oil. With there being volatility in the energy market as a whole, countries have turned to renewables as a way of decreasing some of the volatility their economies face. Murshed and Tanha (2021) have seen that as oil prices rise the consumption of oil decreases and as result of the substitution effect, renewable energy increases. They estimate through their regression that from a panel of 21 OECD countries, from 1980 to 2011, a 1% rise in the price of oil led to a simultaneous increase in per capita renewable energy consumption (REC) of 0.45%. This can work in tandem with the related idea that expansion into renewable energy can be seen as a way of reducing the effects of oil volatility on a country's economy. Rentschler (2013) measured the effects of oil volatility on countries' economies and renewable energy usage and found a direct relationship between the two. This implies that renewable energy can play a significant role in hedging

[8] CO_2 is known as Carbon dioxide, SO_2 as Sulfur Dioxide, NO_2, CO as Nitrogen Dioxide, VOC as Volatile Organic Compounds.

against oil price volatility, as his findings show that an increase in oil price volatility increases renewable energy usage. Looking into this more It should be noted that the IMF, from 1983 to 2011, saw oil prices strongly correlated with Coal and Natural Gas, 0.909/0.864 respectively. With these two inputs being the two other main fossil fuel sources of energy production, a rise in oil prices will also lead to a rise in the cost of these inputs. Then leading to a rise in total cost of energy. This rise in cost of energy is one that countries try to avoid through the subsidization of the energy sector regardless of source. With this being known I theorize there is a relationship between FiT prices and oil price volatility among OECD countries.

The reason for using price volatility not simply price, is because it is not necessarily the price of oil that concerns countries and their governments, it's the dramatic variation in cost, or its volatility that does. This is because if a country knows that oil is going to be cheap or expensive their economy can essentially plan around the price of oil, as long as it is constant. For example, in Europe, specifically the United Kingdom, the cost of gas, is far and away more expensive per gallon then in the United States. To plan for this car manufacturers that sell in the United Kingdom sell smaller displacement engines that are more fuel efficient. Meanwhile, some of the manufacturers that sell the same model in the United States, where gas is cheaper, tend to have larger more powerful engines, which are less fuel efficient. This is product differentiation by these companies is able to be planned when the price of oil is not as volatile. Now, when oil price is volatile, it is impossible for companies and investors to plan out into the future. Therefore, it stunts economic growth and brings volatility to the whole energy market. This, in turn, pressures governments to isolate their countries from oil price volatility. The way of doing this is by decreasing their country's dependency on oil by substituting it with renewable energy.

Feed-in Tariffs would be favored by these governments due to their effectiveness in promoting the use of sustainable energy, which can mean expanding renewable energy production as a whole. If this expansion of renewable energy was to happen, then it allows for increased substitution by countries away from oil for energy. This in turn, increases their insulation from the volatility of oil prices. As for insulation from oil price volatility, it should be acknowledged that countries are leveraged differently regarding oil and the volatility in cost. Countries with greater net exporters than importers are less likely to be susceptible to the volatility of oil prices. Therefore, this leads to the notion that countries that are net importers or become net importers of oil are more likely to favor renewable energy subsidies and thus raise FiT prices. Knowing all of this, I construct the *theory that countries that experience greater volatility in the oil price (standard deviation of oil price) and are more leveraged (net importers of oil), the higher their FiT price will be.* This is due to the government wanting to promote renewable energy, which can lead to further insulation of their country from the adverse effects of volatility of oil prices. This was an original focus of the governments that saw the initial promotion of renewable energy in the 80s. As their policymakers tried to insulate their economies and countries from the oil price volatility seen in 1973 and 1979.

Research Design

I estimate a series of regression models for feed-in tariffs of Wind, Solar, and the feed-in tariff attributed to both forms combined to test my proposed hypotheses. These will include a pooled regression, fixed effects, and random effects within and between for each of my differing dependent variables. Ultimately, I will have nine models constructed to answer my research question: Why do different Countries within the OECD support sustainable energy at different rates?

Each model was estimated using quantitative data I have collected for 36 OECD countries from 2000 to 2019, 20 years in total. This data includes the FIT rate for wind & solar for each of these countries and other variables. These include malapportionment, oil price volatility, GDP per capita, Green Party representation in government, government deficit, and more. Table 4 below shows all of the variables taken into consideration and seen in my data set.

Variable	Abbreviation	Description/Measurement	Data Source
Country	**country**	Name of the Country	OECD Data
Malapportionment	**mal**	Measure of malapportionment within a country using a measure of one-half the sum of the percentage of all seats in a district minus the percentage of the overall population belonging to that district.	(Ong et al., 2017)
Solar Photovoltaic Mean Feed-in Tariff	**fit_s**	Measured in U.S. dollars per kilowatt hour	OECD Data
Wind Mean Feed-in Tariff	**fit_w**	Measured in U.S. dollars per kilowatt hour	OECD Data
Solar & Wind Feed-in Tariff	**fit_b**	Measured in U.S. dollars per kilowatt hour	OECD Data
Renewable Energy	**re**	Measure of renewable energy as a percent of total energy	OECD Data
Electricity Generation	**electricity**	Measure of total electricity generation in a country measured in gigawatt hours	OECD Data
Crude Oil Import Prices	**oil_import**	Measured in U.S. dollars per barrell	OECD Data
Crude Oil Production	**oil_prod**	Measure of oil production in a country, measure in thousand tonne of oil equivalent (TOE)	OECD Data
Green Party Participation	**gp_part**	Percentage of seats held in parliament held by a Green Party	Database of Political Institutions
Energy Price Volatility	**energy_vol**	Measure of energy price volatility in a year by taking the standard deviation of monthly energy prices	The World Bank
Oil Price Volatility	**oil_vol**	Measure of oil price volatility in a year by taking the standard deviation of monthly oil prices	The World Bank
GDP per Capita	**gdp_cap**	Measure of gross domestic product per person within that country	OECD Data
Government Deficit	**gov_def**	Measure of a countries deficit as a percentage of gross domestic product	OECD Data
Net Importer of Oil	**net_importer**	Dummy variable on if a country is a net importer of oil or not	OECD Data

Table 4. *Variables with Units of Dataset*

My dependent variables are Solar PV Mean FiT, Wind Mean FiT, and Wind and Solar Mean FiT. Each of these variables was recorded in the OECD database and is measured in U.S. dollars per Kilo Watt of electricity. My independent variables used to construct my models were Malapportionment, which measures the disjuncture between the share of the population in an electoral district and its share of seats (Ong et al., 2017), Green party participation in

Government, as measured by the number of seats held by the green party in parliament by year and Oil price volatility, as measured by the variation in cost per barrel as measured by the world bank. Now while all my countries are homogeneous because they are OECD countries, which typically have stronger, more robust economies. I also used a series of control variables within my model to control for differences between countries. These included renewable energy as a percent of total energy. This was recorded in the OECD database to measure the percentage of renewable energy as a percentage of primary energy used in a country. Crude oil import price was also used and is measured in U.S. dollars per barrel. Crude oil production volume is also used and measured as thousand tonne of oil equivalent (TOE). GDP per capita and government deficit as a percentage of GDP was also used and measured in U.S dollars. Finally, a dummy variable of whether a country was a net importer of oil was used. This was a simple measure of if they imported more oil than they exported. These variables were all taken from the OECD database. Again, like the dependent variables, these were all recorded from 2000 to 2019 for each country.

OECD Data Sum Stats

Statistic	N	Mean	St. Dev.	Max	Min
Year	421	2,008.860	5.144	2,017	2,000
Solar Feed-in Tariff	421	0.166	0.233	1	0
Wind Feed-in Tariff	421	0.057	0.082	1	0
Both Feed-in Tariff	421	0.224	0.276	1	0
Malapportionment	421	0.042	0.032	0.164	0.000
Renewable Energy	421	13.527	11.899	51.544	0.403
Crude Oil Import Price	421	65.368	30.163	117.780	22.070
Crude Oil Production	421	28,942.980	73,819.610	472,634.900	0.000
Green Party Participartion	421	0.028	0.038	0	0
Oil Price Volatility	421	7.768	6.270	28.920	2.080
GDP per Capita	421	36,226.810	10,166.500	77,832.010	15,442.610
Government Deficit	421	-1.847	4.810	18.638	-32.124
Net Importer of Oil	421	0.914	0.280	1	0

Table 5. *Summary Statistics of Effective Dataset*

Table 5. above shows the summary stats from my constructed dataset, featuring only the effect data points used in my models. The whole dataset spans 20 years and includes close to 700 observations for each independent variable, though missing data reduce the effective sample to 421 country-year observations. As for my dependent variables, the average feed-in tariff rate is 5.7 cents and 16.6 cents per kilowatt-hour for wind and solar, respectively. For solar feed-in rates, we see a large standard deviation of 23.3 cents per kilowatt-hour, with the most considerable rate being 1 dollar per kilowatt-hour. As for oil price volatility and energy price volatility, we see large standard deviations, and both distributions are skewed left. This is expected as price volatility has a minimum bound of zero, indicating no volatility, and no set maximum bound. As for net importer of oil, this is a dummy variable measured as zero or one only. Taking this into consideration analysis of my variables spanned from 2000 to 2019 across

all 36 OECD countries used in my dataset. Each country and its FiT rate for solar, wind, and solar & wind featured 421 country-year observations that are used in each of my three models.

These variables were then constructed into three base theoretical models to try and answer my research question, each with a different dependent variable. These dependent variables are all measured in U.S. Dollars. As for all my independent and control variables, each was lagged. This was to better fit with the reality that their values from the previous year would have more of an impact on FiTS than their values of the same year. This led to the following regression equations. Each of these regressions feature lagged variables to measure the FiT rate in each country for the following year.

Equation 1. *Solar FiT Empirical Model*

$$\begin{aligned} Solar\ FiT_{it} = {} & \beta_0 + \beta_1 Malaportionment_{it-1} + \beta_2 Renewable\ Energy_{it-1} \\ & + \beta_3 Crude\ Oil\ Import\ Price_{it-1} + \beta_3 Crude\ Oil\ Production\ Volume_{it-1} \\ & + \beta_4 Green\ Party\ Participation_{it-1} + \beta_5 Oil\ Price\ Volatility_{it-1} \\ & + \beta_6 GDP\ per\ Capita_{it-1} + \beta_7 Government\ Deficit_{it-1} \\ & + \beta_8 Net\ Oil\ Importer_{it-1} + \varepsilon_{it} \end{aligned}$$

Equation 2. *Wind FiT Empirical Model*

$$\begin{aligned} Wind\ FiT_{i} = {} & \beta_0 + \beta_1 Malaportionment_{it-1} + \beta_2 Renewable\ Energy_{it-1} \\ & + \beta_3 Crude\ Oil\ Import\ Price_{it-1} + \beta_3 Crude\ Oil\ Production\ Volume_{it-1} \\ & + \beta_4 Green\ Party\ Participation_{it-1} + \beta_5 Oil\ Price\ Volatility_{it-1} \\ & + \beta_6 GDP\ per\ Capita_{it-1} + \beta_7 Government\ Deficit_{it-1} \\ & + \beta_8 Net\ Oil\ Importer_{it-1} + \varepsilon_{i} \end{aligned}$$

Equation 3. *Solar and Wind FiT Empirical Model*

$$Solar \, \& \, Wind \, FiT_i = \beta_0 + \beta_1 Malaportionment_{it-1} + \beta_2 Renewable \, Energy_{it-1} + \beta_3 Crude \, Oil \, Import \, Price_{it-1} + \beta_3 Crude \, Oil \, Production \, Volume_{it-1} + \beta_4 Green \, Party \, Participation_{it-1} + \beta_5 Oil \, Price \, Volatility_{it-1} + \beta_6 GDP \, per \, Capita_{it-1} + \beta_7 Government \, Deficit_{it-1} + \beta_8 Net \, Oil \, Importer_{it-1} + \varepsilon_i$$

Variable	Abbreviation	Expected Sign
Malapportionment	**mal**	+
Renewable Energy	**re**	+
Electricity Generation	**electricity**	+
Crude Oil Import Prices	**oil_import**	+
Crude Oil Production	**oil_prod**	-
Green Party Participation	**gp_part**	+
Energy Price Volatility	**energy_vol**	+
Oil Price Volatility	**oil_vol**	+
GDP per Capita	**gdp_cap**	+
Government Deficit	**gov_def**	-
Net Importer of Oil	**net_importer**	+

Table 6. *Summary of Expected Relationship with my dependent variables*

The predicted relationship between each of the different Feed-in Tariffs and each respective independent variable is above in table 6. Each explanatory variable will provide valuable insight into what factors affect policymakers' decisions in promoting renewable energy, specifically through feed-in tariff rate. Initial understanding of the dataset suggests all independent variables, besides two, will have a positive relationship with my dependent variables of feed-in tariff price. Crude Oil Production and Government deficit will be the only two variables with a negative relationship with my feed-in tariff price. The more oil a country produces, the more insulated they are from having to import oil at varying prices to fulfill their energy needs. As for government deficit, the more the deficit increases, the less money the government can genuinely afford to spend on policies like feed-in tariffs, thus resulting in a negative relationship with FiT price.

Estimators and Model Reasoning

I use three different estimators across my three different models. My three estimators for support of renewable energy are the Feed-in Tariff rates for Solar, Wind, Solar & Wind. The reason for doing this is to try and show the most complete picture of support for renewable energy production through Feed-in Tariffs. This is as the technology these FiTs go towards varies across each country. However, it is mainly among solar and wind technologies. Now while most countries have a mix of both solar and wind energy, their levels of installed total capacity differ. This is due to taking into consideration natural factors that will change their effectiveness. Germany for instance is better suited for wind energy due to having access to offshore sites that allow for plentiful production of wind energy. However, not all countries possess this advantage, and some may be better suited for solar energy, i.e. Spain. Therefore, their feed-in rates will differ across technology. Now while this difference can be measured using just my dependent variable that groups solar and wind rates together, it is unable to look deeper into the two specific technologies. That is why I have included an analysis of solar feed-in tariffs, and wind feed-in tariffs separately. This will allow for the analysis of support across different energy sources and will also allow for the analysis of which independent variables are robust across all three estimators.

As for the reasoning behind my three models, they are as follows. First, a pooled OLS model will allow for the analysis of variables across the 20 years in which I have collected data. This will also show preliminary findings that will be further analyzed in the following two models. Second, a fixed-effects OLS model focuses on within-country effects and addresses between-country heterogeneity. This will also allow for control of what is going on for each country over the time horizon given. This is important as while I try to control for differences between countries by using the variables I have chosen and limiting myself to the study of only OECD countries. No two countries are the same, and some differences cannot be accounted for with the variables used. If it was not for using a fixed-effects model, I would run into the issue of overestimating my model and thus finding no statistically significant results. Third, I use the Mundlak specification of a random-effects within-between model (Mundlak 1978; Bell et al. 2019) to jointly estimate within- and between-effects. This will allow the measure of my variables and their effects on FiT price both within and between countries. This will allow for the differentiation of factors that go into policymakers' decisions for individual countries at the national level and broader factors that may be considered at the international level.

Results

Table 7. *Regression Results for Solar Feed-in Tariffs*

Models For Solar Feed-in Tariffs

	Pooled Regression			**Fixed Effects**			**Random Effects Within & Between**		
Predictors	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*
Intercept	1.68041	0.49528	**0.001**				2.19863	2.29914	0.340
Malapportionment	0.53831	0.38064	0.158						
Renewable Energy	-0.00251	0.00113	**0.028**						
Crude Oil Import Price	0.00067	0.00043	0.118						
Crude Oil Production	-0.00000	0.00000	0.099						
Green Party Participation	0.16986	0.35294	0.631						
Oil Price Volatility	0.00613	0.00184	**0.001**						
GDP per Capita	-0.15078	0.04751	**0.002**						
Government Deficit	-0.00848	0.00278	**0.002**						
Net Importer of Oil	-0.03258	0.04603	0.479						
Renewable Energy (within)				-0.01532	0.00375	**<0.001**	-0.01530	0.00374	**<0.001**
Crude Oil Import Price (within)				0.00105	0.00039	**0.008**	0.00105	0.00039	**0.008**
Crude Oil Production (within)				0.00000	0.00000	0.905	0.00000	0.00000	0.904
GDP per Capita (within)				-0.05725	0.07400	0.440	-0.05725	0.07387	0.439
Government Deficit (within)				-0.01147	0.00304	**<0.001**	-0.01151	0.00303	**<0.001**
Oil Price Volatility (within)				0.00557	0.00159	**0.001**	0.00557	0.00158	**<0.001**
Green Party Participation (within)				0.50385	0.72934	0.490	0.50082	0.72794	0.492
Malapportionment (between)							0.79103	1.34128	0.556
Oil Price Volatility (between)							0.06270	0.10566	0.553
Green Party Participation (between)							-0.13096	1.22305	0.915
Renewable Energy (between)							-0.00177	0.00387	0.648
Crude Oil Import Price (between)							-0.01491	0.01115	0.182
GDP per Capita (between)							-0.14761	0.19811	0.457
Government Deficit (between)							-0.00621	0.01378	0.652
Net Importer of Oil (between)							-0.00237	0.14458	0.987
Crude Oil Production (between)							-0.00000	0.00000	0.297
Random Effects									
σ^2							0.03		
τ_{00}							0.03 country		
τ_{11}							0.00 country.year		
ρ_{01}							-1.00 country		
N				25 country			25 country		
Observations	421			421			421		
R^2 / R^2 adjusted	0.183 / 0.165			NA			0.170 / 0.585		

***Table 8**. Regression Results for Wind Feed-in Tariffs*

Models For Wind Feed-in Tariffs

	Pooled Regression			**Fixed Effects**			**Random Effects Within & Between**		
Predictors	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*
Intercept	0.23983	0.16348	0.143				0.72596	0.79502	0.362
Malapportionment	0.45908	0.12564	**<0.001**						
Renewable Energy	-0.00052	0.00037	0.168						
Crude Oil Import Price	0.00044	0.00014	**0.002**						
Crude Oil Production	-0.00000	0.00000	0.261						
Green Party Participation	0.26303	0.11650	**0.024**						
Oil Price Volatility	-0.00003	0.00061	0.962						
GDP per Capita	-0.02163	0.01568	0.168						
Government Deficit	-0.00351	0.00092	**<0.001**						
Net Importer of Oil	-0.01066	0.01519	0.483						
Renewable Energy (within)				0.00320	0.00126	**0.011**	0.00315	0.00130	**0.016**
Crude Oil Import Price (within)				0.00044	0.00013	**0.001**	0.00043	0.00013	**0.001**
Crude Oil Production (within)				-0.00000	0.00000	0.371	-0.00000	0.00000	0.347
GDP per Capita (within)				-0.07972	0.02487	**0.001**	-0.07909	0.02571	**0.002**
Government Deficit (within)				-0.00391	0.00102	**<0.001**	-0.00401	0.00101	**<0.001**
Oil Price Volatility (within)				0.00028	0.00053	0.597	0.00030	0.00052	0.565
Green Party Participation (within)				-0.19251	0.24513	0.433	-0.16638	0.24401	0.496
Malapportionment (between)							0.75117	0.45881	0.102
Oil Price Volatility (between)							-0.03321	0.03686	0.368
Green Party Participation (between)							0.35981	0.41808	0.390
Renewable Energy (between)							-0.00074	0.00132	0.575
Crude Oil Import Price (between)							0.00405	0.00390	0.300
GDP per Capita (between)							-0.06711	0.06864	0.329
Government Deficit (between)							-0.00177	0.00472	0.708
Net Importer of Oil (between)							-0.01317	0.04921	0.789
Crude Oil Production (between)							0.00000	0.00000	0.887
Random Effects									
σ^2							0.00		
τ_{00}							7.53 $_{country}$		
τ_{11}							0.00 $_{country.year}$		
ρ_{01}							-1.00 $_{country}$		
N				25 $_{country}$			25 $_{country}$		
Observations	421			421			421		
R^2 / R^2 adjusted	0.165 / 0.146			NA			0.000 / 1.000		

Table 9. *Regression Results for Solar & Wind Feed-in Tariffs*

Models For Solar & Wind Feed-in Tariffs

	Pooled Regression			**Fixed Effects**			**Random Effects Within & Between**		
Predictors	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*
Intercept	1.92024	0.57015	**0.001**				2.16158	2.67800	0.420
Malapportionment	0.99739	0.43819	**0.023**						
Renewable Energy	-0.00303	0.00131	**0.021**						
Crude Oil Import Price	0.00111	0.00049	**0.025**						
Crude Oil Production	-0.00000	0.00000	0.079						
Green Party Participation	0.43289	0.40630	0.287						
Oil Price Volatility	0.00610	0.00212	**0.004**						
GDP per Capita	-0.17242	0.05469	**0.002**						
Government Deficit	-0.01199	0.00320	**<0.001**						
Net Importer of Oil	-0.04324	0.05299	0.415						
Renewable Energy (within)				-0.01211	0.00432	**0.005**	-0.01210	0.00432	**0.005**
Crude Oil Import Price (within)				0.00149	0.00045	**0.001**	0.00149	0.00045	**0.001**
Crude Oil Production (within)				-0.00000	0.00000	0.875	-0.00000	0.00000	0.875
GDP per Capita (within)				-0.13698	0.08514	0.108	-0.13697	0.08516	0.109
Government Deficit (within)				-0.01539	0.00350	**<0.001**	-0.01541	0.00350	**<0.001**
Oil Price Volatility (within)				0.00585	0.00183	**0.001**	0.00585	0.00183	**0.001**
Green Party Participation (within)				0.31134	0.83908	0.711	0.31032	0.83924	0.712
Malapportionment (between)							1.26412	1.56280	0.419
Oil Price Volatility (between)							0.03407	0.12304	0.782
Green Party Participation (between)							0.21587	1.42533	0.880
Renewable Energy (between)							-0.00270	0.00451	0.550
Crude Oil Import Price (between)							-0.00995	0.01299	0.444
GDP per Capita (between)							-0.14978	0.23074	0.517
Government Deficit (between)							-0.00927	0.01605	0.564
Net Importer of Oil (between)							-0.01035	0.16850	0.951
Crude Oil Production (between)							-0.00000	0.00000	0.364
Random Effects									
σ^2							0.04		
τ_{00}							0.00_{country}		
τ_{11}							$0.00_{\text{country.year}}$		
ρ_{01}									
N				25_{country}			25_{country}		
Observations	421			421			421		
R^2 / R^2 adjusted	0.215 / 0.198			NA			0.299 / NA		

Overview of Findings

Tables 7,8, and 9 above display the results for each of my nine equations grouped by the various dependent variable of what kind of Feed-in Tariff price was measured. Looking at the results for both wind and solar feed-in tariffs, we see that across all three different models, the amount of renewable energy as a percent of total energy, oil price volatility within a country, and government deficit within a country all yield statistically significant coefficients with a p-value less than 0.05. As for my other independent variable of malapportionment and measurement of Green parties in government, we see no statistical evidence to suggest that they affect FiT rates within or between countries. The only exception to this was in the pooled regression of wind feed-in tariffs. We saw the percentage of Green party participation in government-held significance in estimating my model. All other variables yielded no other significance. As for the Mundlak model, the listed coefficients measuring within-country differences were the only ones seen to be significant; there were no significant variables between countries.

Looking at table 7 with the dependent variable of solar FiTs, the pooled OLS regression has significance among the malapportionment, renewable energy, crude oil import prices, oil price volatility, GDP per Capita, and government deficit. All significant variables yielded p-values less than 0.05. However, when controlling for country with a fixed-effects model, and using the random effects within and between model, we see the number of significant variables decrease. These are the variables for renewable energy, crude oil import price, oil price volatility, and government deficit. This is a more reliable representation when controlling for country, as each county's government has its own autonomy when it comes to evaluating what will affect its renewable energy policies. Acknowledging this we see that while all countries are different, some of the same factors may be taken into consideration by policymakers within those countries.

Looking at Table 8, we see much of the same results for the dependent variable wind FiT, as we do with solar FiT. The only differences arise in the pooled model, in which the renewable energy variable, oil price volatility variable, and GDP per capita variable are seen to be insignificant. However, when controlling for the country within my following regression models they become significant with p-values less than 0.05. When controlling for country and evaluating if the effect is within or between countries, we yield consistent results. This is seen again in table 9 which uses the dependent variable solar and wind FiTs. This shows regression results with oil price volatility, government deficit, renewable energy, and crude oil import price all being significant in my model with p-values less than 0.05. This consistency among results indicates these factors are just some of what is valuable to policymakers when deciding support for renewable energy. As a whole we see the same factors come into consideration both across technology and country when evaluating FiT rate.

Results for political explanations for FiTs

The coefficient for malapportionment and Green party participation in government yielded no significant findings. My models show there is no consistent evidence to suggest the results of Bayer & Ureplainen (2016) that countries with greater malapportionment support renewable energy and FiTs at higher rates. This was because FiTs disproportionately favored rural communities. After all, they now allow rural areas to join in on energy production. However, my results show no support for their original findings. This may be a development of my model, which looked to feature more current data and holds other variables that may have been overlooked when estimating their original model. I also measured the effect on the feed-in tariff rate, not just if the country adopted a feed-in tariff.

As for the relationship between Green parties' participation in government and feed-in tariffs, we see no evidence to suggest any relationship between the two. This could be attributed to green parties making up a tiny portion of a country's legislature. Out of my data spanning 36 countries over 20 years, only one country, Iceland, had Green party participation above 30 percent of total seats in the legislature. Many other countries typically had less than 10 percent or none at all. This limited role we have seen by Green parties in governmental decisions could explain why we see no relationship between Green parties and renewable energy support, specifically feed-in tariffs. They simply don't have enough political clout in parliamentary decisions. The reason for this can be explained by looking at multi-party systems.

While all of the countries I studied were democratic, most were also multi-party systems. This means that usually, no single party has a parliament majority by itself. This is different from the United States' two-party system, where one single party can have a majority by itself. However, to avoid political gridlock in multi-party systems, multiple parties are forced to form compromised coalitions to develop power blocks and obtain legitimate mandate in government. Therefore, two things should be considered. First, if the Green party is not in the block with control, it will have no voice in creating policies that would increase FiT rates or promote renewable energy. Secondly, most green parties in countries have high turnover rates on their seats in government. One election cycle, they may have a seat in government, and come to the next cycle, they don't. This stops them from holding any weight to their name that would make them more attractive in forming a coalition with, especially if they might not be represented at all in the next election cycle.

Results for economic explanations of FiTs

Looking first at the variable measuring already installed renewable energy production, we see an inverse relationship between FiT rate and renewable energy as a percent of total energy. We see that every one percentage point more of renewable energy as a percentage of the total energy produced within a country in the previous year will correspond with a 0.02 dollar decrease in FiT rate for solar the following year. This would make sense and support much of the literature and results we see in the real world. As a country's volume of renewable power increases less, subsidies are needed to promote the growth of renewable energy. This can be for one of two main reasons.

Firstly, many countries have a goal of how much renewable energy they want to produce. Hence, as they approach their goal with more renewable energy production, the less likely they are going to keep subsidizing at the same rate. The reason for this can be explained by scarcity. As we know from above, these types of subsidies require a large amount of capital. This is either financed directly by taxpayers or energy users or indirectly through government coffers, all of which have a finite amount. Therefore, it makes no sense to continue subsidizing projects at the same rate because as goals become closer to being met, they must continue to allocate resources efficiently.

Secondly is the concept of economies of scale. As the percentage of renewable energy increases, fewer subsidies are needed to entice more renewable energy producers. This is because as solar technology is used more and more and more and more solar panels are being made, the cost of producing and installing each panel decreases. The same goes for the infrastructure to handle solar energy. Once it’s in place, it is only needed to be expanded and updated, which costs less than the initial installation in the first place. Therefore, to be allocatively efficient, governments can subsidize more renewable energy less because if done right, firms will still enter the market and reap a similar incentive. This is because, even though the paid-out incentive of the FiT is less than it was before, the costs are also less, which in turn leaves the economic incentive of producing renewable energy unchanged.

As for the variable measuring government deficit being statistically significant, we see an inverse relationship between it and the FiT rate. This can be explained since subsidies like FiTs cost money, and the more debt a country has, the less money it can afford to spend on programs like promoting cleaner, greener energy. In both my fixed effects and random effects within and between models, we see an estimated coefficient of -0.01151. This means that for every one percentage point increase in government deficit as a percentage of GDP in the previous year, we will see a 0.01 dollar decrease in FiT rate for solar the following year. In other words, for every one percentage point increase in government deficit as a percentage of GDP in the previous year, we will see an 8.33% percent decrease in the mean FiT rate when assuming the average rate is 12 cents.

As for the variable oil price volatility, this was the only independent variable in my theoretical model to produce any statistically significant findings. With a coefficient of 0.0557 and a p-value less than 0.05, we see that every dollar increase in price per barrel in the previous year will increase the FiT rate for solar by 0.01 dollars in the following year. This result supports my theoretical economic model concerning FiTs that as the price and volatility of oil increase, so will FiT rates. This increase in FiT rate may then lead to possible expansion in capacity installed. This can then reinforce why governments choose to invest in renewable energy.

As explained previously, renewable energy was seen as a way for governments to isolate their countries from the issues caused by their dependence on oil and the volatility that came with it. After the oil crisis of 1973 and 1979, governments needed to make their countries less dependent on fossil fuels, which caused the investment in renewable technology such as wind and solar. With the results seen in my models, we have evidence to suggest that the same relationship still exists between oil volatility and government support for the promotion of renewable energy, but this time through the specific use of FiTs. This relationship is further supported through all my other models even when the dependent variable for what type of FiT is changed. This indicates that the relationship exists for renewable energy in general, rather than just solar energy. A summary of my findings and whether they supported my hypotheses can be seen in table 10. Some coefficients show they support my hypotheses but not at a level that would be seen as statistically significant.

Variable	Abbreviation	Expected Sign	Supported
Malapportionment	**mal**	+	No
Renewable Energy	**re**	+	Yes
Electricity Generation	**electricity**	+	Yes
Crude Oil Import Prices	**oil_import**	+	**Yes**
Crude Oil Production	**oil_prod**	-	**Yes**
Green Party Participation	**gp_part**	+	Yes
Energy Price Volatility	**energy_vol**	+	Yes
Oil Price Volatility	**oil_vol**	+	**Yes**
GDP per Capita	**gdp_cap**	+	No
Government Deficit	**gov_def**	-	**Yes**
Net Importer of Oil	**net_importer**	+	No

Table 10. *Summary of support for the expected relationship between my independent and dependent variables using results from my Random Effects Within and Between models. All variables with statistically significant support are bolded and are supported from the within variable only, not between.*

Broader Implication of Findings

My findings from all nine models, using three different dependent variables, suggest that the only statistically significant indicator and explanation for why OECD countries differ in their support for sustainable energy is oil price volatility. If this is the case, this would indicate and provide evidence to suggest that the relationship between the amount of the FiT rate, to promote renewable energy, in the hopes of possible increasing its production, is not in correspondence with government focus on the environment or government representation in general. But more focused on the price volatility of Oil. If that is the case, then there remains the fact that the push for renewable energy was born purely to isolate countries' economies away from the volatility of oil. Therefore, reaffirming the fundamental relationship between renewable energy promotion and oil price volatility has not changed since the initial push for renewable energy 50 years ago with the first energy crisis.

If this relationship still exists, we see that both OECD renewable energy goals and the United Nation's goals could be subject to being met, all dependent on oil price volatility. This would mean that the economic impact of oil and its price outweigh all decision-making factors concerning promoting renewable energy on the world stage. As oil price fluctuates more, governments choose to subsidize out of oil and into other energy forms, such as renewables, to reduce volatility in the energy market. Should this be the case, the effects of the Russian invasion of Ukraine and the subsequent shockwave it sent into the oil market, as seen in 2022, may become an indicator for more renewable energy promotion in the years to come.

The Green parties' policies are centered around saving the environment and ending global warming. But to do that on the international scale, they need more political clout across many countries. Green parties across the globe are very much minor players in government. Like in the United States, they have relatively little support from voters due to the lack of power in government and affecting decisions. Until their platform expands, they will continue to have little lasting impact on passing legislature and policies that will aid in truly ending global warming. Until then, we will see oil and its effects on government coffers dictate the majority of policies for governments promoting renewable energy.

Renewable Energy Success: Germany

To illustrate the quantitative findings, this thesis turns to a brief discussion of the case of Germany. There is no getting around that Germany sits as one of the world leaders when using renewable energy on a massive scale. As of 2019, 40.9% of all energy produced in Germany came from renewable sources (BDEW, 2021), with a 2030 target of 80% down the road. Of this 40.9% of renewable energy in Germany, the majority comes from wind energy. As of 2002, Germany accounted for close to 40% of installed world wind capacity. This was due to an early government focus on renewable policy and a shifting public opinion, and the presence of a politically strong green party.

The Oil crisis of 1973 demonstrated to the German government its dependence on fossil fuel and energy imports and its consequence. This fundamentally transformed the German energy policy from limited intervention to protect coal companies and their employees to active management to secure a low-cost energy supply (Renn & Marshall, 2016). At roughly the same time in 1974, the controversy behind nuclear energy hit its peak. This stemmed from the birth of Germany's green party in the federal government in 1998, which grew from the anti-nuclear movement in 1980 (Wustenhagen & Bilharz, 2006). This later led to the commissioning of government projects to develop wind turbine technology which later grew to commercial offshore wind projects in the North Sea. This was all due to German citizens seeing that renewables would play a more critical role in energy production and the German government. After the two-world energy crisis, the German government's spending on energy production R&D became more diversified. This led to nearly 80% of nuclear R&D funding being shifted to focusing on renewables. This financing shift ultimately allowed for a whole new market in the German economy to develop. Over 120,000 jobs were seen to have been created in the development of an 8.2 billion Euro revenue-generating market for renewables.

During this same time, Germany saw more and more policies being passed to promote renewable energy. Among them was the "100 MW wind" program. This effectively introduced the first feed-in tariff as it featured a production incentive of 3-euro cents per kilowatt-hour of energy produced. This program was later expanded to 250 megawatts, just as more feed-in tariffs became available under the Feed-in Law (StrEG) of 1991. Following this, solar energy was then a point of specific focus and, for the first time, became commercially viable as a source of power. From this growth of renewables and the Feed-in Law came the new Renewable Energy Act (EGG). This ended up becoming the groundwork for all Feed-in tariffs to follow. It featured a purchase obligation for the local grid obligator, guaranteed minimum prices for electricity, and a nationwide cost settlement system to balance out regional disparities in energy price. This later led to long-term pricing agreements and a regressive tariff we see in most other FiTs today. This provided a more stable foundation for investors to invest in and to account for economies of scale as these renewable energy projects expanded.

This has allowed Germany to become a world leader in renewable energy and a catalyst for other counties to follow. Germany’s investment saw renewable energy prices fall by 60% by 2002 (Wustenhagen & Bilharz, 2006) and growth in the renewable energy production sector in the world economy. Their policies paved the way for other countries' FiTs and demonstrated their extreme effectiveness of them. Even as of 2019, Germany remains one of the prominent leaders in the growth of renewables, with more installed capacity than any other European country besides the Nordic countries. Germany's case proves that a shift away from fossil fuels is possible and remains economically viable.

Conclusion

The objective of this thesis was to analyze why different countries in the OECD supported renewable energy at different rates. Looking at the results of my theorized model, oil price volatility remains the main reason countries have different levels of support. We see no results to indicate that Green party participation in government and levels of malapportionment have any relationship to the feed-in tariff. This contrasts with Bayer and Ureplainen (2016), which this paper took its original inspiration from. Their findings didn’t consider the significance of oil price volatility, which was the main reason for sustainable energy promotion in the first place. However, their paper focused on measuring feed-in tariff adoption, not the feed-in tariff rate. As for the relationship between oil price volatility and the promotion of renewables, this dates back to the oil crisis of 1973, which displayed the consequences of countries that were too heavily dependent on oil and not adequately insulated from its price volatility. While Green party participation in government and malapportionment show no statistically strong evidence of having a relationship with FiT rate, the theory behind their inclusion is solid, as evidenced in other work used to define my theory.

As for the reasoning behind including some of the variables in this paper, each was carefully thought-out and backed by solid evidence to be included and ultimately valid. First comes how to measure support for sustainable energy. Over the course of this study, there were proven to be many different ways of measuring support for sustainable energy, as many different policies have been made to do so. However, to measure support over various countries more accurately, the feed-in tariff price was decided on. This was due to the two main factors of them being the most effective policy choice by governments and also the most widely adopted. As for what countries to measure, this also proved challenging. OECD countries were chosen due to limiting some significant differences between other countries, like government regime, and finding a large enough sample size to conduct this study. This also allowed the measurement of a homogenous group of countries having the same collective renewable energy goal and target year. By using OECD countries, data collection and measurement for feed-in tariff rate was the same across all countries, which allows for better measurement of the relationship between my dependent and independent variables. It also provided access to a comprehensive and reliable source of other data points that are constantly measured by the OECD, World Bank, and International Monetary Fund. This allowed for the creation of a vast dataset with reliable data on which to conduct my analysis. However, with this being said, a future improvement to this paper could include differently defined models by way of measuring green party ideation in government, not just green party participation.

Undertaking this study allowed for a more in-depth understanding of renewable energies and the policies used to promote them. While there are many different forms of policy and renewable energy, there are clear favorites across all governments worldwide. Wind and solar energy are widely viewed as the two only commercially viable options for renewable energy at this moment in time. This is due to cost and infrastructure requirements and the advances in their technology. As for renewable energy policy, feed-in tariffs have been and remain the clear favorite. This is because they are sustainable and production-driven. They allow economies of scale to eventually phase them out after initially starting the investment into renewable energy. They provided not only capital but stability, enabling investors to garner a favorable return on investment, which allows for more significant investment into renewable energy. As for the environment and its relationship with the promotion of sustainable energy, this paper suggests that conservation of the environment and subsequent end to global warming is only coincidently connected to renewable energy support. Oil price volatility and governments' desire to insulate their countries from this volatility are the main reasons for promoting renewable energy.

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