Policy Mix for Emissions Reduction and Renewables Development

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Concerns about global warming and climate change have led countries in the world to adopt various policy schemes for reducing national carbon footprint. As the source of two-thirds of global GHG emissions, the energy sector (including energy production and use) has been at the core of efforts. Governments at different levels apply a mix of policies to reduce GHG emissions from the power industry and significantly expand the use of carbon-free renewable sources. Born out of comprehensive considerations between social, political, legal, and administrative factors, the mechanism for each scheme varies and usually has a different approach or target group. In this write-up, we will briefly review several effective schemes adopted by world governments and see how those policy instruments differ from each other.

Carbon emissions reduction

As climate policy emerged in the 1990s, market-based tools tailored to reduce carbon emission dominated. This reflects the emphasis of the Kyoto Protocol on "market mechanisms", which treats emissions as tradable products between countries or companies. Essentially, counterparties can sell excess emit rights to those who need to buy in for making up shortfall over emissions allowance cap, and this process is called **Emission trading**, or cap and trade. Depending on the cap restriction, the net pollution emit-

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ted to the atmosphere stays still, however, trading allows more flexibility for companies to balance the tradeoff between operating activities and climate investments – having the opportunity to buy allowances in the short or medium run enable a more elaborate emissions-cutting plan. Holistically, under a moderate emissions cap, polluters will implement mitigation measures until the marginal cost of reducing one more unit of GHG emissions is higher than buying one unit of allowance. Therefore, the system will force counterparties to carry out the cheapest mitigation options to guarantee the most cost-effective path for reaching carbon-reduction goals. However, several design flaws can limit the effectiveness of this scheme: emission caps need to be neither too tight nor too loose to facilitate significant and effective reduction; lack of transaction transparency may fail to ensure additionality of emission reductions; initial allocation of allowances assigned to regulated entities should not be too generous... Many sizeable trading systems have involved during the last two decades and made important strides in developing straightforward solutions to these concerns. The best-known pioneer system is the European Union Emission Trading System (EU ETS) created in 2005. Operating in 31 countries of the European Economic Area, UE UTS caps around 45% of the EU's total GHG emissions, mostly from power generators, energy-intensive manufacturing industry, and aircraft operators. Other large systems include U.S. Regional Greenhouse Gas Initiative (RGGI), New Zealand Emissions Trading Scheme (NZ ETS), and the newly launched, also the largest, China national ETS. Build on the tradition of "learning-by-doing", ETSs around the world continuously reform to introduce new design features and have emphasized its role as a key climate policy instrument in carbon reductions.

Tradable pollution permits are usually grouped with another market-based instruments: **Carbon tax**. By putting a price on emissions, a carbon tax can directly incentivize the lowest-cost reductions and encourage the development of innovative low-carbon technologies. Compared to the emission trading system, where emission allowance price is determined by supply and demand, carbon tax provides a stable price, so companies can avoid volatility in regulatory costs. Besides, while emission trading does not necessarily encourage additional reductions below cap restriction, the carbon tax is a constant price signal that inspires emitters to continuously cut emissions for reducing tax expense. But the disadvantage of carbon tax is that it can be difficult to quantify how much the tax should exactly be – after all it's a measure of virtual environmental externalities. Too low a carbon tax will fail to encourage substantial emission-cutting, while a higher carbon price can become a cost burden for companies and reduce investment level and economic growth. Besides, firms may shift production to countries without a carbon tax

to escape tax expenses, leading to severe pollution outsourcing. Nevertheless, economists generally argue carbon tax to be the most efficient and effective way of combating climate change, as long as it's in a well-functioned market. Leading by Sweden, which by far levies the highest carbon tax in the world, 25 countries around the world have proposed to implement a carbon tax to decrease GHG emissions.

Other non-market-based instruments for cutting carbon emissions also include explicit obligations to use "**Best available technique**" (BAT). Under such a scheme, counterparties need to use the available technology that is best for diminishing emissions during new installation, operations, and maintenance. The U.S. and the European Commission all released similar regulations to restrict constructions of new factories or power plants.

1 Renewable Energy deployment

We have seen a range of policies helping to reduce worldwide greenhouse gas emissions from the energy sector. While those were enacted explicitly to address climate change, others have reached the goal through a complementary way – supporting generators of preferred clean energy sources. Many countries have adopted various policy tools to promote renewable energy and technology development to curb carbon emissions since the 1990s. In 2015, 55 countries of 117 Nationally Determined Contributions (NDCs) submitted from the Paris Agreement officially pledged to include targets for increasing renewable energy through a mix of policy schemes. These instruments aim at reinventing various aspects of the energy system, including power generation, transportation, building heating and cooling. All have played a vital role in increasing the uptake of renewables across the world.

Generally, policy schemes related to renewable energy can be divided into investment-based and production-based. The former is associated with direct public funds to renewable projects from grants or loans, while the latter may be linked to physical electricity generated by power plants. Production-based instruments can be further classified as quantity-based and price-based. With such broad classifications, deployment schemes and subsidies come in various options, as we will discuss in the following.

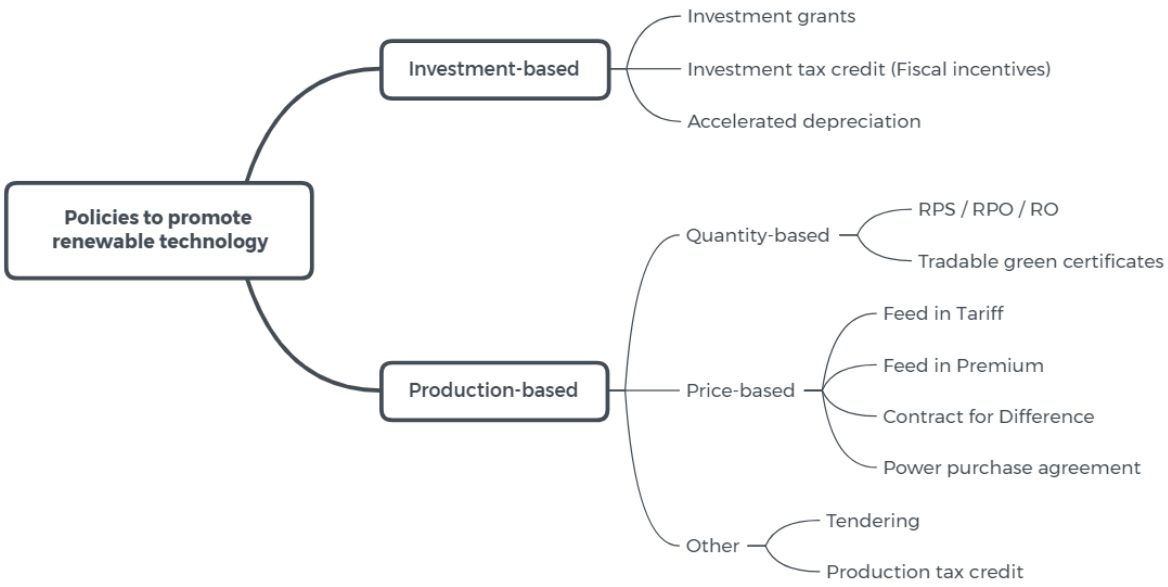

Figure 1: Key supporting policies divided by function

1.1 Investment-based scheme

Investment tax incentive is a common way used by world governments to encourage active capital spending on renewable energy. Issuing **Investment grants** is one way to explicitly direct financial subsidies for covering some of the huge upfront costs of setting up renewable projects. This can be calculated as either a percentage of total construction costs or a specific amount per MW capacity of the project. For instance, China launched the "Golden Sun Project" in 2009 to promote the large-scale development of the photovoltaic power generation industry. 50% of the total investments were subsidized directly by the government. By the end of 2012, installed PV capacity of the Golden Sun Project has exceeded 6 GW. **Investment tax credit (ITC)**, used extensively in the United States, provides another dollar-for-dollar reduction to stimulate renewable activities. But different from direct subsidies, tax credit takes the form of a rebate that mitigates investor's state or federal tax liability. For example, the U.S. government offers an investment credit of 30% for investments in both residential and commercial solar projects, so businesses can take advantage of these credits to enjoy lower-than-normal tax payable. Small businesses that do not have enough tax liability to benefit from the full amount of tax credits can also use the credits to raise financing from a third-party

investor. Since first implemented in 2006, solar ITC has helped the U.S. solar industry to grow by more than 10,000%. The same scheme is included in broad **Fiscal incentives** in the EU. In addition to two above schemes, renewable energy generators in some countries are politically allowed to depreciate equipment at a higher rate, which is called **Accelerated depreciation** (AD). This benefits investors in that taxable income after deduction of depreciation cost is lower when adopting a higher-than-normal depreciation rate. Therefore, tax payable for generators is mitigated. A case in point is India's experience with wind energy: early in the 1990s, India implemented a policy to provide 100% depreciation option in the first operating year of new wind projects, leading to a wind power boom in the country. In 2014, the incentive was raised again and has stimulated another surge in its wind energy development. All such investment incentives, though taking different forms of tax liability or tax payable deduction, have helped to channel significant capitals to renewable energy projects.

1.2 Production-based scheme

1.2.1 Quantity-based scheme

From the perspective of total renewable generation quantity, one of the most effective policy instruments is to mandate electric providers to include certain amount of electricity from renewable energy sources as a percentage of the total electricity delivered to customers. Creating such a compulsory target is useful as it deterministically includes renewable resources into a country or state's electricity portfolio, so a fixed amount of renewable generation is ensured to be dispatched. Besides, the mandatory period is usually planned on a sufficient duration, which allows for long-term financing or contracting with renewable projects. While setting a mandatory target, it can also be ramped up steadily over time to strengthen stimulation. These all guarantee that investors can have secured returns in the long run and therefore are more encouraged to deploy carbon-free energies. Some form of third-party entities will regulate the whole process to ensure obligations are met, otherwise, penalties will be levied on energy suppliers for missing compliance targets. However, one disadvantage of adopting such an instrument is that adding new technologies or procurement can incur increased electricity costs in the near term, which typically will be passed to customers. Additionally, the amount of obligation should also be set properly to effectively encourages the adoption of cleaner electricity generation technologies. Nonetheless, this type of scheme has been adopted in several countries, though with different terminologies: the mandatory target is termed as "**Renewable**

Portfolio Standard" (RPS) in the United States, is called "Renewable Purchase Obligation" (RPO) or "Renewables Obligation" (RO) in India or the UK, respectively, and is named "Quota Obligation" in European countries. Out of considerations regarding resource availability and political factors, the same scheme in each region may have slightly different definitions on eligible resources, penalty fines, and how exactly the standard is defined – the mandatory percentage can be in terms of total electricity production or capacity the providers need to supply. Nevertheless, it has been one key driver for renewable generation growth in the world. In the US, RPS alone has constituted roughly half of total renewable growth since the early 2000s.

Despite the minor difference in policy design, the mandatory renewable targets are generally complemented by a framework of **Tradable green certificates** (also called Renewable Energy Credit or Renewable Obligation Certificate), which represent all the positive environmental attributes corresponding to 1 MWh of renewable energy generated. Under such a framework, electricity providers can buy green certificates instead of physical electricity from renewable power plants to meet its mandatory target. This means that transmission or distribution constraints during real electricity procurement are not considered anymore. Therefore, quotas can be fulfilled more cost-effectively – the cost of procurement, i.e. the price of green certificate, is determined by the market force, and each supplier has strong incentives to choose the most economical way to meet obligations. This also improves the individual RPS or RO scheme in that the overall costs of implementing the supporting scheme is minimized. Additionally, digitalized certificate is a tool for regulatory authorities to better measure and monitor energy suppliers' compliance status. However, the additionality and transparency of green certificates and trade are essential to ensure the effectiveness of this scheme. The former means that energy suppliers need to contract with and finance new, expanding renewable sources and obtain their green certificates, as opposed to buying into what is already available or planned resources. While the latter requires each MWH of renewable generation to be visibly tracked from its point of creation to point of final use, to ensure additional carbon-free electricity is purchased and retired by one supplier.

1.2.2 Price-based scheme

Price-based policies, different from quantity-based ones, involve a payment per MW of produced electricity to renewable energy generators. For instance, **Feed in tariffs** (FiT) are fixed electricity prices mandated by the government that is paid to renewable

energy producers for each unit of energy produced and injected into the electricity grid. Generally, the level of fixed price is determined by the levelized cost of electricity (LCOE) produced from each renewable technology. This allows the investors to recover expenses and realize a return on the capital spending, during a guaranteed certain period of time. In the 2000s, FiT was widely used in China and many European countries, and had been the cornerstone of their renewable energy policies. However, to make it profitable for investors to finance new alternative technologies which has a higher LCOE than conventional resources, FiTs were set higher than the market price, and thus became an anomaly in liberalized electricity markets where the price of electricity is determined by market forces. For instance, since 2000, Germany has largely promoted the development of solar industry through high-compensation and long-term FiT scheme. But it gradually became the burden of government finances and raised Germany's electricity rate to one of the highest in the EU countries. In 2012, Germany has to halt FiT compensations of a large proportion of solar projects and since then brought the industry to a downturn. This has prompted governments to innovatively introduce more cost-effective price-based instruments, for example, **Feed in premium** (FiP). Under a FiP scheme, the government only provides partial support to renewable investors by offering a premium on top of market price, which fills the gap between revenues and costs. As a result, FiP integrated compensation mechanism to a market system to reduce renewable generators' explicit dependence on governmental supporting policies. The premium can either be constant, or it can vary based on a sliding scale. While sliding premium ensures better cost predictability, constant premium better facilitates the integration of renewables at times when market value of renewables is higher. Build on the design of sliding FiP, the UK government further pioneered a new form of FiP – **Contract for difference** (CfD). This is to solve the issue when market price is higher than the fixed supporting level, i.e. the sliding cap, which makes premium a negative value. Under the CfD scheme, when he market price is higher than a certain strike price, the negative premium will be deducted from the overall subsidy received by the power plants, so generators will not be eligible to keep gaining from high market prices. This also relieves the government's financial burden on the energy sector.

As the renewable sector gradually scales up, renewable assets have become cheaper to build. Consequently, some governments begin to move away from FiT and FiP schemes. Instead, non-governmental agencies like corporations, state-owned companies, or transmission system operators started to engage in the contract, which is also called **Power Purchase Agreements** (PPA). Like government subsidies, renewable power producers

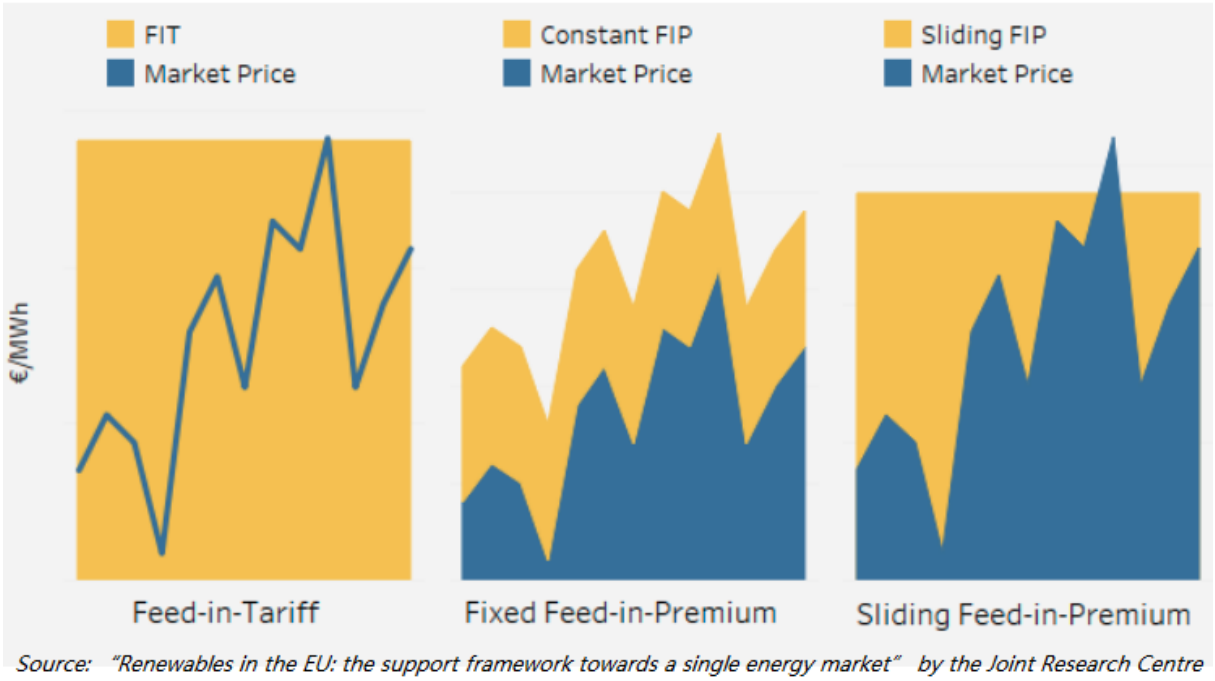

Figure 2: An intuitive comparison between FiT and two types of FiT

create legally binding agreements with offtakers (i.e. purchasers) for 10 to 20 years, during which time the purchasers buy part or all of the generations. The price per MW unit paid to generators is negotiated between two counterparties, to ensure investors can recover construction and operation costs while not be overcompensated. For instance, technology giants in Silicon Valley like Google, Apple, Microsoft, and Amazon all actively participated in creating corporate PPAs to finance clean energy projects and source green power for their own electricity use. Google and Apple have reached 100% renewable for all global operations including office buildings and data centers, principally contributed by renewable PPA contracts.

Other production-based schemes commonly used in the world also include **Production tax credit** (PTC) and **Tendering** (also called auction schemes). Just like the investment tax credit, a PTC enables renewable resources in the U.S. to benefit from a per-kWh based tax credit and sell it to unrelated taxpayers during the taxable year, therefore have competitive returns on large renewable projects. The tender scheme, more deployed in the EU, is to allocate financial support to different renewable generators in a competitive biffing procedure. This is cost-efficient since the bidding process stimulates power plants in different locations or with different technologies to compete and provide

the lowest bids. The competitive mechanism also helps to reveal the true cost of each technology and preventing overcompensation.

2 Conclusion

A wide range of national policies is now available for governments to limit GHG emissions across energy sectors. As specified above, for both direct carbon control measures and complementary renewable supporting tools, market-based instruments like emission trading, tradable certificates, and tendering, have the advantage of cost efficiency, as they introduce a market mechanism to facilitate the cheapest abatement options being implemented first, which markedly enhance the optimal social welfare. On the other, non-market policies like best available technology, direct investment loans, and indirect tax incentives can escape from imperfections from price mechanisms and provide direct incentives for technology development and innovation. With each scheme has different environmental effectiveness and cost-effectiveness, finding the right portfolio of policies tailored to fit specific national circumstances is thus challenging but necessary. Governments, companies and civil society should all be actively grappling with the climate change issues, use the wealth of regulations, standards, compensations and market mechanism to collectively provide a framework for effectively curbing carbon emissions.