CHAPTER 5

Phase-out policies

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Phase-out policies are policies that rule out the use or sale of specific technologies or products by a certain date. They have been increasingly popular since the Paris Agreement. Examples include urban low-emission zones that exclude the use of some vehicles in specific areas, bans on the sale of fossil-fuel boilers, bans on internal combustion engine cars, bans on coal-based electricity production and exits from coal mining.

Phase-out policies vary in their design. They typically come with some advance notice allowing owners and producers to plan and adjust to the policy. Investment subsidies for the technologies not phased out are common. When stranding of assets is involved, owners are sometimes compensated. What is common across all phase-out policies, however, is an explicit account for the time dimension of the problem at hand.

In this chapter, we explore the case in favour of phase-out policies for physical capital that uses fossil fuels.[1] This is important because energy consumption, and hence greenhouse gas (GHG) emissions, is largely driven by the type and energy-efficiency of the equipment we use, and these have long investment cycles.[2] Fossil-based equipment can then lock in emissions for a long time. We will argue that the main advantage of phase-out policies is redistributive: they can drive out fossil-based equipment without imposing excessive charges on those consumers who are temporarily (due to their current equipment) dependent on fossil fuels. Phase-out policies are therefore particularly attractive in contexts where redistribution and political feasibility are salient concerns.

A FIRST LOOK AT THE ECONOMICS OF PHASE-OUTS

The following example will help crystalise how phase-out policies work and how they compare with other policies.[3] Consider a piece of equipment that comes in two varieties. One relies on fossil fuels for its operation (let's call it the 'brown' technology). The other

1 We will therefore abstract from bans on fossil fuel extraction, as the economics differs somewhat from the economics of fossil-based equipment phase-outs.
2 In the EU, around 55% of GHG emissions are driven by capital stocks: emissions from electricity production represent about 26% of total GHG emissions, road transport accounts for 16% of emissions, and heating in the residential and commercial sectors represents another 13% (data source: European Environmental Agency).
3 From a theoretical perspective, phase-out policies are a special kind of standard command-and-control policy instrument. Unlike mandates, they do not impose a choice of technology but simply rule out specific technologies. Because the banned technology will typically be the most polluting, they can be seen as an extreme version of a performance standard, one that cannot be met by the banned technology.

one does not produce emissions when used (let's call it the 'green' technology). The green technology is more expensive to buy, but cheaper to operate. Assume for now that usage is independent of the chosen technology (you need to heat your home, you need to drive to work, etc).

When deciding between the two technologies, a well-informed and rational consumer who is not financially constrained will consider the total cost of ownership, which includes the investment and (appropriately discounted) operating costs. If the total cost of ownership for the green technology is lower, then the consumer will choose the green technology, otherwise they will choose the brown technology.

Suppose that in the absence of a policy, the brown technology has lower total cost of ownership. A ban on new purchases of the brown technology will ensure that this technology is nevertheless gradually phased-out. For example, if the typical lifetime of the equipment under consideration is 20 years, we can expect about 5% of the existing stock to be renewed every year and therefore the green technology to be the only used technology after 20 years.

Alternatively, we could put a price on carbon and thereby increase the operating cost of the brown technology up to the level that the total cost of ownership of the green technology is lower. That policy will lead to exactly the same outcome: consumers will select the green technology at the end of the life of their current (brown) equipment, and if the price is set exactly at the level to tilt the investment decision in favour of the green technology, it will not affect the decisions by owners of brown equipment before the end of the lifetime of their equipment. These will prefer to keep their equipment even if the operating costs have increased.[4]

The main difference between a phase-out policy and a carbon price in this simple example is the financial impact on consumers and public finances. In the case of a ban on the brown technology, consumers incur a higher cost when renewing their equipment. In the case of a carbon price, all owners of the brown technology equipment incur an extra cost of operations, even if it is not economical to change their equipment. They are 'locked-in' to the brown technology. On the other hand, the carbon tax generates financial resources for the state that can be used for redistribution.

Equity concerns are central in the context of the energy (and thus climate) transition. Energy represents a higher fraction of expenses for lower-income households. Higher energy prices – or equivalently (in today's world where the carbon intensity of energy remains high), higher carbon prices – are therefore regressive. In principle, the money raised from the carbon tax could be redistributed to ease the financial pain borne by these households. Such redistribution should be independent of actual consumption to keep incentives right, but administrative, political or legal constraints often make this

4 Intuitively, they benefit from the service provided by the equipment until the end of its lifetime, without having to incur capital costs (which are sunk by then).

impractical. In the case of our simple example, one would want to exempt locked-in consumers but apply the carbon tax to all users of new equipment, an administrative and legal conundrum.

This example suggests that a phase-out policy can have the same effect as a price on carbon, with less negative distributional impact. To further reduce the negative distributional impact of phase-out policies when the green technology is more expensive, phase-out policies can be combined with means-tested investment subsidies.

VARIATIONS ON PHASE-OUTS

Table 1 describes existing phase-out policies in different geographical jurisdictions for heating in buildings and road transport.[5] The first row describes the recommendations derived by the International Energy Association (IEA) from their net zero emissions trajectory aligned with the Paris Agreement (IEA 2021). For buildings, the IEA trajectory requires that all new buildings meet high standards of energy efficiency and either use biomass or an energy supply that can be fully decarbonised by 2050, such as electricity or district heat. This effectively rules out all fossil fuel boilers in new buildings by 2030. For road transport, the IEA recommends a ban on new internal combustion engine vehicles by 2035.

The table shows that the measures approved at the EU level as part of the Fit for 55 package are largely in line with the IEA recommendations. The Netherlands and the UK are implementing earlier phase-outs. Germany is implementing a more aggressive target and is phasing out fossil-based heating in existing buildings as well. Norway has banned new fossil-based heating installations since 2017 and has banned the use of oil for heating since 2020.

This variety of policies illustrates how the speed of the technology phase-out can be tailored according to national ambitions. A ban on new installations in new buildings is easiest to implement, but the renewal rate of housing stock is low (around 1% in the EU) and new additions to the building stock varies across countries. Next comes a ban on new installations in existing buildings, as these might involve significant renovation work (more radiators or floor heating). Finally, a ban on the use of the fuel, as in Norway, effectively comes down to forcing existing oil-based installation into early retirement (stranding).

5 See Kerr and Winskel (2022) for a description and discussion of other phase-out policies.

TABLE 1 EXAMPLES OF FOSSIL FUEL PHASE-OUT POLICIES ACROSS THE WORLD

	Heating	Road transport
IEA net zero benchmark	Mandatory zero-carbon-ready building energy codes for all new buildings by 2030; retrofits to make all buildings zero-carbon ready by 2050.	No new internal combustion engines by 2035
EU (Fit for 55 package)	No fossil-based heating in new buildings by 2030 (2028 for new buildings owned by public bodies)	By 2035, all new cars must be zero-emission
Germany	No new fossil-based heating in buildings (existing and new) by 2026	-
The Netherlands	No new fossil-based installation by 2026	Local bans for internal combustion engine vehicles by 2030
UK	No fossil-based heating in new buildings by 2025 (2024 in Scotland)	No new petrol and diesel cars by 2030; sale of hybrids possible until 2035
Norway	Ban on fossil-based heating installation since 2017, ban on the use of oil for heating in new and existing buildings since 2020	Ban for new passenger vehicles by 2024
China	-	Ban for new private vehicle by 2035, earlier in some provinces
US	Some local bans for new buildings (e.g. New York City by 2024)	Some local bans for new vehicles (e.g. California by 2035)

Notes: Zero-carbon-ready buildings are highly energy efficient building that either use renewable energy directly (biomass) or use an energy supply that will be fully decarbonised by 2050 such as electricity or district heat. Some of these policies are combined with investment subsidies.

Source: Author's compilation from IEA (2021), Braungardt et al. (2022) and different public sources (official websites and news).

Vehicles have shorter life times than heat boilers and thus a ban on only new vehicles can rapidly decrease emissions. This lower inertia explains why the IEA's recommended phase-out dates are later for internal combustion engine vehicles compared to fossil-based boilers. However, some local jurisdictions are banning the use of internal combustion engine vehicles, or at least the most polluting ones, earlier. These take the form of low-emission zones and are typically city initiatives.

ADDITIONAL CONSIDERATIONS

Of course, the real world differs from our simple example. First, consumers have some agency as to the intensity of use of their equipment. Higher operating costs will lead to a less intense use of the technology. In this case, a price on carbon can perform the double duty of both impacting use (the intensive margin) and investment decisions (the extensive margin), whereas phase-out policies only impact investment decisions.

Second, at the time policies are decided, there typically remains significant uncertainty about future economic conditions, technology costs and consumer behaviour. Such uncertainty breaks down the equivalence between a carbon price and a phase-out even in our simple example (Weitzman 1974). A drop in fossil fuel prices or a higher-than-expected price for the green technology may fail to tilt investment decisions towards the green technology if the price of carbon is not sufficiently high. Likewise, a phase-out policy on new purchases may lead consumers to keep their old polluting equipment longer if the green technology is too expensive. In both cases, the climate target may not be met. The received wisdom, from Weitzman (1974) and the follow-on literature, is that phase-out policies are likely to be better at delivering quantity targets, though both approaches will benefit from being part of a policy mix that somewhat adjusts to observed behaviour. So, for example, both policies can be combined with investment subsidies for the green technology.[6]

A third dimension in which the real world differs from our simple example is that consumers are typically short-sighted and may be financially constrained. Short-sightedness is a robust psychological bias (DellaVigna 2009). When evaluating an investment, current expenses are salient and future operating costs are less so, leading consumers to opt for less energy-efficient equipment even when its total cost of operations is higher (the seminal paper here is Hausman 1979). Uncertainty about future operating costs and financial constraints exacerbate this bias. Unlike carbon pricing, which leaves full choice to consumers, phase-out policies are immune to these behavioural biases but, as noted previously, may nevertheless lead consumers to inefficiently postpone the acquisition of new equipment if they are financially constrained.

A related concern is the split-incentives problem that arises when the person buying the equipment is not the same as the person using it, as is commonly the case in residential rental markets (e.g Gillingham et al. 2012). The presence of split incentives reduces the effectiveness of carbon pricing as a way to push out the brown technology because owners do not incur the operating costs of the equipment, and these tend to be only partially reflected in the rent they get. By contrast, phase-out policies operate independently of the way ownership and use is split.

6 These investment subsidies can also be rationalised as a subsidy for research and development when the green technology is still immature (Acemoglu et al. 2012).

Finally, some studies suggest that early retirement of some equipment will be necessary to meet the objectives of the Paris Agreement (IPCC 2022). This will be all the more likely if ambitious climate action continues to be delayed as currently. Phase-out policies and carbon prices operate differently in these circumstances. Early retirement of equipment can be implemented under a phase-out policy by banning the use of the most polluting (typically older) part of existing stocks. Low-emission zones operate exactly in that fashion for cars. Partial early retirement requires monitoring and enforcement, however, and may not be feasible – or at least not feasible at the required level of granularity – for all types of equipment. It is more difficult for domestic boilers, for example, even if technicians performing annual maintenance can play a role. On the other hand, a high enough carbon price can also push brown technologies into early retirement. If all vintages of the brown technology are equally polluting, equipment owners will decide to strand their brown equipment and invest in the green technology independently of the residual lifetime of their equipment.[7] When older vintages are also more polluting and therefore more costly to operate with the carbon tax, older vintages will be pushed out first.

A BROADER PERSPECTIVE ON PHASE-OUTS

So far, we have applied standard economic reasoning to the analysis of phase-out policies as a policy instrument. Phase-out policies also have advantages from a political and industrial policy perspectives.

Politically, phase-out policies put everyone on the same footing. They apply to the rich and the poor. You cannot 'pay your way out of it' like carbon taxes. When they apply to new purchases, they only impact a fraction of the population and avoid impacting locked-in consumers that can do little to change their behaviours anyway. This contributes to their social acceptability and makes them popular with politicians.

Phase-out policies are also attractive from an industrial policy perspective. Changes in technology require that an entire supply chain is set up around the new technology, from production to servicing to end-of-life management and recycling. Such changes can be subject to coordination failures because a critical mass is needed to make entry in production, servicing and end-of-life management profitable. Phase-out policies boost demand for green technologies and create predictability for market participants, who can more easily coordinate on the needed investments to serve the emerging market. The EU decision in October 2022 to phase out internal combustion engine cars is a case in point. EU legislators had been discussing measures to reduce emissions from road transport since the adoption of the Green Deal in December 2019 and some car manufacturers had

7 Intuitively, early retirement becomes economical when operating costs are so high that the net value of the service of the equipment is smaller than if it was replaced with a new one, even after accounting for the capital cost. At the value of the carbon tax that makes the owner of an equipment with one remaining year left indifferent between early retirement (and investment) and keeping the existing equipment, owners of newer vintages are also indifferent between these two options. If early retirement becomes profitable for the first owner, it also becomes profitable for owners of all newer vintages.

started to make moves in support of electric vehicles. At the announcement of the phase-out decision in October 2022, EU Commissioner Frans Timmermans tweeted “EU car industry is ready, consumers are eager to embrace zero-emission mobility”[8] while Jan Huitema, the European Parliament’s rapporteur and author of the car emissions report, stated that the new rule created “clarity for the car industry and stimulate[d] innovation and investments for car manufacturers. (...)”.[9]

CONCLUDING COMMENTS

When it comes to climate action, there is no ‘one size fits all’. Policies need to be tailored to the specificities of the sectors and markets at hand to ensure they are effective, efficient, socially acceptable and administratively feasible. Phase-out policies are – rightly so – part of the toolbox of policymakers.

Phase-out policies are especially attractive options when dealing with long-lived fossil-based equipment in markets where at least one of the following conditions holds: equity concerns are salient, usage is inelastic (captive consumption), the person deciding on the investment is either short-sighted or does not bear the operating costs of the equipment (split incentives), the alternative technology is at its infancy and a new supply chain needs to be set up to support it. Under these conditions, phase-out policies can be more effective than a simple carbon price while accounting for equity considerations. Long-lived consumer goods, such as boilers and electric vehicles, are therefore sensible sectors for phase-outs. These are sectors that, in the EU, have until recently escaped the introduction of a carbon price exactly for these equity concerns.[10]

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10 In December 2022, EU legislators have agreed, as part of a broad reform of the Emissions Trading Scheme, to create a separate trading scheme for the building and road transport sectors. Prices would be effectively capped at 45 EUR per ton, which is much below estimates of the social cost of carbon and prevailing prices on the main emissions trading scheme, presumably to protect consumers.

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