Environmental Economics

Prof. Philippe Thalmann

EPFL ENAC LEUrE

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EPFL
Philippe Thalmann
LEUrE

Abatement

COMPARISON OF ENVIRONMENTAL POLICY INSTRUMENTS

Illustration: Adobe Stock n° 355466876

Outline

- Various instruments allow for decentralisation of environmental protection: families of instruments
- Comparison and choice criteria
- Application of these criteria to assess the different instrument families

Why instruments ?

- Start from a problem of excess harmful emissions
- Engineering and planning models define the optimal abatement solutions (quantity, distribution of efforts, asf.)
- Their implementation requires individual participation of the emitters

$\Rightarrow$ Need to decentralise

$\Rightarrow$ Different instruments are possible

POSSIBLE INSTRUMENTS

Grand families of instruments of environmental policy

1. Inform and call to reason: **voluntary approaches (self-regulation)**
2. Propose alternatives: **Public investment**
3. Forbid, limit, impose measures: **prescriptions**, **command-and-control**
4. Put a price on deposits into the atmospheric landfill (tax, subsidy, tradable emission quotas): **economic instruments**
5. Without intervention by some public administration: **litigation**

Least constraining instruments

- **Voluntary approaches (self-regulation)**: stewardship, education, information, good examples, naming and shaming, labels, nudges…

- **Public activities not directly linked to the environment**, e.g. subsidised R&D, infrastructure and public services offering alternatives to polluting activities, environmental criteria in public procurement and authorisations (e.g. development plans, building permits), exemplary management by the public administration, etc.

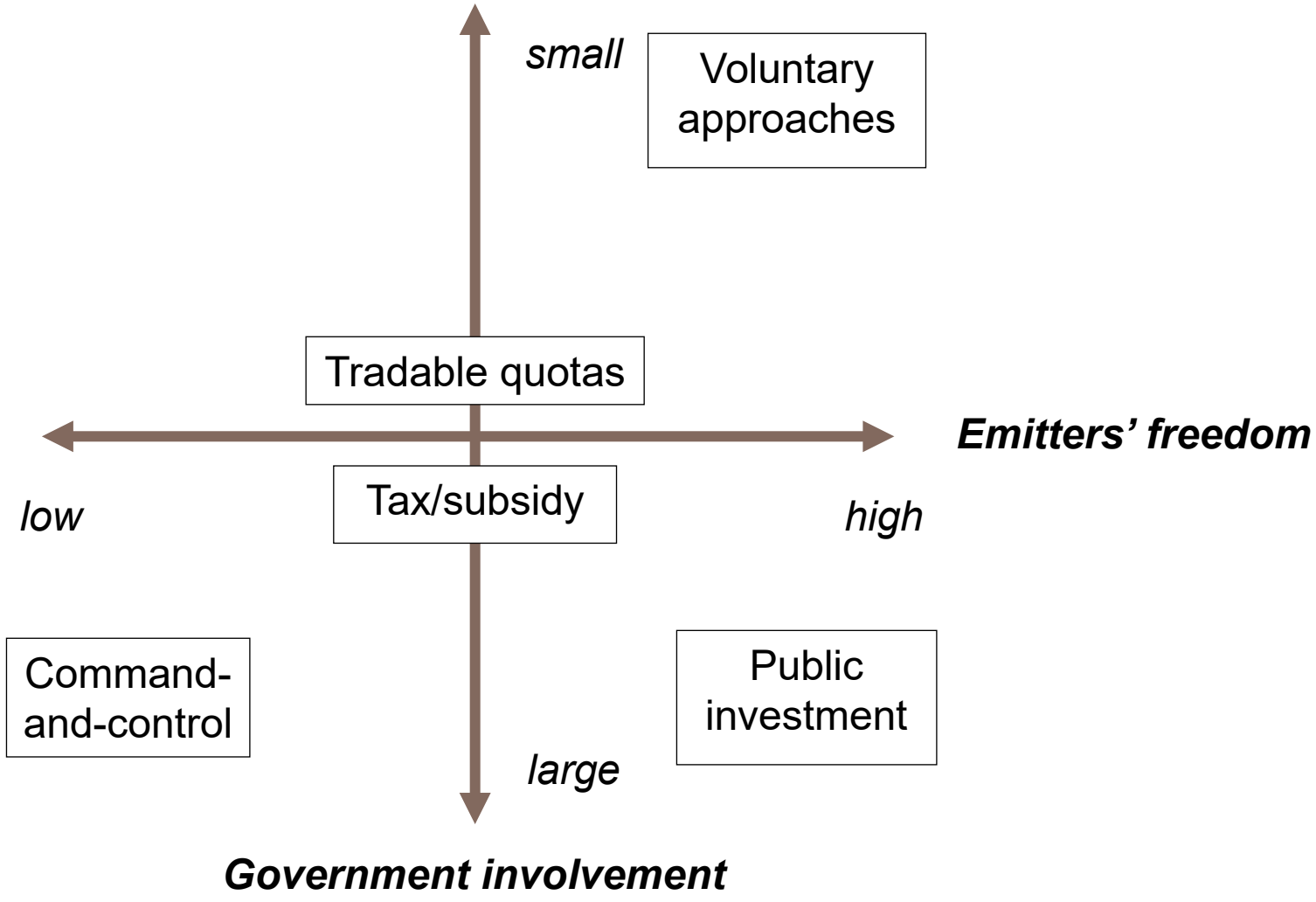
More constraining instruments

- **Prescriptions** set the quantity, and sometimes even the means (standards and norms, certification, building codes, etc.), but not the price; they are accompanied by penalties; civil and/or criminal liability can be added
- **Pure price instruments** (taxes or subsidies) either put a price on emissions and let emitters decide on the quantities to be reduced and the means to achieve them, or target specific abatement measures
- **Hybrid instruments**: prescription with flexibility, e.g. tradable emission quotas (TEQs)

A mix of instruments

- New environmental policies use a combination of instruments
- This makes it possible to individualise the instruments and increase their effectiveness and efficiency
- A mix of instruments signals a coherent approach
- It tends to increase the cost of abatement, in particular administrative costs

Fundamental differences



COMPARISON AND CHOICE CRITERIA

Criteria for assessing instruments

- **Environmental effectiveness** – the extent to which an instrument achieves the intended environmental objective or realizes positive environmental outcomes
- **Cost-efficiency** – the extent to which the instrument achieves the objective or outcome at minimum cost to society, broadly defined
- **Equity** or fairness – the incidence, or distributional consequences of the instrument; who bears the costs
- **Budgetary impact** – the instrument may generate revenue or burden public budgets
- **Practical feasibility** – the extent to which an instrument can be implemented and monitored at reasonable cost; its compatibility with legal principles (equal treatment, proportionality, asf.)
- **Political feasibility** (acceptability) – the likelihood that it is viewed as legitimate and adopted

Assessment of voluntary approaches

- It is difficult to assess VAs, because we cannot predict which emitters will participate and how much effort they will put in
- The assessment must consider the main motive for participation:
  a) If participation is linked to abatement costs, it is the emitters with low abatement costs who participate
  b) If participation is linked to certain advantages such as reputation or exemption from binding instruments, it is the emitters who can benefit most from these advantages who participate
  c) If participation is based on a sense of responsibility, it is the most 'ethical' emitters who participate

Assessment of prescriptions

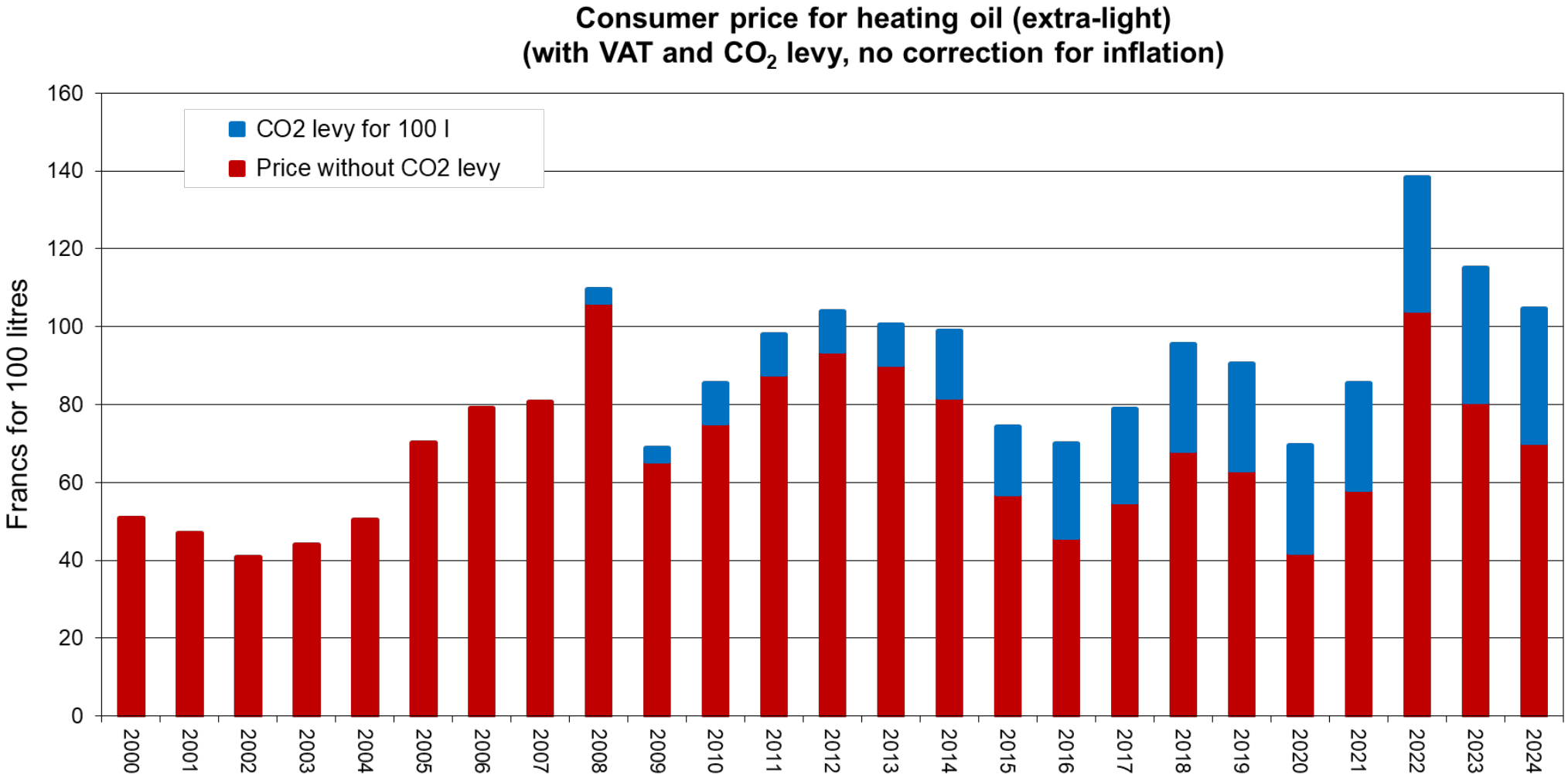
To assess prescriptions, they must be qualified:

- What do they apply to? Emissions, products, technologies, specific abatement measures?
- Are they the same for all emitters or are there variations and exceptions?
- Is there full compliance? If not, who complies and to what extent?

Assessment of economic instruments

- First, the same questions must be addressed as above for prescriptions: what do these instruments apply to? Are they uniform? Is there full compliance?
- In the case of taxes, the use to which their revenues are put plays a central role in assessing their impact
- In the case of subsidies, we should also take into account where the money comes from
- The analysis becomes more complicated when a tax is so high that it can lead to the closure of a business, or a subsidy so high that it can save a business
- In the case of TEQs, the way in which they are distributed is very important for certain assessment criteria
- Economic instruments are particularly sensitive to economic and price trends (next slide)

The effect of the CO_2 tax neutralised by changes in the price of crude oil



Source of data: Swiss Federal Office of Statistics, CPI data, and own calculations

Comparison and choice criteria

ENVIRONMENTAL EFFECTIVENESS

What is environmental effectiveness?

- In most cases, a target is set:
  - for emissions (e.g. max 1 ton CO_2 or 2 kW of power per person)
  - for emissions reduction (e.g. emissions decrease by 30% until 2030)
  - for environmental quality (e.g. max 450 ppm CO_2 in the atmosphere)
- The environmental effectiveness of an instrument is measured by its ability to bring emitters to meet the environmental target

Assessing the effectiveness of instruments

- When assessing instruments, these questions must be asked:
  - Is it possible to meet the target with the instrument?
  - Does the instrument guarantee that the target is met?
  - Does the instrument allow for fine-tuning (zeroing-in on the target, avoiding over-shooting)?
- Some instruments structurally fail these tests
- For most instruments, feasibility constraints limit their effectiveness

A few basic results about environmental effectiveness

- The effectiveness of voluntary approaches and public investment is particularly uncertain, as it depends strongly on the good-will of firms and consumers
- Such instruments are hard to fine-tune if they turn out not effective enough
- Effectiveness rises with the commitment of the authorities (e.g., they offer a quid pro quo and check that the pledges are honoured)
- Prescriptions on emissions are very effective – if they are fully enforced …
- Economic instruments (taxes, subsidies, TEQs) can easily be made more or less stringent – if this is politically feasible …

Prescription as a random price for pollution

Consider a prescription that prohibits some pollution

In the event of infringement: financial penalty ***F*** (a fine)

Only the proportion ***p*** of emitters are controlled

Emitters who are controlled and not complying pay the penalty

Emitter ***i*** has a choice between avoiding the pollution, which costs him $\boldsymbol{C_{Ai}}$, and risking paying the penalty ***F*** with probability ***p***

Compliance can be expected of emitters for whom $\boldsymbol{C_{Ai} < pF}$

We would see exactly the same thing if the pollution was taxed at $\boldsymbol{T = pF}$

Disproportionate penalties?

China threatens death penalty for serious polluters

By **Reuters**

June 19, 2013 4:50 PM GMT+2 · Updated 11 years ago

Demonstrators hold up sheets of paper which read, "Kunming PX", during a protest against production at a planned plant of paraxylene (PX), a chemical used in making fabrics and plastic bottles, outside the Yunnan provincial government in Kunming, Yunnan province May 16, 2013. REUTERS/Wong Campion *Purchase Licensing Rights*

BEIJING (Reuters) - Chinese authorities have given courts the powers to hand down the death penalty in serious pollution cases, state media said, as the government tries to assuage growing public anger at environmental desecration.

Comparison and choice criteria

COST-EFFICIENCY

There exist generally many possible abatement measures

Many abatement options, e.g., for CO_2 from energy:

- adopting technologies to reduce actual emissions (end-of-pipe, CCS)
- switching to less CO_2-intensive fuels (e.g., natural gas for coal, renewables)
- increasing energy efficiency per unit of output by using less energy-intensive technologies
- reducing the production and consumption of energy-intensive goods (fewer goods, more services; less waste; circular economy)
- increasing the sequestration of CO_2 through reforestation and other measures ('carbon dioxide removal' CDR)

Abatement costs depend very much on the abatement measures chosen

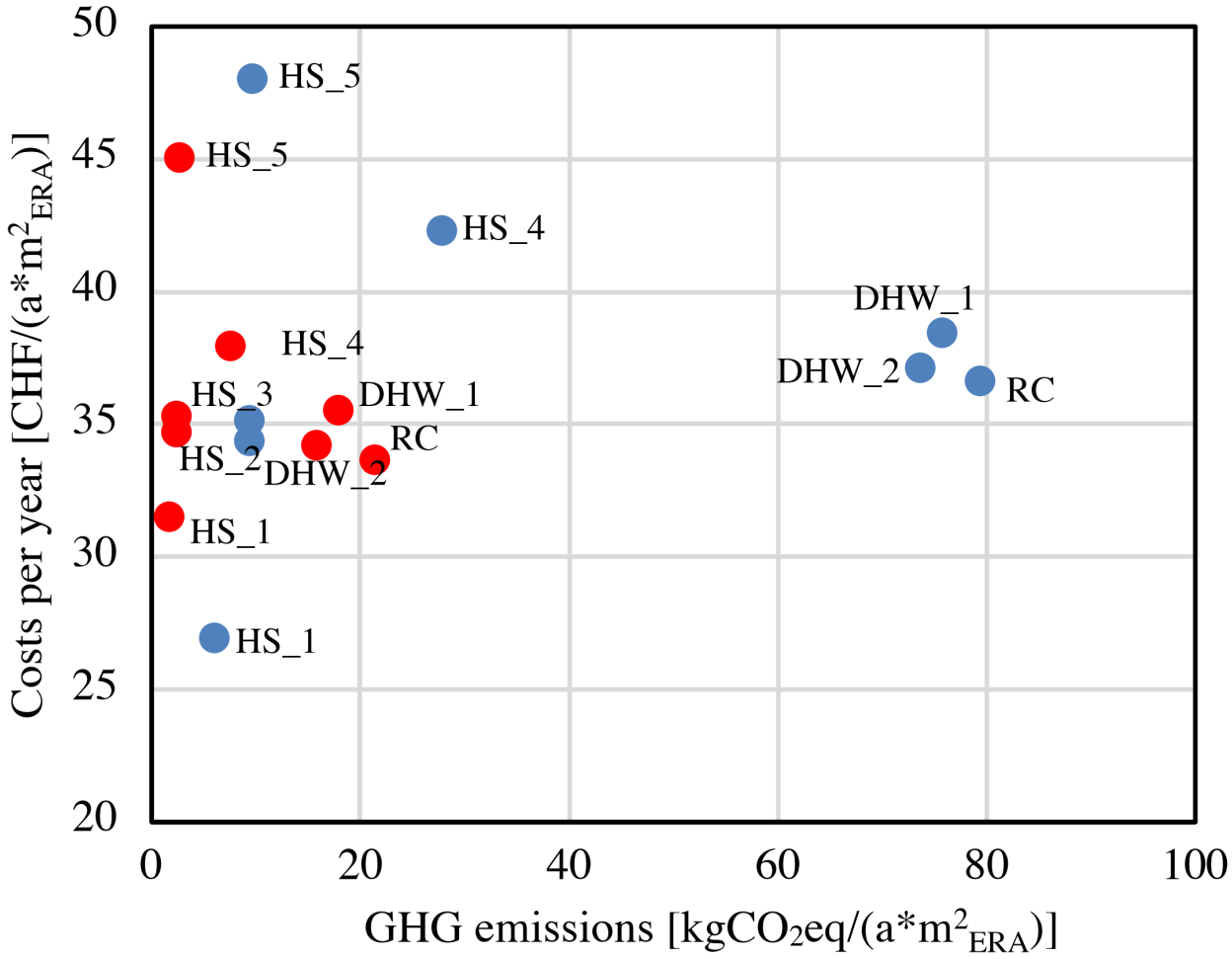
Very different costs and effects for different energy renovation measures for buildings

Annualised life-cycle costs and greenhouse gas emissions associated with heating and hot water production for a typical detached house, depending on the method of heat production and insulation measures

Blue dots: without insulation; red dots: with insulation roof, facade, windows, foundations

RC = oil-fired, DHW = oil-fired + renewable solution for domestic hot water, HS_1 = geothermal heat pump, HS_4 = district heating; HS_5 = pellets

Diego Sigrist et al (2019), Cost-optimal retrofit analysis for residential buildings, J. Phys.: Conf. Ser. 1343 012030



Very different costs and effects for different energy renovation measures for buildings

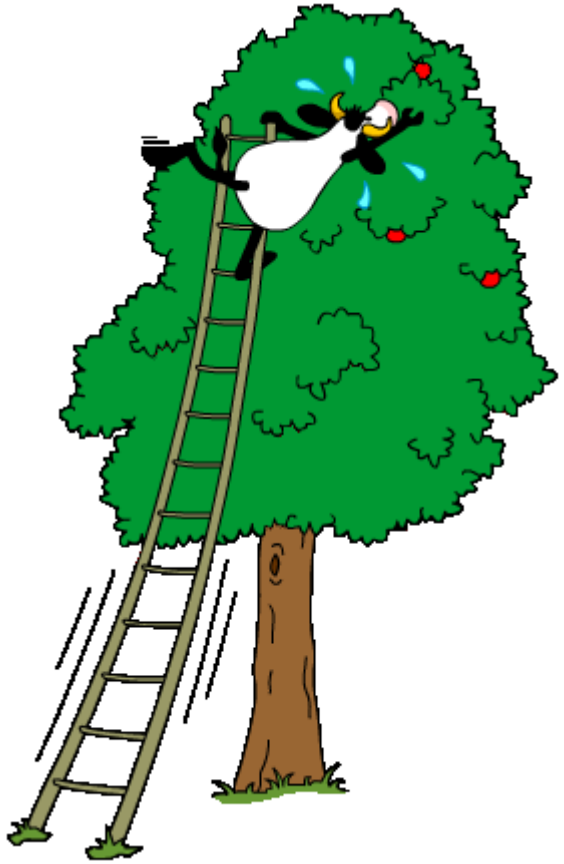
Table 3. Lifecycle costs of retrofit strategies [CHF/(a*m$^2_{ERA}$)]

Retrofit measures on the building envelope	Heating and DHW systems: Oil boiler (RC)	Geotherm. heat pump (HS_1)	Ext. air-to-water heat pump (HS_2)	Int. air-to-water heat pump (HS_3)	District heating (HS_4)	Pellet boiler (HS_5)	Thermal solar collectors (DHW_1)	Heat pump boiler (DHW_2)
No retrofit measures (RC)	36.7	27.0	34.4	35.2	42.4	48.1	38.5	37.2
Roof (BE_1b)	33.8	26.1	32.2	32.9	39.5	45.4	35.7	34.3
Façade (BE_4a)	37.7	29.7	36.0	36.7	43.4	49.3	39.6	38.2
Cellar ceiling (BE_5b)	33.3	25.3	31.5	32.2	39.0	44.9	35.2	33.8
Windows (BE_6b)	37.3	30.4	36.1	36.8	42.5	48.8	39.2	37.8
Roof, façade	35.2	29.2	34.4	35.1	40.6	46.6	37.1	35.7
Roof, cellar ceiling	30.8	24.8	30.0	30.7	36.2	42.2	32.6	31.3
Roof, windows	34.7	29.5	34.0	34.7	39.6	46.2	36.6	35.2
Façade, cellar ceiling	34.7	28.5	33.8	34.5	40.1	46.1	36.5	35.2
Façade, windows	38.6	33.1	37.8	38.5	43.5	50.1	40.4	39.1
Cellar ceiling, windows	34.2	28.8	33.4	34.1	39.1	45.6	36.0	34.7
Roof, façade, cellar ceiling	32.1	27.7	31.8	32.5	37.3	43.6	34.0	32.6
Roof, façade, windows	36.3	32.4	36.4	36.9	40.9	47.7	38.1	36.8
Roof, cellar ceiling, windows	31.9	28.1	32.0	32.6	36.5	43.3	33.7	32.4
Façade, cellar ceiling, windows	35.7	31.7	35.7	36.3	40.3	47.2	37.6	36.2
Roof, façade, cellar ceiling, windows	33.7	31.5	34.8	35.4	38.0	45.1	35.6	34.2

Diego Sigrist et al (2019), Cost-optimal retrofit analysis for residential buildings, J. Phys.: Conf. Ser. 1343 012030

Cost-efficiency

As a first approximation, cost-efficiency requires that the cheapest abatement efforts be taken first, independent of who is responsible for the emissions and their reduction



http://www.recipeforlowhangingfruit.com/christmas/

Cost-efficiency conditions

- Each emitter reduces its emissions at the lowest cost
- The total emission reduction is distributed among emitters in such a way as to minimise the total abatement cost
- As a first approximation, cost-efficiency requires that emitters with the lowest abatement costs reduce their emissions the most
- Specifically, abatement efforts should be distributed in such a way as to equalise the marginal abatement costs of all emitters

Letting emitters choose the least costly measures

- Emitters seek to minimise their costs, so, if they have to reduce their emissions, they choose the cheapest measures
- Consequently, they should be given as much freedom as possible to achieve a target for emissions or environmental quality
- But, beware:
  - The private costs of measures do not always correspond to their costs to the community (e.g., waste in the forest or in the sewers)
  - Issuers are sometimes "a little irrational", especially when it comes to measures that involve a higher initial investment for greater savings later on ("myopia")

Cost-efficiency of voluntary approaches

- The piecemeal approach, sector by sector, is a problem
- The fact that not all emitters participate is a problem
- To the extent that emitters with the lowest abatement costs are more likely to make voluntary efforts, there is a beginning of cost-efficiency

Cost-efficiency of prescriptions

- The desired result is not achieved at the lowest cost, because the prescription struggles to differentiate between abatement costs
- *End-of-pipe* standards are preferable to technology standards, as they let emitters choose the cheapest solutions ... but they are more difficult to control

Cost-efficiency of economic instruments

- Economic instruments put a price on emissions, the same for all emitters (in principle)
- Each emitter compares its marginal abatement cost with the price of emissions (tax on emissions, subsidy for emission reduction, price of TEQs) and takes all measures that cost less than this price
- Therefore, the marginal abatement costs of all emitters are equalized
- The desired result is achieved at the lowest cost, as if a central authority had been able to allocate emission reduction efforts efficiently

Cost-efficiency of economic instruments

- Economic instruments hold the best promise of cost-efficiency
- Practical recommendations to enforce this:
  - emitters pay for the costs of their emissions (at least the clean-up costs, polluter pays principle)
  - emitters pay full production costs, including external costs (cost internalisation, level playing field)

Comparison and choice criteria

EQUITY

A distinct criterion from political feasibility?

- A fairer instrument is more politically acceptable, so equity could be treated as a component of political feasibility
- In fact, acceptability depends on perceived equity
- For the objective equity criterion, the distributional impacts of an instrument are assessed

Many impacts of public intervention

- Consider an agent i whose initial situation (quality of life, well-being) in the absence of the pollution that we are considering is S_{i0}
- With pollution, he suffers a loss of well-being of L_{i1}; therefore, his actual current well-being is $S_{i1} = S_{i0} - L_{i1}$
- Public intervention alters the loss to the agent through different channels: overall abatement that lowers pollution, money transfers, impacts via incomes and prices, etc. $\rightarrow L_{i2}$
- If the agent must contribute abatement Δ_{i2}, this costs him C_{i2}
- The agent is in a different situation as a result of the public intervention: $S_{i2} = S_{i0} - L_{i2} - C_{i2} = S_{i1} + (L_{i1} - L_{i2}) - C_{i2}$
- Variation of the agent's situation by public intervention: gain $G_i = S_{i2} - S_{i1} = (L_{i1} - L_{i2}) - C_{i2}$

Many dimensions of equity

A public intervention concerning a harmful emission is fair if...

- it maximises the gains of those most affected ($L_{i1} > L_{mean,1}$)
- it maximises the gains of those whose initial situation is least favourable ($S_{i1} < S_{mean,1}$)
- it reduces the diversity of personal situations (dispersion of S_{i2} < dispersion of S_{i1})
- it distributes the overall effort to reduce emissions fairly in terms of who bears what costs C_{i2} (see below)
- it correlates the personal effort (C_{i2}) with the gains from the public intervention ($L_{i1} - L_{i2}$)

Focus on equity of effort

- In general, in assessing instruments, the focus is on the fairness of the efforts required of individual emitters, with efforts depending on
  - economic capacity
  - opportunities to reduce emissions (abatement costs)
  - abatement requested
- This can be deviated from to take into account
  - contribution to emissions: those who emit more must make a greater effort (polluter pays, equivalence principle or causality principle)
  - gain-sharing: those who are more exposed to the emissions and benefit more from their abatement must make a greater effort

What is a fair distribution of efforts?

Some accepted principles of taxation :

- Horizontal equity: people in comparable situations, with equal capacity to pay, should bear the same burden
- Vertical equity: those with a greater capacity to contribute should bear a greater burden, which implies progressivity of the contribution
- Principle of equivalence or Principle of causality: those who benefit directly from a public service must finance it

How to measure the 'burden'?

- Direct burden: costs of compliance and abatement
- Indirect burden: translation of costs (e.g. more expensive products when producers pay for compliance and abatement)
- Fiscal impacts (e.g. recycling of tax revenues or funding of a subsidy)
- Possibly, environmental improvement

Equity of voluntary approaches

- The burden should not be too high for anyone, as everyone can avoid it by opting out of the voluntary measure
- The fact that some (many) emitters do not participate poses a (serious) problem of justice
- The largest emitters may be those least inclined to voluntary action

Equity of prescriptions

- A prescription does not distinguish between 'rich' and 'poor' (provided that all comply equally), which corresponds to a certain definition of equity
- But this does not imply the same burden for all
- The 'rich' can often avoid a prescription more easily
- Only the 'rich' are affected by the regulation of typically rich-people's activities (e.g. flying)
- Penalties rarely represent the same burden, and therefore the same deterrent effect, for the 'rich' and the 'poor'

Equity of economic instruments

- Increasing the cost of emitting activities affects the 'poor' more than the 'rich'
- But, is it unfair that the 'rich' can buy things that the 'poor' cannot? Is this not in line with our market system (when prices reflect all costs)?
- Distinguish between essential goods, which should be exempt from the 'laws of the market' (e.g., warm housing, adequate food, basic education, basic health), and non-essential goods, which can be subject to the laws of the market

Equity of economic instruments (2)

- With the emissions tax, the emitter pays for the residual emissions, whereas it pays nothing for these emissions in case of prescription or VA
- It is possible, in principle, to levy the tax only on emissions that exceed a certain 'tolerated' level
- The subsidy on avoided emissions exceeds the abatement cost
- If the TEQs are sold, it is the same as the tax; if they are (partially) given away for free, it implies a right to emit that level of emissions for free
- Distributed TEQs are an attractive source of revenue for issuers who receive 'too many'

Comparison and choice criteria

BUDGETARY IMPACT

A distinct criterion from political feasibility?

- Same question as for equity: it could be interpreted as a condition for acceptability
- But in what way? While there is a consensus that (perceived) fairness increases acceptability, the same cannot be said of the budgetary impact
- A widely shared opinion is that environmental policy should not generate revenues for the public sector (this is also linked to legal rules)
- There is indeed a risk in using environmental policy instruments to finance public tasks
- Here, we look at the objective budgetary impact

We're starting to see significant revenues from environmental taxes

- Revenue from the CO tax_2 has exceeded one billion Swiss francs since 2016. 1/3 for the Buildings Programme, 2/3 redistributed to the population and businesses
- Should the revenue from an incentive tax be neutralised?
- **Ecological tax reform**: use incentive tax revenues to replace taxes that discourage work, training, savings, investment, innovation, risk-taking, etc.: second and third dividends (fiscal and growth)!
- Incidence on the revenues of other taxes (e.g., an effective CO_2 tax on motor fuels would reduce the revenues of the mineral oil tax)

Budgetary impact of other types of instruments

- Voluntary approaches: low (with the possible exception of public voluntary programmes)
- Public activities not directly linked to the environment: they can be costly for public budgets, especially infrastructure
- Regulations: inspection costs, fine revenue
- Subsidies: where does the money come from?
- Emission quotas: budgetary impact depends on the issuance method used

Comparison and choice criteria

PRACTICAL FEASIBILITY

Link between practical feasibility and other criteria

- A prescription could be cost-efficient…
  - if the authority knew all marginal abatement costs (perfect information)
  - if the authority were allowed to impose differentiated reduction targets (no equality of treatment)
- Firms are very protective of their production costs, including abatement cost information
- Firms have no incentive to report truly their abatement costs (cf. EU-ETS)

Determinants of practical feasibility

- Who can use the instrument?
  - is coercive power necessary?
  - is financial support needed?
- What information is needed?
  - to set up the instrument (e.g. marginal abatement costs, damage function, clean-up costs)
  - to use the instrument (e.g. emission quantities, checking compliance with standards)

Practical feasibility of voluntary approaches

- The practical feasibility of VAs is ensured by the minimum involvement of the authorities
- The awarding of labels still requires controls
- Generally speaking, the credibility of the efforts made and results achieved requires certification that can be trusted (no greenwashing)

Practical feasibility of prescriptions

- Prescriptions require a lot of controls ... or else very high penalties
- They often focus on things that are easy to observe, even when they are far removed from the emissions that need to be reduced

Practical feasibility of economic instruments

- The authority must know the emissions or emission reductions to which the tax, subsidy or quota relates
- When emissions are difficult to measure, we measure things that are closely linked: the sale of fossil energy for CO_2 emissions, units sold and units brought back for certain products
- The emitter has a dual financial interest in concealing emissions: saving on abatement costs + saving on tax or getting more subsidies
- The burden of administrative costs can sometimes be reversed by requiring the emitter to prove that it has reduced its emissions (→ tax refund, e.g. with a deposit)

Comparison and choice criteria

POLITICAL FEASIBILITY (ACCEPTANCE)

Acceptability

- Do not look at all the qualities presented above only: instruments must be accepted !
- Policy-makers often select instruments that perform poorly on these objective criteria but are better accepted
- Typical conditions for acceptability:
  - The problem and solution are understood
  - The measure is perceived to be necessary
  - The measure is expected to yield sufficient environmental effect
  - The measure is perceived to be fair
  - No emitter bears an excessive burden, no firm is threatened in its survival
  - No firm is strongly disadvantaged in international competition
  - The budgetary impact of the instrument is accepted

Acceptability of AVs and prescriptions

- Clearly, voluntary approaches (VAs) are the most acceptable instrument for emitters, as they leave them the greatest freedom to comply or not
- Some also accept them because they are based on individual responsibility, with minimal interference from the public authorities
- On the other hand, prescriptions are the most popular instruments with the "polluted", as they are perceived as being the most effective and fairest (by applying equally to all emitters)
- Emitters oppose their freedom to prescriptions: they are the instrument that gives them the least freedom (although they can still take the risk of paying the fine)

Incentive taxes have the biggest problem of acceptability

- An instrument that economists have been advocating for its effectiveness and cost-efficiency since the 1920s, but which is still rarely used
- Perceived defects:
  - Its effectiveness is not directly understood, especially for emissions that are not very price-sensitive
  - Emitters do not understand that they still have to pay the tax when they have reduced their emissions by the proportion targeted by the instrument; they want to be able to avoid the tax altogether by behaving "correctly" (as with fines)
  - What is done with the revenues is not understood
  - Environmentalists do not understand that the right to pollute can be "bought" (commodification of the environment; cf. the sale of indulgences by the catholic church)

Textbook economic instruments can be made more acceptable

- Public budget neutrality can be achieved with combined tax-subsidy scheme or by free distribution of tradable emission quotas (TEQs)
- Burdens can be limited with exemptions: tax exempted baseline, lump-sum reimbursement of tax paid on an average or acceptable volume of emissions, initial endowment of TEQs, …
- Use the revenues to offset high burdens and communicate about it

CONCLUSIONS

General comparison of instruments (1)

	Environmental effectiveness	Cost-efficiency	Equity	Budgetary impact	Practical feasibility	Political feasibility
Voluntary approaches	Low, as everything is voluntary	Average, if emitters with lower abatement costs take action first	Threatened by freeriders, unless significant benefits are provided to participants	Low	High, unless efforts or improvements have to be proven	High among emitters and some politicians, as they leave freedom and responsibility to emitters
Public activities	Weak, especially with poor governance	Possibly costly activities, but secondary benefits	Depends on who pays and who benefits	Low to high, depending on activity	Requires legal adjustments	High among politicians who like 'cutting ribbons'
Strict prescriptions	High, provided compliance is ensured	Low: high abatement and administrative costs	Imposing equal efforts is not necessarily fair	Low, possibly positive through fines	Reduced by the need for detailed controls	High among pollutees and regulatory bodies

General comparison of instruments (2)

	Environmental effectiveness	Cost-efficiency	Equity	Budgetary impact	Practical feasibility	Political feasibility
Taxes on emissions	Uncertain, unless the instrument is regularly adjusted	Optimal, if the prices are right	The burden may be high, but the revenue can be used for social cushioning	Depends on the use of the revenue and the impacts on the revenues of other taxes	Can be raised by building on existing taxes	Low, as taxes are particularly unpopular with emitters
Subsidies on abated emissions	Uncertain, unless the instrument is regularly adjusted	Optimal, if the prices are right	Emitters receive money when they reduce their environmental impact…	High	Depends on how strict one wishes to be about who benefits from subsidies	High, as subsidies are particularly popular with emitters
Tradable emission quotas	High, provided compliance is ensured	Optimal in theory, if markets are efficient	Depends on the initial allocation of quotas	Low if quotas are distributed for free; high and positive if sold	Medium, as a market has to be set up and detailed control has to be applied	High among emitters if quotas are distributed for free

Conclusions

- The power of economic instruments is the minimisation of global abatement cost (efficient allocation of total abatement effort among all emitters)
- The power of prescriptions is the guaranteed abatement result (if compliance is ensured)
- The cost-inefficiency of prescriptions is smaller the closer they apply to the actual emissions
- Voluntary approaches are justified in a first stage, to build acceptance
- Public investments can lower abatement costs and contribute to acceptance (showing true involvement of the authorities)