The New Emission Trading System on Diffuse Emission in the European Policy Mix

Coline Metta-Versmessen, Anna Creti

LEDa Dauphine PSL University, Climate Economics Chair

Workshop Gas Economics Chair

Ecole des Mines - Paris

September 26, 2024

A new Emission Trading System on diffuse emissions

- Part of the EU's plan for carbon neutrality by 2050.
- Initiated by the European Commission in the 2018 Green Deal.
- Covers transport and building sectors (diffuse emissions).
- Aims for 44% emissions reduction by 2030 (compared to 2005).
- ETS2 operational in 2027, emission cap calculation in 2024.

Characteristics Inspired by ETS1

- Allowances based on 2024 emission levels, decreasing annually.
- Reduction rate: 5% annually.
- No risk of leakage: 100% auctioned permits.
- Delayed start possible if energy prices spike.
- Market Stability Reserve (MSR) to prevent extreme price hikes.

Market Stability Reserve (MSR) - 2027

Key Points:

- Starts with 600M allowances (in addition to cap)
- Purpose Stabilize prices by adjusting allowances.

Triggers:

- If Total Allowances in Circulation $<$ 210M: Release 100M allowances.
- If Total Allowances in Circulation $>$ 440M: Store 100M allowances in MSR2.
- Price $>$ €45/t (2 months): Release up to 40M allowances.
- Rapid price increase: 50M (2x price), 150M (3x price).

Limitations:

- Max 150M allowances/year.
- Delays in activating measures.

Risk of High Prices in ETS2

Price Estimates for 2030 (without complementary policies):

- €180/t (France, Germany, Poland) Jon Stenning et al. 2021.
- €174/t (France, Spain, Poland) Maj et al. 2021.
- €297/t (EU-wide) Rickels et al. 2023.
- €275/t (REMIND EU model) Pietzcker et al. 2021.

Price Estimates for 2030 (with complementary policies):

- Range: €175/t to €360/t Abrell et al. 2024.
- Price reductions with complementary policies: €71/t (PRIMES model) Günther et al. 2024.

Interaction with Effort Sharing Regulation-ESR

Key Points:

- Link to ESR: Same sectoral targets, but national budgets Abrell et al. 2024.
- New waterbed Effect: ETS2 and Annual Emission Allocations (AEA) prices should add up to a unified carbon price Görlach et al. 2022.

Disparities:

- Poorer countries exceed targets due to ETS2, wealthier countries rely on ESR Haywood et al. 2023.
- Southern/Eastern Europe as net sellers of ETS2 permits Rickels et al. 2023.

Importance of Complementary Policies:

- Limit inequalities and ensure ESR goals Günther et al. 2024.
- Example: California WCI shows 80% reliance on complementary policies Cullenward et al. 2016.

Impact on Households and Inequalities

Key Concerns:

- Inequalities: Higher cost burden for the poorer Hübler et al. 2024. Significant concerns between and within countries Jacobs et al. 2022.
- Climate Social Fund (CSF): Redistributes revenue from 150M allowances (25%), but may be insufficient for full progressive redistribution Gore 2022.

Sector-Specific Effects of ETS2:

- Transport: Reduces regressivity of existing taxes Jacobs et al. 2022.
- Buildings: Redistribution struggles to offset costs for poorest tenants George et al. 2023.

Complementary Policies:

- Necessary to mitigate inequalities Görlach et al. 2022 and improve social acceptability Braungardt et al. 2021.

Literature Gaps

- Few academic studies focus on the ETS2 market, and even fewer use a microeconomic framework.
- Unclear interaction between ETS1 and ETS2.
- Limited analysis on ETS2's long-term social and economic impacts.
- Insufficient exploration of complementary policies to lower ETS2 prices.

Research Questions

- How will ETS2 influence household decarbonization choices?
- How will ETS2 interact with ETS1?

Methodology

Based on Eichner and Pethig (2019):

- Productive sector based on fossil fuel,
- Climate regulations with emission quotas,
- Substitution between carbonized and clean technologies.

Our Contributions:

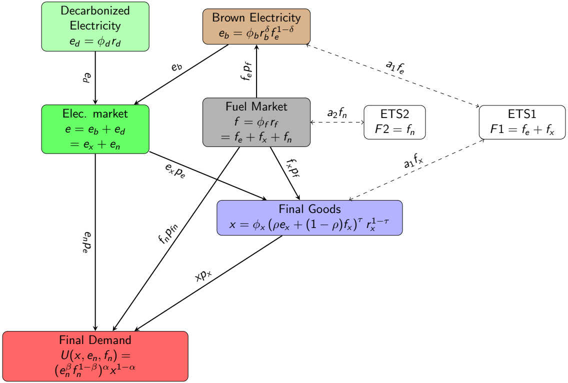
- Endogenous fossil fuel production.
- Broader quotas across all sectors, integrating national policies.
- Final energy demand added, with substitution between electricity and fossil fuels.

Comparison with Model Extensions:

- Cournot competition between fuel and electricity producers.
- Two-country model, reflecting consumer and policy differences.
- Resistance to change: households' reluctance to shift to electricity.

A reference model inspired by Eichner and Pethig (2019)

Technologies Regulations demand Results



Schematic representation of the reference model

Main variables

Productive Technologies

Main variables Model

- 2 productive technologies for Electricity production

$$e = \phi_d r_d + \phi_b r_b^{\delta} f_e^{1-\delta}$$

- A Composite good production

$$x = X(e_x, f_x, r_x) = \phi_x \left(\rho e_x + (1-\rho) f_x\right)^{\tau} r_x^{1-\tau}$$

- A representative fossil fuel production
(Can be representative of coal, gas, oil, independent on final uses)

$$f = \phi_f r_f$$

Climate Regulations

▸ Main variables ▸ Model

All fossil fuel used is capped, but with two different regulations:

- ETS 1: Caps and Targets electricity producers and Final good producers

$$F1 = f_e + f_x$$

- ETS 2: Caps fossil fuels final consumption but targets fossil fuel producers

$$F2 = f_n$$

➤ $f = f_n + f_e + f_x = F_1 + F_2 = F$

Demand

▸ Main variables ▸ Model

- The utility $U_(x_, e_n, f_n)$ is increasing with their consumption of final goods, x, and of energy services. For the latter, each agent can either consume fuel, f_n or electricity e_n

  ➤ $U(x, e_n, f_n) = (e_n^{\beta} f_n^{1-\beta})^{\alpha} x^{1-\alpha}$

- It is assumed that consumers' original equipment enables them to purchase up to $\bar{e_n}$ of electricity at the price p_e. More electricity can only be acquired by paying a fixed cost K

$$\text{s.c. } R = I_{[\bar{e_n},\infty)}(e_n)K + p_e e_n + p_{fn} f_n + p_x x$$

Assumptions on Production

Main variables Model

- **Assumption 1:** All productivity coefficients are constant and equal except for brown electricity:

$$\phi_d = \phi_f = \phi_x = \phi \quad \text{and} \quad \phi_b = z\phi$$

- **Assumption 2:** The price of the composite good taken as numeraire:

$$p_x = 1$$

➤ Profit functions simplified under these assumptions without loss of generalization.

Electricity Production Profit

▸ Main variables ▸ Model

$$\Pi_e = p_e \phi (r_d + z r_b^{\delta} f_e^{1-\delta}) - \bar{p}_r (r_d + r_b) - (p_f + a_1) f_e$$

- First-order conditions yield:

$$\begin{aligned} p_e &= \frac{\bar{p}_r}{\phi}, \\ &= \frac{\bar{p}_r}{\phi z \delta r_b^{\delta-1} f_e^{1-\delta}}, \\ &= \frac{p_f + a_1}{\phi z (1-\delta) r_b^{\delta} f_e^{-\delta}}. \end{aligned}$$

Fossil Fuel Production Profit

Main variables Model

$$\Pi_f = p_f(\phi r_f - f_n) + (p_{fn} - a_2) f_n - \bar{p}_r r_f$$

- First-order conditions yield:

$$p_f = \frac{\bar{p}_r}{\phi},$$
$$p_{fn} = \frac{\bar{p}_r}{\phi} + a_2,$$
$$\Rightarrow p_{fn} = p_f + a_2.$$

Final Goods Production Profit (with $p_x = 1$)

Main variables Model

$$\Pi_x = \phi\left((\rho e_x + (1-\rho)f_x)^{\tau}\, r_x^{1-\tau}\right) - p_e e_x - (p_f + a_1)f_x - \bar{p}_r r_x$$

- First-order conditions yield:

$$\begin{aligned} \bar{p}_r &= \phi(1-\tau)(\rho e_x + (1-\rho)f_x)^{\tau} r_x^{\tau}, \\ p_e &= \phi\tau\rho(\rho e_x + (1-\rho)f_x)^{\tau-1} r_x^{1-\tau}, \\ p_f + a_1 &= \phi\tau(1-\rho)(\rho e_x + (1-\rho)f_x)^{\tau-1} r_x^{1-\tau}. \end{aligned}$$

Consumer's Problem

Main variables Model

$$\mathcal{L}_c = (e_n^{\beta} f_n^{1-\beta})^{\alpha} x^{1-\alpha} + \lambda \left(R - I_{[\bar{e}_n,\infty)}(e_n)K - p_e e_n - p_{fn} f_n - p_x x \right)$$

- From the first-order conditions, we derive:

$$x = \frac{p_e}{p_x} \frac{(1-\alpha)e_n}{\alpha\beta},$$
$$f_n = \frac{p_e}{p_{fn}} \frac{(1-\beta)e_n}{\beta},$$
$$e_n = \frac{p_{fn}}{p_e} \frac{\beta f_n}{1-\beta}.$$

Total Demand Functions

▸ Main variables ▸ Model

- Substituting back in the budget constraint, final demand functions derived:

$$x = (1-\alpha)(R - I_{[\bar{e}_n,\infty)}(e_n)K),$$
$$f_n = \frac{\alpha(1-\beta)(R - I_{[\bar{e}_n,\infty)}(e_n)K)}{p_{fn}},$$
$$e_n = \frac{\alpha\beta(R - I_{[\bar{e}_n,\infty)}(e_n)K)}{p_e}.$$

Equilibrium Results

Main variables Model

- At equilibrium, energy prices are equal:

$$p_f^* = p_e^* = \frac{\bar{p}_r}{\phi}$$

- Carbon prices on ETS1 and ETS2 differ:

$$a_1^* = \frac{\bar{p}_r}{\phi\rho} - \frac{2\bar{p}_r}{\phi} \neq a_2^* = \frac{\alpha(1-\beta)(R - I_{[\bar{e}_n,\infty)}(e_n^*)K)}{F_2} - \frac{\bar{p}_r}{\phi}$$

  - a_1 depends on productivity (ϕ) and the share of fossil fuels (ρ) in production.
  - a_2 depends on the energy price, substitutability, and quota F_2.

Contribution and Next steps

A first model on ETS2 with consumer integration

- Including demand side changes the results of the literature,
- Carbon prices on ETS 1 and ETS 2 are different,
- Constraint on the demand side investment may necessitate complementary policies.

Future developments

- Comparative statics,
- To compare the results with the extended model,
- Numerical illustration.

Discussion

Thank You
for your attention.

Happy to answer your questions!

anna.creti@dauphine.psl.eu
coline.metta-versmessen@chaireeconomieduclimat.org

References I

Abrell, Jan et al. (Jan. 2024). "Optimal allocation of the EU carbon budget: A multi-model assessment". In: *Energy Strategy Reviews* 51, p. 101271.

Braungardt, Sibylle, Veit Bürger, and Benjamin Köhler (Jan. 2021). "Carbon Pricing and Complementary Policies—Consistency of the Policy Mix for Decarbonizing Buildings in Germany". en. In: *Energies* 14.21. Number: 21 Publisher: Multidisciplinary Digital Publishing Institute, p. 7143.

Cullenward, Danny and Andy Coghlan (June 2016). "Structural oversupply and credibility in California's carbon market". In: *The Electricity Journal* 29.5, pp. 7–14.

George, Jan Frederick et al. (June 2023). "The landlord-tenant dilemma: Distributional effects of carbon prices, redistribution and building modernisation policies in the German heating transition". en. In: *Applied Energy* 339, p. 120783.

References II

Gore, Tim (2022). *Can Polluter Pays policies in the buildings and transport sectors be progressive?* en. Tech. rep. Institute for European Environmental Policy.

Görlach, Benjamin et al. (June 2022). *A Fair and Solidarity-based EU Emissions Trading System for Buildings and Road Transport*. Tech. rep. Porsdam: Ariadne.

Günther, Claudia et al. (2024). "Carbon prices on the rise? Shedding light on the emerging EU ETS2". en. In: *Working Paper SSRN Electronic Journal*.

Haywood, Luke and Michael Jakob (Aug. 2023). "The role of the emissions trading scheme 2 in the policy mix to decarbonize road transport in the European Union". In: *Transport Policy* 139, pp. 99–108.

Hübler, Michael et al. (Apr. 2024). "The distributional effects of CO 2 pricing at home and at the border on German income groups". en. In: *Resource and Energy Economics* 77, p. 101435.

References III

Jacobs, Leif, Lara Quack, and Mario Mechtel (Oct. 2022). "Distributional effects of carbon pricing by transport fuel taxation". en. In: *Energy Economics* 114, p. 106290.

Jon Stenning et al. (2021). *Exploring the trade-offs in different paths to reduce transport and heating emissions in Europe*. Tech. rep. Cambridge, UK: Cambridge Econometrics.

Maj, M. et al. (2021). *Impact on Households of the Inclusion of Transport and Residential Buildings in the EU ETS*. Tech. rep. Warsaw: Polish Economic Institute, ERCST, Cambridge Economics.

Pietzcker, Robert et al. (2021). *Notwendige CO2-Preise zum Erreichen des europäischen Klimaziels 2030*. de. Tech. rep. Artwork Size: 20 pages Medium: pdf. Potsdam Institute for Climate Impact Research, 20 pages.

References IV

Rickels, Wilfried et al. (2023). *Potential efficiency gains from the introduction of an emissions trading system for the buildings and road transport sectors in the European Union*. eng. Kiel Working Paper. Kiel.

Main Variables

Method

e:	Electricity supply	f:	Fossil fuel supply	p_e:	Electricity price
e_d:	Decar. electricity	f_x:	Fossil fuel for final goods	p_f:	Fossil fuel price for production
e_b:	Brown electricity	f_n:	Fossil fuel for consumption	p_{fn}:	Fossil fuel price for consumption
r_d:	input - decarb. electricity	f_e:	Fossil fuel for elec	p_x:	Final goods price
r_b:	Input for brown electricity	e_x:	Elec for final goods	R:	Consumer income
r_f:	Input for fossil fuel production	e_n:	Elec for consumers	a_1:	Emission price on ETS1
r_x:	Input for final goods	x:	Total final goods	a_2:	Emission price on ETS2

Results: Work in Progress

▸ Results

$e^* =$		$f^* =$	$F = F_1 + F_2$
$e_d^* =$		$f_n^* =$	F_2
$e_b^* =$		$f_x^* =$	
$e_x^* =$		$f_e^* =$	
$e_n^* =$	$\frac{\phi\alpha\beta(R - I_{[\bar{e_n},\infty)}(e_n^*)K)}{\bar{p}_r}$	$x^* =$	$(1-\alpha)(R - I_{[\bar{e_n},\infty)}(e_n^*)K)$
$r_b^* =$		$r_x^* =$	$\frac{(1-\tau)(1-\alpha)(R - I_{[\bar{e_n},\infty)}(e_n^*)K)}{\bar{p}_r}$
$r_d^* =$		$r_f^* =$	
$p_e^* =$	$p_f^* = \frac{\bar{p}_r}{\phi}$	$p_{fn}^* =$	$p_f^* + a_2^* = \frac{\alpha(1-\beta)(R - I_{[\bar{e_n},\infty)}(e_n^*)K)}{F_2}$
$a_1^* =$	$\frac{\bar{p}_r}{\phi\rho} - \frac{2\bar{p}_r}{\phi}$	$a_2^* =$	$\frac{\alpha(1-\beta)(R - I_{[\bar{e_n},\infty)}(e_n^*)K)}{F_2} - \frac{\bar{p}_r}{\phi}$