The Climate Policy Assessment Tool (CPAT)

World Bank/International Monetary Fund (IMF) Fiscal Affairs Department

A contribution to the 'Compendium of Practice from a Global Community of Ministries of Finance and Leading Organizations: Economic analysis and modeling tools to assist Ministries of Finance in driving green and resilient transitions'

Topic: Modeling tools relevant to Ministries of Finance

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Access the full Compendium at www.greenandresilienteconomics.org

About CPAT

The Climate Policy Assessment Tool (CPAT) is a spreadsheet-based 'model of models' built by economists at the IMF and World Bank (WB). It allows the rapid estimation of effects of mitigation policies for over 200 countries.[1] This includes impacts on energy demand and prices, CO_2, and other greenhouse gas (GHG) emissions, fiscal revenues, GDP, welfare, distributional impacts on households and industries, and development co-benefits such as health benefits from reductions in local air pollution and road accidents. CPAT is the result of a multi-year collaboration between the World Bank and IMF staff.

CPAT helps governments design and implement climate mitigation policies:

- **Quantification of many impacts:** including impacts on energy production, consumption, trade, and prices; emissions of local and global pollutants including reductions needed to achieve Nationally Determined Contributions (NDCs); GDP (disaggregated by revenue usage) and economic welfare; revenues (disaggregated by fuel, sector, and tax instrument); industry incidence (across many sectors); household incidence (across deciles, urban vs. rural samples, and horizontal equity); and development co-benefits (local air pollution and health impacts). This allows the assessment of tradeoffs (e.g., among efficiency, equity, or administrative burden) and, hence, tailoring of policy design to each country's context.
- **Climate mitigation policies:** CPAT focuses mainly on policies that impact energy costs. This covers direct and indirect carbon pricing policies and other mitigation policies, including carbon taxes, emissions trading systems (ETSs), fossil fuel subsidy reform, energy price liberalization, electricity and fuel taxes, removal of preferential VAT rates for fuels, energy efficiency and emission rate regulations, feebates, clean technology subsidies, and, importantly, combinations of some of these policies ('policy mixes').
- **Multi-country coverage:** CPAT covers over 200 countries with no need for external data[2] inputs (though the user has the option of incorporating their own data or parameter assumptions).
- **Transparent, user-friendly, and consistent framework:** Results are presented rapidly via a chart-driven interface (see Figure 1), allowing experimentation (and sensitivity analyses) in designing new policies or assessing existing proposals and quick incorporation of results into reports.

Using the model

The user interacts primarily with the 'dashboard' without the need to input external data (Figure 1). The dashboard is a chart-driven, user-friendly interface. The user selects the country of interest, mitigation 'policy scenario' (e.g., carbon or energy taxes), the strength/coverage of the policy (across fuels and sectors), and complementary policies (e.g., fossil fuel subsidy reform, energy price liberalization, and feed-in subsidies for renewables). Any revenue raised or saved can be allocated to tax reductions, current spending, public investment, or transfers. Key parameters (e.g., price and income elasticities) can be customized by the user. CPAT does not require any external data to function for the countries covered, but users can input such data (e.g., on domestic energy prices) in the 'Manual Inputs' tab.

Figure 2 shows example outputs from CPAT. There are around 150 other charts available to the user, with outputs including: energy demand and prices (including gaps to socially optimal price levels);

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[1] The full, detailed methodology can be found at https://cpmodel.github.io/cpat_public/; it is available in summary form here: https://www.imf.org/en/Publications/WP/Issues/2023/06/22/The-IMF-World-Bank-Climate-Policy-Assessment-Tool-CPAT-A-Model-to-Help-Countries-Mitigate-535096.
[2] Energy demand and production data is from the International Energy Agency (IEA), Enerdata, and other sources. GDP projections are from the latest IMF forecasts. Data on energy taxes, subsidies, and prices by energy product has been compiled from publicly available and IMF sources, with inputs from proprietary and third-party sources.

national emissions and electricity capacity, investment and generation by energy source; impacts on trade of energy goods; sectoral decarbonization targets (in NDCs); impacts on revenues from changes in taxes and subsidies on fuels, electricity, and renewables; impacts on GDP over time and by policy change (taxes, expenditures, investments, or transfers); GHG emissions by sector, gas, and fuel; and, finally, energy-related CO_2 emissions by sector, industry, and fuel. CPAT also shows impacts on industry, direct and indirect effects on households from changes in energy and other goods'/services' prices, and net incidence impacts (accounting for 'revenue recycling' i.e., use of revenues raised or saved for, e.g., PIT cuts or cash transfers). Lastly, CPAT shows the welfare spillovers from climate policy on health, congestion, and road safety (known as 'development co-benefits'). Fossil fuel combustion creates emissions of local air pollutants like fine particulate matter ($PM_{2.5}$) and low-lying ozone (O_3). Cuts in fuel combustion can, therefore, help improve human health. CPAT estimates these benefits by disease, age group, location, and source using several methods. Lastly, increases in road fuel prices tend to cut road accidents, congestion, and their associated external costs which, alongside other road sector impacts, are estimated and shown to users.

CPAT is a spreadsheet-based 'model of models' with four key modules:

1. Mitigation module: a reduced-form macro-energy model for estimating impacts of climate mitigation policies on energy consumption, prices, GHGs, local air pollutants, revenues, GDP, and welfare
2. Distribution module: a cost-push microsimulation model for estimating impacts of energy and non-energy price changes on industries and households (by consumption decile and region), net of revenues used ('revenue recycling') for public investment, transfers, or personal income tax (PIT) cuts
3. Air pollution module: a reduced-form air pollution and health model for estimating impacts on premature deaths and disease from local air pollutants like fine particles (e.g., $PM_{2.5}$) and ozone
4. Transport module: a reduced-form model for estimating the impacts of motor fuel price changes on congestion and road accidents/fatalities as well as their external costs.
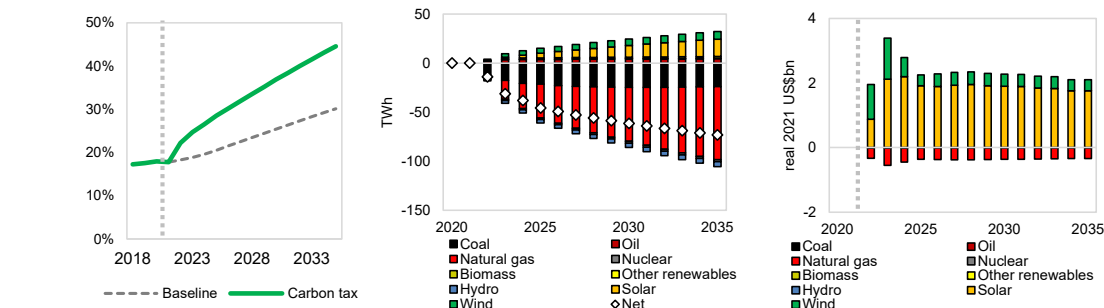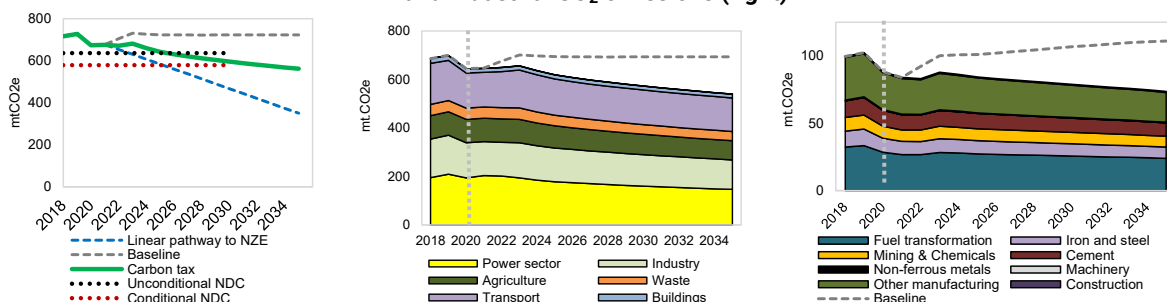
Figure 1. The main CPAT interface or dashboard
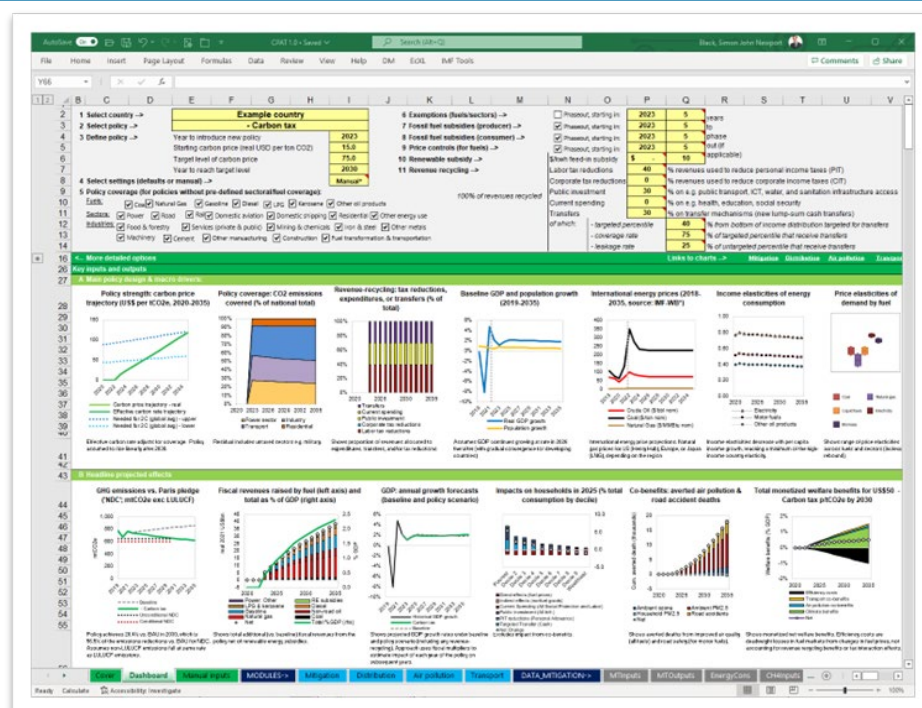
Source: World Bank and IMF staff

Figure 2. Example outputs from CPAT (for economy-wide US$75 carbon price/ton CO_2e by 2030, unspecified country)
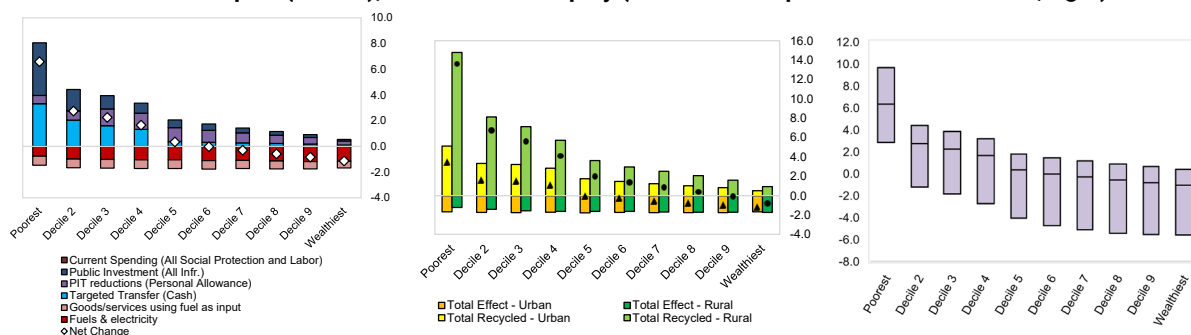
Panel A. Energy—renewable shares of power generation (left), changes in generation by source (middle), and changes in annual investment in power capacity (right)
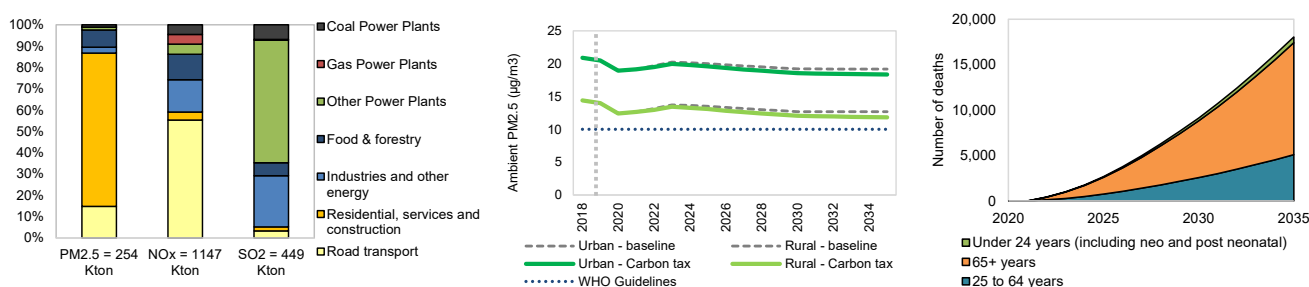

Left chart y-axis: 50%, 40%, 30%, 20%, 10%, 0%; x-axis: 2018, 2023, 2028, 2033
Legend: Baseline; Carbon tax

Middle chart y-axis (TWh): 50, 0, -50, -100, -150; x-axis: 2020, 2025, 2030, 2035
Legend: Coal; Oil; Natural gas; Nuclear; Biomass; Other renewables; Hydro; Solar; Wind; Net

Right chart y-axis (real 2021 US$bn): 4, 2, 0, -2; x-axis: 2020, 2025, 2030, 2035
Legend: Coal; Oil; Natural gas; Nuclear; Biomass; Other renewables; Hydro; Solar

Panel B. Emissions—GHGs vs. targets (left), GHG by sector (middle), and industrial CO_2 emissions (right)

Left chart y-axis (mtCO2e): 800, 600, 400, 200, 0; x-axis: 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034
Legend: Linear pathway to NZE; Baseline; Carbon tax; Unconditional NDC; Conditional NDC

Middle chart y-axis (mt CO2e): 800, 600, 400, 200, 0; x-axis: 2018 2020 2022 2024 2026 2028 2030 2032 2034
Legend: Power sector; Industry; Agriculture; Waste; Transport; Buildings

Right chart y-axis (mt.CO2e): 100, 50, 0; x-axis: 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034
Legend: Fuel transformation; Iron and steel; Mining & Chemicals; Cement; Non-ferrous metals; Machinery; Other manufacturing; Construction; Baseline

Panel C. Net household incidence—mean consumption effect (percent pre-policy consumption; left), between urban and rural sub-samples (middle); and horizontal equity (for 25th–75th percentiles and median; right)

Left chart y-axis: 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0; x-axis: Poorest, Decile 2, Decile 3, Decile 4, Decile 5, Decile 6, Decile 7, Decile 8, Decile 9, Wealthiest
Legend: Current Spending (All Social Protection and Labor); Public Investment (All Infr.); PIT reductions (Personal Allowance); Targeted Transfer (Cash); Goods/services using fuel as input; Fuels & electricity; Net Change

Middle chart y-axis: 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0; x-axis: Poorest, Decile 2, Decile 3, Decile 4, Decile 5, Decile 6, Decile 7, Decile 8, Decile 9, Wealthiest
Legend: Total Effect - Urban; Total Effect - Rural; Total Recycled - Urban; Total Recycled - Rural

Right chart y-axis: 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0; x-axis: Poorest, Decile 2, Decile 3, Decile 4, Decile 5, Decile 6, Decile 7, Decile 8, Decile 9, Wealthiest

Panel D. Air pollution—baseline emissions of local air pollution by source and pollutant (left), changes in local air pollution concentrations (middle), and cumulative avoided deaths by age (right)

Left chart y-axis: 100%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, 0%; x-axis: PM2.5 = 254 Kton, NOx = 1147 Kton, SO2 = 449 Kton
Legend: Coal Power Plants; Gas Power Plants; Other Power Plants; Food & forestry; Industries and other energy; Residential, services and construction; Road transport

Middle chart y-axis (Ambient PM2.5 (µg/m3)): 25, 20, 15, 10, 5, 0; x-axis: 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034
Legend: Urban - baseline; Rural - baseline; Urban - Carbon tax; Rural - Carbon tax; WHO Guidelines

Right chart y-axis (Number of deaths): 20,000, 15,000, 10,000, 5,000, 0; x-axis: 2020, 2025, 2030, 2035
Legend: Under 24 years (including neo and post neonatal); 65+ years; 25 to 64 years

Source: IMF and WB staff using CPAT

CPAT is part of a growing climate policy analysis toolbox but nonetheless has strengths and weaknesses. CPAT's strengths include its comprehensive country coverage, its multiple sectors and policies, and the assessment of economic and non-economic outcomes. Its core strength is in covering many different tradeoffs of climate policies for rapid policy assessment and design. But no model can answer all policy questions, and other models can be more appropriate in certain contexts. Among CPAT's limitations are omitting policies targeting the land use, land use change forestry (LULUCF) sector and its reliance on an elasticity-based approach (except in the power sector) which may not capture non-linear responses to sudden or large price changes.

Planned future improvements to CPAT include better coverage of sectors, impacts, and policy mixes. In implementing mitigation policies, countries are increasingly adopting a sectoral approach. Models with dynamic capital turnover have been developed separately for transport and buildings and will be incorporated in future versions. These models include a dynamic capital stock which enables better modeling of sectoral policies, such as a tightening of emission rate standards (for new or existing vehicles and buildings) and green industrial policies such as subsidization of newer technologies. This can also allow quantification of the spillover impact of technology policies on costs due to learning curve effects[3] and the impact of capital vintages on optimal mitigation strategies.[4] Other, more refined, industry- and activity-specific sectoral models, such as for industrial sectors like steel, chemicals, and cement, alongside agriculture, and forestry, are being modeled. Additionally, economic impacts, policy coverage, and international linkages will be enhanced. Lastly, it is envisioned that CPAT will increasingly allow linkages with external models, either to give outputs to or consider inputs from.

CPAT has been used extensively by IMF and WB staff for climate mitigation policy analysis (see Table 1 for a list of example publications for each institution). For the IMF, this includes:

- Country-level analyses produced as part of the IMF's regular economic consultations with countries (Article IV Reports), country-specific working papers, technical assistance, and in support of the Resilience and Sustainability Trust (RST).
- Regional analyses, for example on needed policies and impacts of global energy price shocks.
- Global analysis on the implications of the global economic crisis for mitigation, gaps in global climate policy and options for scaling-up action equitably, and proposing an international carbon price floor.
- Thematic policy analyses, notably for the IMF's new Staff Climate Note (SCN) series, such as quantified comparisons of mitigation instruments (e.g., carbon taxes and ETSs), fossil fuel subsidy reform, methane taxes, and the carbon price equivalence of mitigation policies.

For the World Bank, example publications include country core analytical reports such as Public Finance Reviews and Country Climate and Development Reports, as well as other Analytical and Advisory Services reports, technical assistance reports and World Bank Working Papers. These reports and publications primarily focus on fossil fuel subsidy reforms, carbon taxes, ETSs, VAT differential rate reforms, and energy tax reforms, following the Total Carbon Pricing approach.

CPAT is being made available to governments by both the WB and IMF. To request access from the WB, countries can email cpat@worldbank.org. To request access from the IMF, countries can request through their ED offices, and further details can be found at www.imf.org/cpat. Overall, the CPAT model can help MoFs, along with planning and line ministries, to rapidly assess, design, and implement climate mitigation policies needed for economy-wide decarbonization.

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3 Wright's law relates the impact of cumulative production of technologies with the change in unit costs: as firms get better at producing technologies (e.g., via learning-by-doing) average total costs decline. Currently in CPAT, a learning rate methodology is applied on decline of costs of renewables, indicating the price reduction of technology arising from every doubling of cumulative installed capacity (experience rate). Four types of learning rate parameters (low, medium, high, very high) are specific for solar and wind.

4 The need for rapid decarbonization and the long-lived nature of some energy-consuming capital goods as buildings (in addition to market failures) justifies additional policy effort in these sectors.

Table 1. Selected IMF and WB applications of CPAT (as of March 2025)

Coverage	Year	Publication	Title
IMF publications:			
<u>Country and regional analysis</u>			
France	2024	WP	Balancing Impacts of Transportation Decarbonization in France
Gambia	2024	TAR	The Gambia: Climate Policy Diagnostic
Jordan	2024	TAR	Jordan: Climate Policy Diagnostic
Belgium	2023	SIP	Fiscal Policy Options to Accelerate Emissions Reductions in Belgium
Chile	2023	TAR	Chile: An Evaluation of Improved Green Tax Options
Middle East	2023	DP	A Low-Carbon Future for the Middle East and Central Asia: What are the Options?
Latin America	2023	REO	Regional Economic Outlook for Latin America and the Caribbean, October 2021
Europe	2022	WP	Surging Energy Prices in Europe in the Aftermath of the War
<u>Global and thematic analysis</u>			
All countries	2024	SCN	Destination Net Zero: The Urgent Need for a Global Carbon Tax on Aviation and Shipping
All countries	2024	SCN	Sleepwalking to the Cliff Edge? A Wake-up Call for Global Climate Action
G20	2024	WP	Fiscal Implications of Global Decarbonization
All countries	2023	WP	IMF Fossil Fuel Subsidies Data: 2023 Update
G20	2022	SCN	Carbon Taxes or Emissions Trading Systems? Instrument Choice and Design
G20	2022	WP	A Framework for Comparing Climate Mitigation Policies Across Countries
Various	2022	SCN	How to Cut Methane Emissions
G20	2021	SCN	Proposal for an International Carbon Price Floor Among Large Emitters
G20	2019	FM	Fiscal Monitor: How to Mitigate Climate Change
WB publications:			
<u>Country analysis</u>			
Armenia	2024	PFR	Armenia Public Finance Review: Enhancing Fiscal Policy Efficiency
Brazil	2023	CCDR	Brazil Country Climate and Development Report
Colombia	2024	TA	Una mirada de la desigualdad y los efectos distributivos del impuesto nacional al carbono with an associated press release
Georgia	2024	PFR	Georgia: Public Finance Review Fiscal Policy for Inclusive Growth
Indonesia	2023	CCDR	Indonesia Country Climate and Development Report
Poland	2024	CCDR	Poland Country Climate and Development Report
Romania	2023	ASA CCDR	Reimbursable Advisory Services Agreement on Improving the Tax Framework in Romania in the context of the National Recovery and Resilience Plan; Romania Country Climate and Development Report
Tajikistan	2024	CCDR	Tajikistan Country Climate and Development Report
Thailand	2023	PFR	Thailand Public Spending and Revenue Assessment: Promoting an Inclusive and Sustainable Future
Tunisia	2023	CCDR	Tunisia Country Climate and Development Report
South Asia	2022	EF	South Asia Economic Focus, Spring 2022. Reshaping Norms: A New Way Forward
Western Balkans	2024	CCDR	Western Balkans 6 Country Climate and Development Report
Uzbekistan	2023	CCDR	Uzbekistan Country Climate and Development Report
<u>Regional/thematic analysis</u>			
Bulgaria, Croatia, Poland, Romania	2022	RER	EU Regular Economic Report. Green Fiscal Reform. Part Two of Strengthening Inclusion and Facilitating the Green Transition.
South Asia	2024	WP	Toward a Low-Carbon and Just Energy Transition in Developing Asia
South Asia	2024	WP	Are Carbon Taxes Good for South Asia?

Coverage	Year	Publication	Title
35 countries	2023	WP	Distributional and Health Co-Benefits of Fossil Fuel Subsidy Reforms

Notes: SIP = Selected Issues Paper, TAR = Technical Assistance Report, SR = Article IV Staff Report, WP = Working paper, DP = Departmental Paper, FM = Fiscal Monitor, REO = Regional Economic Outlook, SCN = IMF Staff Climate Note, BP = Board Paper, BC = Book Chapter, JA = Journal Article. PFR = Public Financial Review. CCDR = Country Climate Diagnostic Report. RER = Regular Economic Review. EF = Economic Focus.
Source: WB and IMF staff.