CLIMATE & SUSTAINABILITY
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WHAT POLICYMAKERS SHOULD KNOW ABOUT ENERGY TRANSITION AFFORDABILITY

THREE CRITICAL POLICY ELEMENTS WHEN STEPPING UP FROM "STEPS" TO NET ZERO

AN AFFORDABLE GREEN TRANSITION: THE WHAT AND THE HOW

To limit global rises in temperature, the economies of the world need to radically change the way they produce and consume energy. Policies currently in place to address this challenge often referred to as "stated policies" or the STEPS scenario, are not sufficient. For a sustainable future, the world will need to reach net zero emissions, the so-called "NZE scenario", driven by substantially more ambitious climate policies.

Addressing climate change effectively will not only impact our ability to curb emissions, but also mitigate rising social costs from extreme weather events, droughts, and rising sea levels. In doing so, effective climate policy will entail transition costs. Abatement of CO_2 by transitioning from high- to low-carbon technology options is expensive. The cost of reducing emissions is referred to as the "abatement cost", and reductions by one additional tonne of CO_2 as the "marginal abatement cost".

Global willingness to accept these changes will ultimately depend on whether the transformation is seen as affordable, which means that consumers across the world avoid significant decreases in living standards as energy-consuming products become more expensive. Global, regional, and national policies will need to deliver an affordable global green transition: otherwise, comprehensive decarbonisation will not happen.

In this brief, we examine whether it is possible to deliver an affordable green transition, the investment needed to go from STEPS to NZE ("stepping up from STEPS") in terms of emissions, and what policies make this process as affordable as possible. We use INTERSECT^{SM}, our newly developed global climate-economic model co-developed with Bain & Company, to provide quantifiable insights informing the answers to these important questions.

Our INTERSECT^{SM} model provides both detailed and coherent forecasts across sectors and regions. Covering the entire global economy, it links the macroeconomy with greenhouse gas emissions. INTERSECT^{SM} incorporates green technology options, for example within transportation fuels, into a wider policy perspective. The model forecast can be based on different climate scenarios such as the IEA STEPS or Net Zero.

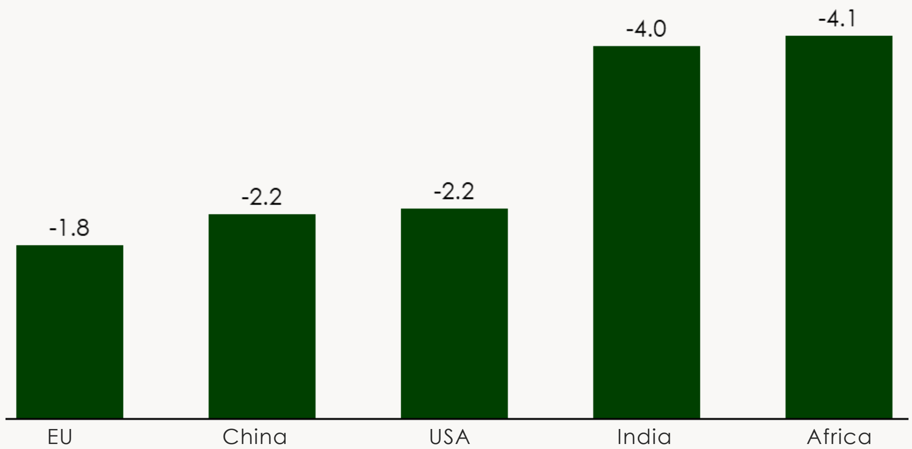
Is it possible to deliver an affordable green transition?

ABSOLUTELY

While the green transition will inevitably involve costs, it can be achieved affordably if executed in the right way.

Figure 1
Effect on real private consumption per capita when going from stated policies to net zero emissions, 2040

Percent (%)



Note: Impact on private consumption is measured in real terms.

Source: INTERSECT[SM], Copenhagen Economics' climate-economic model.

Is it possible to deliver an affordable green transition? Absolutely! While the transition effectively lowers consumers' real income by increasing production costs based either on more expensive but green technologies or a CO_2 tax, our calculations suggest that the cost of going from STEPS to NZE is manageable.

When we run the scenarios in our model, we estimate that the reduction in private consumption in NZE compared to STEPS may be as low as 2% to 4% annually by 2040 in most countries, with high-income countries typically at the lower end of this range.

The relative burden on low-income countries is heavier, partly because the absolute cost of green technologies is similar across countries and partly because their per capita consumption is lower.

While these costs are not negligible, they should be seen in the context of the growing standards of living in general.

Most forecasters expect per capita income to have increased by more than 50% in a majority of countries by the middle of this century.

To deliver on net zero while maintaining this level of affordability, policies will need to be timely, efficient, and credible to drive and support the green transition.

This requires a combination of three critical elements in climate policy: 1. higher carbon pricing, 2. international cooperation (notably on burden-sharing), and 3. maturing of critical technologies.

1 EFFECTIVE CARBON PRICING BOOSTS APPEAL OF COSTLY GREEN TECH

Carbon pricing is currently underutilised as an incentive for investments, even in relatively cost-effective green technologies. The global average may be as low as USD 6 per tonne of CO_2 emitted. Higher effective levels of carbon pricing - from market-based pricing or direct policy interventions - are needed.

For several green technologies, a carbon price well below USD 100 per tonne would likely be sufficient to make them competitive with the conventional options subjected to a CO_2 tax. Already today in many regions, light-duty electrical vehicles and solar and wind energy are cost-competitive compared to their more carbon-intensive counterparts.

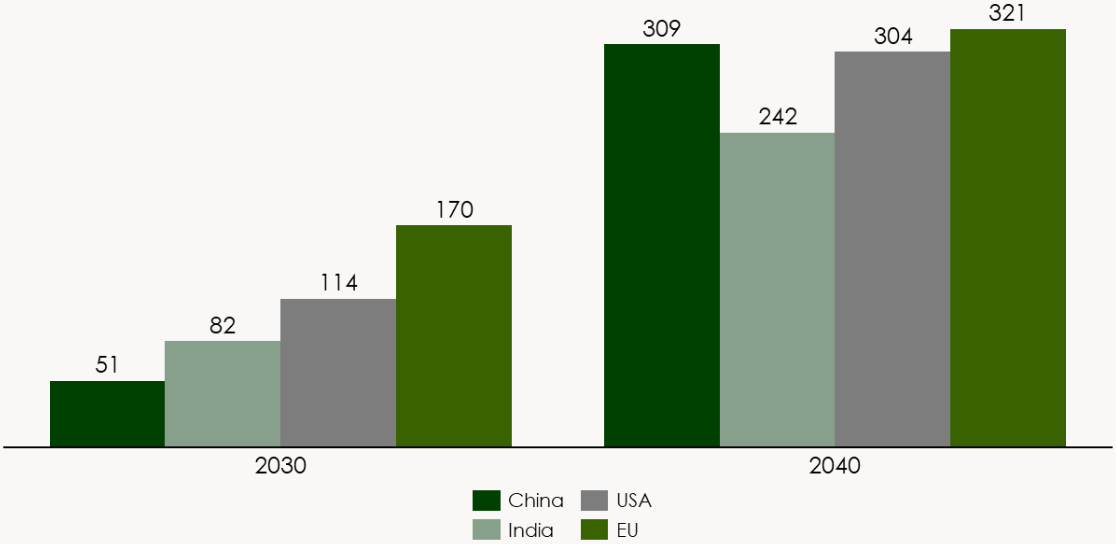
In the NZE scenario, we expect significant reductions in emissions from buildings. The existing housing stock will continue to be retrofitted for energy efficiency improvements, which is a significant and relatively cheap way to abate CO_2. Heat pumps will replace gas boilers for residential heating in many regions as we approach 2030-35. However, efficiency improvements and direct electrification will only take us some of the way towards net zero.

Where direct electrification is not an option, higher levels of carbon pricing are needed to drive decarbonisation. In these hard-to-abate sectors such as energy-intensive manufacturing (e.g. steel and cement) or long-distance transportation, greener options are still less mature and hence more expensive to deploy. As we discuss below, another critical element will be to promote the maturity of these technologies (see point 3 below).

As we run the emissions reductions from the NZE scenario in our model, we see that the effective carbon price needs to increase significantly across all regions. As high-income countries already need to make significant emission cuts towards 2030, they have to implement a carbon price above USD 100 (see Figure 2). In developing countries, the price needed is significantly lower, around USD 50-80 in 2030. Later, as all regions will need to decarbonise more aggressively, carbon prices must increase to much higher levels to incentivise the uptake of the most expensive options.

Figure 2
CO_2 prices in selected regions | Net Zero Emissions Scenario

USD/tCO_2



Note: CO_2 prices reflect marginal abatement costs. They can represent a market-based carbon price or more direct policy interventions.

Source: INTERSECT[SM], Copenhagen Economics' climate-economic model.

2 INTERNATIONAL COOPERATION

Broadening international cooperation has great potential to improve affordability and spur climate action. Currently, political concerns over domestic job and production losses delay significant climate action. Furthermore, in order to protect emission- and trade-intensive industries such as steel and cement, the de facto tendency is for climate policies to be coupled with trade protectionist measures.

Instead of maintaining a domestic perspective on climate policy, we suggest that burden-sharing be put at the forefront of global climate actions. By burden-sharing, we mean that high-income countries commit to the most comprehensive emission cuts and that the physical abatement will happen where it is cheapest on the margin.

This decreases the necessary carbon price in high-income countries because they can compensate other regions to allow cheaper abatement to be located there. An efficient, market-based mechanism to achieve burden-sharing is for multiple regions to engage in emissions allowance trading.

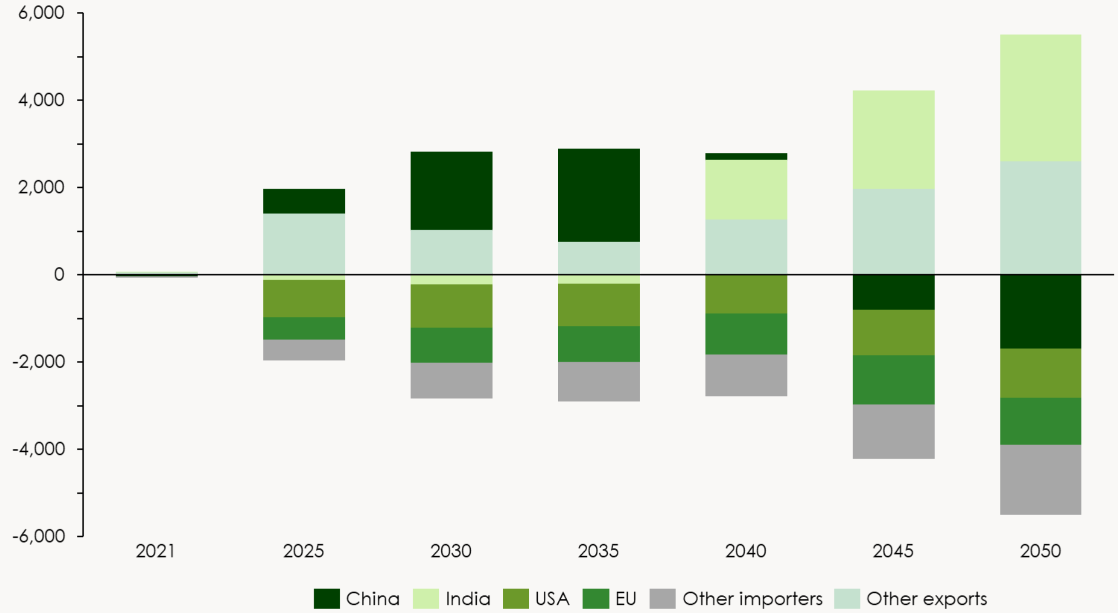
To illustrate the potential of this action, Figure 3 shows our model's estimate of what happens under a global carbon trading mechanism (with all regions participating). As one might expect, the biggest exporters of CO_2 allowances will be regions like China and India, reflecting the fact that these countries have a large potential for cheap abatement, in particular by phasing out coal power. Both regions are large emitters of CO_2 and therefore have great potential to increase the supply of allowances.

Marginal abatement costs are lower in China until 2040, when India starts exporting allowances due to relatively low abatement costs. High-income regions such as the EU and the USA will be importers of allowances.

The starting point for these regions is a lower emission intensity per GDP as they have already picked some of the "low-hanging fruits", for example, through a higher share of renewable electricity production. As a result, these regions would prefer to pay other regions to do part of the total abatement, which they have otherwise committed to do themselves.

Figure 3
Global volumes of carbon trading by origin and destination | Net Zero Emissions Scenario

Annual net export of emission allowances, Mt CO_2



Source: INTERSECT℠, Copenhagen Economics' climate-economic model.

The potential scale of this mechanism is significant: our model predicts that the total potential corresponds to 12% and 67% of global gross emissions in 2030 and 2050, respectively.

Carbon trading illustrates one of the key benefits of international cooperation: it breaks the tight link between regional transition costs and regional marginal abatement costs.

In this way, an international carbon trading scheme paves the way for a more efficient allocation of resources to combat climate change.

While a global emissions trading scheme is unlikely at this point for various political reasons, we do see China, the USA, India, and the EU as natural and beneficial candidates for this kind of cooperation.

In reality, the path from "large potential" to a credible and well-implemented multinational policy mechanism is long. Besides addressing basic issues of governance structures and surveillance of such a scheme, for a global carbon trading mechanism to work, we also see a need for an international standard for the measurement of carbon content for inter-regional trade in products.

To harvest the benefits of burden-sharing it is a prerequisite that political risks are reduced. Particularly in emerging economies, governance structures are making large green energy investments unattractive in some regions. Even if an efficient global carbon trading mechanism was in place, the lack of investment in renewable energy production would diminish or remove these comparative cost advantages.

3 PROMOTING THE ECONOMIC MATURITY OF CRITICAL TECHNOLOGIES

Reaching net zero will require significant uptake of new technologies such as Carbon Capture, Utilisation, and Storage (CCUS), direct air capture (DAC), and Power-to-X (PtX). These technologies are all widely believed to play an important role in the future decarbonisation of hard-to-abate sectors.

Even in the NZE scenario, our model simulations suggest that it will be cost-effective to allow some subsectors to continue to use fossil fuel-based energy, and even remain net emitters. We project that this will be the case, for example, for some areas of manufacturing and transportation. Net zero emissions can still be reached if CCUS and DAC technologies are deployed and remove sufficient CO_2 from the atmosphere to balance emissions from the continued use of fossil fuels in these subsectors.

Once these key technologies mature, policymakers can push decarbonisation more aggressively without increasing the marginal abatement costs to society. If a new DAC facility powered by solar cells can be deployed at USD 300 per tonne of CO_2 abated, for example, this effectively caps the necessary carbon price due to the fact that, even if the marginal abatement cost in other sectors surpasses USD 300, it will always be cheaper for them to pay for an emission allowance offset by a DAC facility.

In the end, this limits the additional cost that is passed on to consumers.

Most of the technologies that are critical to the green transition will become cheaper over time, as firms become more skilled at using and producing green energy products. Because of this, the INTERSECT[SM] model includes these learning effects when analysing different scenarios.

As learning happens by doing, this too will improve affordability as a reduced cost of key technologies means a reduced marginal abatement cost. Such a scenario relies heavily on early adoption.

While delayed promotion of key technologies increases the future cost of the transition, timely technology support, including from high carbon prices, will increase affordability beyond the near term.

As mentioned, our model points to CCUS playing a key role in the NZE scenario, reducing emissions affordably. Hence, the early maturity of CCUS technology will reduce the necessary carbon price towards 2050.

INTERSECT[SM]

the Global Climate Economic Model
by Copenhagen Economics and Bain & Company

INTERSECT[SM] is a CGE model combining economic theory with real-world data across 30 sectors and 18 regions, allowing for simulations up to 2050.

A new climate- and energy-based dynamic Computable General Equilibrium model

Dynamic
The model tracks flows, technology development, and investments year-by-year towards 2050.

Climate
Carbon emissions are built into the core of the model, enabling insights into detailed decarbonisation paths and their impacts.

Computable
Historical data serves as the foundation for the model, allowing magnitudes of opportunities and costs to be quantified under a range of scenarios.

General
It simultaneously models all economic activity in the global economy, including production, consumption, employment, investment, taxes and trade, as well as the linkages between them.

Equilibrium
Supply and demand are in balance and there is no pressure for prices or quantities to adjust, giving a robust set of prices, quantities and trade volumes for all industries and regions up to 2050.

Market-leading and innovative features

Supply curves for key minerals and fuels
We supplement endogenous supply curves with insights from industry experts to compile rich supply curves on oil, gas and key minerals.

Vintage capital approach
We track capital investments for capital-heavy assets year-by-year to allow for sunk-cost aspects.

Endogenous technology costs based on learning curves
Technology cost developments are endogenous, based on deployment in previous model years.

Synergy of top-down and bottom-up approaches
A hybrid approach allows for explicit choice of technology while considering the broader economic impacts of these choices.

Global in scope, consistency and coverage
Based on a complete value-chain approach, the model is custom-designed to provide region-specific insights on investment and sensitivity to global trends, advancements and responses.

HOW THE MODEL WORKS

The core of our simulation engine is a general equilibrium economic model with additional detailed modules. It can be used to analyse and forecast how different climate scenarios affect the rest of the economy.

INPUT

Data Sources
- IEA
- Worldbank
- EIA
- Input-Output data
- Option: client data

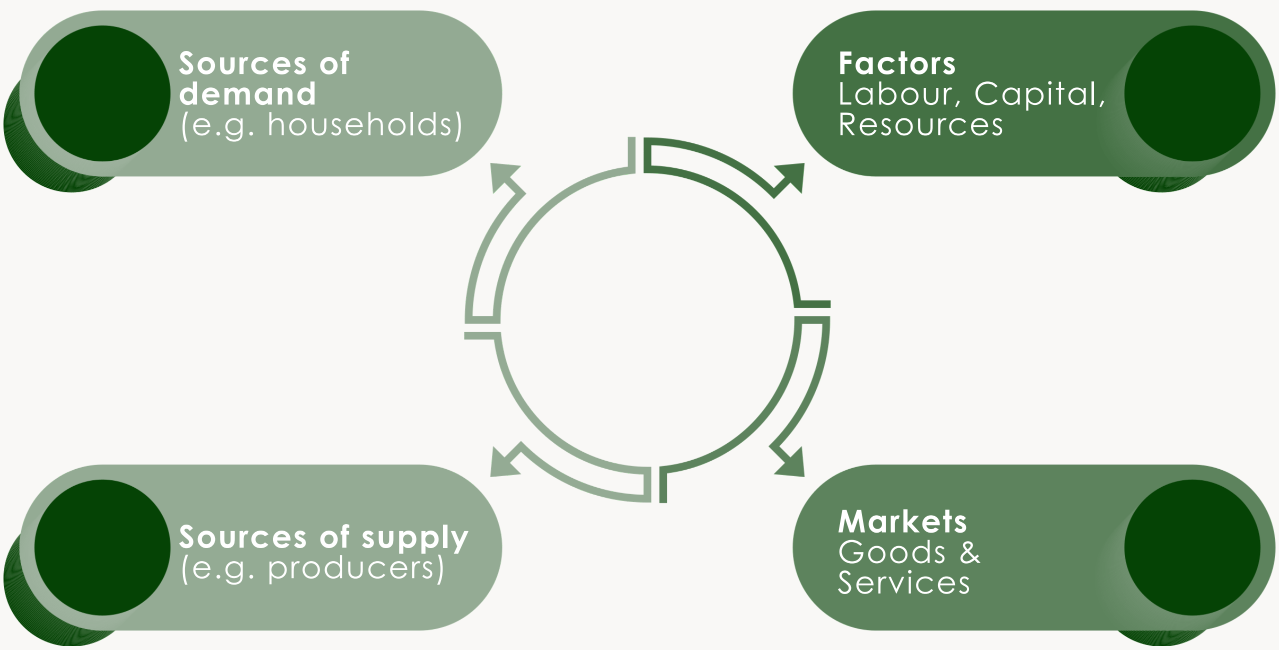
Research
- Policy & Pledges
- Macro Trends
- Carbon markets
- OPEC & policies

Trends
- EVs
- Plastics
- Hydrogen
- CCUS
- Carbon pricing

Tools
- Experience curves
- Tipping points
- Macro Trends

SIMULATION ENGINE

The core model is a Computable General Equilibrium (CGE) Model



Detailed modules

- Transport
- Oil & Gas
- Green Steel
- Carbon capture
- Hydrogen
- Non Ferrous Metals
- Liquid Fuels
- Customised module

All calibrated to public and proprietary, customisable scenarios

OUTPUT & INSIGHTS

- Price and volumes forecasts for commodities and markets
- Sector- and country-specific abatement costs
- Global and country specific Marginal Abatement Cost Curves (MACCs)
- Energy supply stack
- CO_2 emission trajectories and carbon leakage
- Technology cost development
- GDP, output and taxes
- Investments and return on capital

Copenhagen Economics

Hard facts. Clear stories.

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About Copenhagen Economics

Copenhagen Economics is one of the leading economics firms in Europe. Founded in 2000, the company currently employs over 100 staff operating from our offices in Brussels, Copenhagen, Helsinki, and Stockholm.

The INTERSECT^{SM} model was co-developed by Copenhagen Economics and Bain & Company.

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