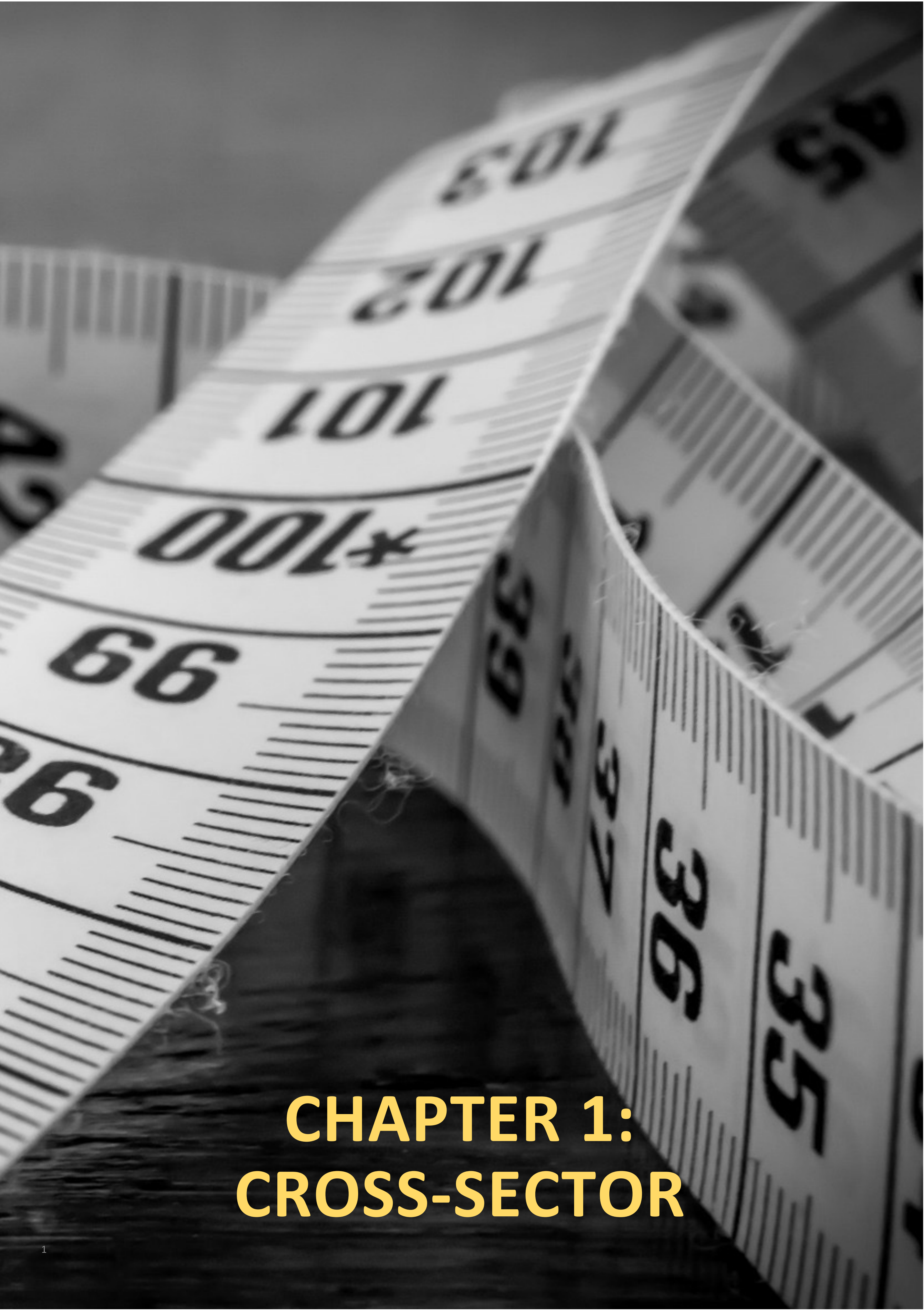


CHAPTER 1: CROSS-SECTOR

1 CROSS-SECTOR INDICATORS

GENERAL OVERVIEW

Cross sector risk drivers (see table below) have an impact on all the sectors in scope of the Energy Transition risk project. Two types of cross-sector risk drivers are considered, notably commodity prices and carbon prices / incentives. In addition, the box on the next page also reviews indicators around commodity production although these elements would be integrated into the downstream energy and commodity use assumptions and act as risk drivers for the commodity producers (e.g. oil & gas, coal companies).

The market price of a commodity is generally speaking a function of supply and demand. This function can be influenced in several ways:

- If a sector deals with commodities that are limited such as fossil fuels, the whole supply chain can face an irregular supply and high price fluctuations are resulting.

- Sourcing or generation costs can change (e.g. due to changes in regulations).

- For commodities traded via an exchange, there can be exchange price fluctuations that are caused by expectations about the future price developments of the market participants.

- Energy prices are influenced by a variety of other factors such as GDP, or population growth or the availability of substitutes (e. g. use of natural gas instead of oil). The scenarios presented here are based on IEA scenarios, thus the prices described in this report are dependent on the supply and demand assumptions set by IEA ETP.

The scenario involves the following parameters:

	MARKET PRICING	
	Crude oil prices (USD / bbl) Natural gas prices (USD /Mbtu)	Coal price (USD / ton) Electricity prices (EUR / MWh)
	POLICY MANDATES, INCENTIVES & TAXES	
	Carbon prices (EUR / MWh)	

1.1 CRUDE OIL PRICES

Overview. Oil prices are one of the most important influencers of the global economy, important enough to be included in the adverse growth scenarios of bank stress-tests (for example the ESRB 2016 stress-test). In the transport sector, for instance, the price of oil, along with taxes, is the core driver of fuel costs, directly affecting production and consumer decision-making variables (e.g. fuel efficiency considerations). For aviation and marine shipping, oil prices will influence production decisions and processes for products that use oil derivatives (e.g. chemicals, etc.). One key challenge around oil price estimates relates to forecasting both short-term and long-term prices, given the prominence of non-'market' drivers in setting the price (e.g. output quotes among OPEC members), as well as the relatively new unconventional oil markets that still exhibit significant volatility in terms of costs.

Risk pass-through mechanism. Changes in oil prices can generate risks to companies in terms of rising input prices in some sectors (e.g. power, agriculture, etc.), as well as potential changes in consumer preferences as companies seek to pass on these costs or consumers directly face these costs (e.g. automobile).

Sources. Long-run prices for oil are generally modelled as a function of the projected global energy demand vs. supply. Given their prominence, they form a core part of most standard integrated assessment and energy technology scenario models (e.g. IEA 2D Scenario, IEA 450 scenario). Alternative modelling approaches exist, adding assumptions around e.g. geopolitical events (Lee & Huh, 2017).

Method. Oil prices are taken from IEA Energy Technology Perspectives. The ACT scenario is built upon the 2DS scenario, likewise the LCT scenario is built upon the 4DS. The ETP scenario is preferred over the WEO scenario to keep consistency around underlying assumptions of other sector-specific risk drivers (e.g. power, aviation). Analysts assessing the impact of other drivers in the oil price (e.g. imbalances between supply and demand) need to consult the production and supply estimates (of ETP).

Results. The ACT scenario projects lower oil prices compared to the LCT scenario as it considers that lower demand for the fuel will make the production from more costly fields higher up the supply curve less likely. After the last fall in oil prices – with a historic low in 2016 — the projections show a price increase by 2020. The 2014 price level will be reached by 2030 in the ACT scenario and 2025 in the LCT scenario. The ACT will maintain a similar trend in prices up to 2040, while the LCT scenario expects a 24% increase with respect to 2014 prices.

TABLE 1.1 BRENT OIL PRICE (USD/BBL) UNDER THE ACT AND LCT SCENARIOS (SOURCE: AUTHORS, BASED ON IEA ETP 2016)

Year	ACT	LCT
2014	97	97
2020	77	80
2025	87	97
2030	97	113
2035	96	121
2040	95	128

1.2. NATURAL GAS PRICES

Overview. Natural gas plays an important role in decarbonisation scenarios, by being the "cleanest fossil fuel" when it comes to CO_2 emissions. Prices for natural gas are directly affected by demand, which as described in the previous section, will have a higher uptake. Indirectly, gas prices are often affected through the underlying link to oil prices present in long-term gas supply contracts. This oil price link is expected to become weaker as the price indexation business model is gradually being phased out in international markets. Similarly, many 'non-market' drivers, as in oil, make the forecasting of gas prices challenging.

Risk pass-through mechanism. The rise in gas prices will have an impact across sectors, for example through its impact on input prices in the most energy intensive sectors (e.g. power generation, chemicals and petrochemicals industry). However, for other sectors in which the penetration of natural gas is expected as an alternative fuel source (e.g. transportation) the exposure could be limited due to the effect of other market prices mechanisms (e.g. carbon taxes, carbon offsets).

Sources. Generally, gas prices models assume a correlation with the price of oil, due to the historical similarity in price behaviour. Factors that impact crude oil have – in most cases – impacted natural gas, as their production and explorations mechanisms are similar (IEA 2016b). Other models consider assumptions around domestic resource and technology exploration, moving away from the correlation with oil (EIA 2017).

Method. Natural gas prices for the US and Europe are taken from IEA ETP estimates. The ACT Scenario was built upon the 2DS scenario, likewise the LCT Scenario on the 4DS. As in the case of oil prices, this scenario is preferred to keep consistency with other projections.

Results. The ACT scenario projects a price recovery after the last fall in gas prices. In the EU market, the ACT scenario will match 2014 prices by 2030 and the LCT by 2025. The downward pressure for lower prices pushed by a decreasing demand will revert the trend, reaching a price of $ 8.9/MBtu by 2040. The ACT scenario will have a decrease of 4% respect to 2014 levels and the LCT scenario a rise of 33% by 2040. The US gas prices differ to that of the EU, as its production is domestic. The LCT Natural gas prices have an increasing trend through 2040.

TABLE 1.2 NATURAL GAS PRICE (USD/MBTU) FOR BOTH SCENARIOS (SOURCE: AUTHORS, BASED ON IEA 2016A)

Year	European Market		US Market	
	ACT	LCT	ACT	LCT
2014	9.3	9.3	4.4	4.4
2020	7.5	7.8	4.5	4.7
2025	8.5	9.5	5.1	5.5
2030	9.4	11.2	5.7	6.2
2035	9.2	11.8	5.8	6.9
2040	8.9	12.4	5.9	7.5

1.3 COAL PRICES

Overview. Coal prices vary in relation to the regional markets (differences are primarily due to transportation cost, infrastructure constraints and coal quality), however, the overall trading price is determined by the international coal market. Global demand for coal, the main driver of price, is expected to decrease under the decarbonisation scenarios, where a switch from high-carbon-intensive coal to other technology sources is expected. Besides market drivers, coal demand will be affected by worsening geological conditions that will decrease coal quality, and policy changes resulting in the decommissioning of coal mines.

Risk pass-through mechanism. Changes in coal prices will have an impact across sectors, resulting in an increase of input prices and thus companies' operational costs. The most exposed sector is power utilities, followed by the cement and iron and steel industry due to the prevalence of coal derived energy in their industrial processes.

Sources. Coal price futures are generally based in forecasts of the different sub-markets, with assumptions in supply-demand, domestic consumption and import-export rates among others. The international price is an average that connects the regional prices. In terms of application however for companies, it is relevant to understand regional pricing models. Models focused on decarbonisation scenarios also integrate current and expected policy changes around coal phase-out (e.g. IEA ETP 2016, IEA WEO 2016).

Method. The coal prices presented here correspond to the OECD average price of the 2DS and 4DS scenarios modelled in IEA's Energy Technology Perspectives. These estimates were preferred to keep consistency across scenarios, as several sectors covered in the report (e.g. power, cement and iron and steel) base some indicator's estimations upon IEA's ETP scenarios. As outlined above, alternative coal prices may be more appropriate for certain companies.

Results. The ACT scenario projects a low variation in the price of coal from the current value of 78 USD/ ton in 2014 to a slightly lower price of 77 USD/ton by 2040. This responds to a context with strong policy support for coal phase-out and low recovery costs of coal plants, thus creating a supply-demand balance that sustains prices (IEA 2016b). The LCT scenario considers a higher global demand for coal, especially coming from India alongside an overall supply drop. This will partially absorb overcapacity driving the coal prices to a rise trend line reaching a value of 108 USD/ton by 2040.

TABLE 1.3 COAL PRICE (USD/TON) FOR BOTH SCENARIOS (SOURCE: AUTHORS, BASED ON IEA 2016A)

Year	Coal Price (USD/ton)	
	ACT	LCT
2014	78	78
2020	80	94
2025	80	98
2030	79	102
2035	78	105
2040	77	108

1.4 ELECTRICTY PRICES

Overview. Electricity prices to end-users are a function of wholesale power generation costs (capital and operation and maintenance costs), transmission, distribution and retail costs, subsidies and taxes, as well as of course mark-ups by retailers. In the transition to a low-carbon economy electricity prices are expected to increase due to additional capital costs associated with the deployment of renewable sources, but these will be partially offset by the reduction of fuels costs (i.e. raw material and taxes) as the share of clean technologies increases.

Risk pass-through mechanism. Electricity prices may act as risk drivers for companies where electricity is a key driver of production costs, and through changes in consumer preferences around electronics and their associated energy efficiency. They also help to contextualize impacts on other risk indicators.

Sources. Electricity prices are not specifically given as parameters in the 2°C scenario of the IEA and others. IEA's WEO 2016 edition publishes the electricity prices for their NPS scenario, these are disclosed however with limited regional country-level granularity, which is seen as a caveat due to the need to provide highly granular country specific price estimates in most cases (with some exceptions for fully or partially integrated electricity markets e.g. Europe).

Method ACT. Estimates for electricity prices rely on two third party sources using electricity price modelling techniques. One critical element to consider is that the prices shown here are average prices and do not capture potential price fluctuations. The starting points for country estimates are taken from IEA 2016 Energy Prices and Taxes. Brazil current estimates are taken from BEN 2016. Prices for Mexico and Brazil were computed using US prices growth rate. France, Germany and Italy prices were computed using EU prices growth rate.

These prices include taxes but do not include renewable energy subsidies in their calculation. The effect of the subsidies in the electricity price increase will mainly depend on the economics of renewable sources. Most sources will not require a subsidy already in 2025 (see Page 34 and 87), thus a significant impact on the electricity price is not foreseen. Based on the LCT method, analyst assuming a price increase should consider on average a <5% increase[2].

Method LCT. In the LCT Scenario starting points are taken from the IEA 2016 Energy Prices and Taxes. Brazil current estimates are taken from BEN 2016. Future prices for European and Latin-American countries are computed using regional growth rates of IEA WEO 2016. These prices include taxes and renewable energy subsidies.

Results. Table 1.4 shows the electricity prices for the ambitious and limited climate transition scenarios. In the ACT scenario, a high penetration of renewable energy is enabled by advanced technological improvements with a lower costs structure allowing for lower electricity prices. In the EU prices are expected to increase, as a result of the retirement of old fossil fuel plants and the replacement with capital-intensive renewable energies.

TABLE 1.4 ELECTRICTY PRICES FOR INDUSTRY UNDER THE ACT AND LCT SCENARIOS (SOURCE: AUTHORS, BASED ON CAPROS ET AL. 2012, TRIEU ET AL. 2013, IEA 2016A, IEA 2016C)

Country	Price reference	2020		2025		2030		2035		2040	
		ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT
Brazil	2015 EUR/MWh	151	162	154	163	157	164	162	168	167	173
France	2015 EUR/MWh	90	105	92	108	94	111	93	111	93	111
Germany	2015 EUR/MWh	111	143	113	147	116	151	115	151	115	151
Italy	2015 EUR/MWh	250	252	255	259	260	266	259	266	258	266
Mexico	2015 EUR/MWh	79	98	81	102	83	106	85	106	88	106
US	2015 EUR/MWh	60	71	61	71	63	72	65	74	67	76

1.5 CARBON PRICES

Overview. Carbon prices and/or taxes are considered a critical policy tool for achieving the transition to a low-carbon economy. At the same time, implementation of carbon price policies is not consistent across all geographies, with differences in application in terms of sector coverage, accounting, pricing mechanism, and geographic reach. Carbon pricing can be considered either in terms of 'social cost of carbon' or a policy intervention to align relative prices (which may or may not reflect social costs).

Risk-pass through mechanism. Depending on the scope of the carbon price regulation, the risks will materialize in different sectors, primarily in the form of changing the relative economics for inputs, production processes and / or end products.

Sources. Carbon prices are a standard element of most if not all transition scenarios, albeit modelled at various degrees of geographic granularity and precision (e.g. either as an 'actual' price or an 'implied' policy price).

Method. Carbon prices for both scenarios are taken from IEA 450 and NPS scenarios. These estimates are line with and were preferred to, the CO_2 marginal abatement costs assumed in IEA ETP 2015 due to higher granularity. In the case of Mexico, it was assumed an increase in the current carbon price (3.5 $2015 / t-COeq) in line with the US increase for both scenarios. Values for 2025 and 2035 were interpolated. The LCT scenario assumes that those countries that have already announced their intention to introduce carbon prices or emissions trading systems effectively do so. The ACT scenario assumes that use of carbon price instruments become more widespread affecting all countries under scope.

Results. Carbon prices are expected to increase in both scenarios. Notably, the ACT scenario assumes a higher increase in prices due to more stringent government efforts to strengthen climate policies to spur innovation in low-carbon technologies and enable the phase out of coal.

TABLE 1.5 CARBON PRICE (2015 USD / T-CO_2eq) (SOURCE: AUTHORS, BASED ON IEA 2016b, SEMARNAT 2016)

Year	EU		USA		Brazil		Mexico	
	ACT	LCT	ACT	LCT	ACT	LCT	ACT	LCT
2020	20	20	20	0	10	0	18	7
2025	60	29	60	15	43	0	53	13
2030	100	37	100	30	75	0	88	18
2035	120	44	120	35	100	0	105	23
2040	140	50	140	40	125	0	123	28

MEET THE BUILDERS - ET RISK CONSORTIUM

The ET Risk consortium, funded by the European Commission, is working to develop the key analytical building blocks (Fig. 0.1) needed for Energy Transition risk assessment and bring them to market over the coming two years.

ENERGY TRANSITION
RISKS & OPPORTUNITIES

1. TRANSITION SCENARIOS

The consortium will develop and publicly release two transition risk scenarios, the first representing a 'soft' transition extending current and planned policies and technological trends (e.g. an IEA NPS trajectory), and the second representing an ambitious scenario that expands on the data from the IEA 450S /2DS, the project's asset level data work (see Number 2), and relevant third-party literature. The project will also explore more accelerated decarbonization scenarios.

2. COMPANY & FINANCIAL DATA

Oxford Smith School and 2° Investing Initiative will jointly consolidate and analyze asset level information across six energy-relevant sectors (power, automotive, steel, cement, aircraft, shipping), including an assessment of committed emissions and the ability to potentially 'unlock' such emissions (e.g. reducing load factors).

3. VALUATION AND RISK MODELS

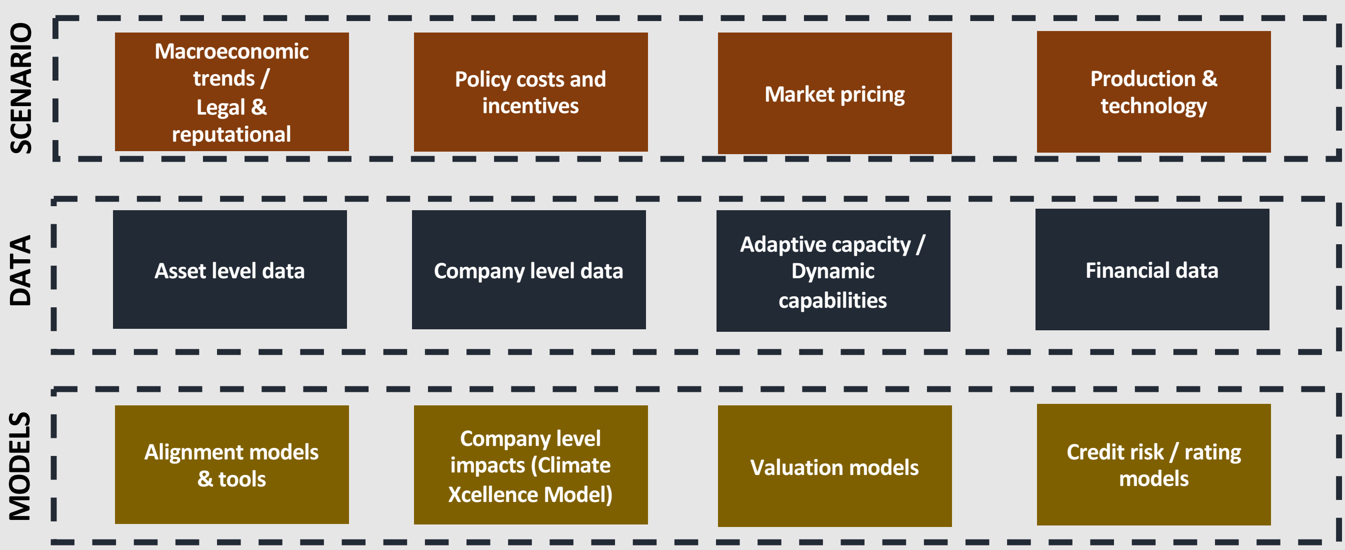
a) **2°C portfolio assessment – 2° Investing Initiative.** 2° Investing Initiative will seek to integrate the project results into their 2°C alignment model and portfolio tool and analytics developed as part of the SEI metrics project.

b) **ClimateXcellence Model – The CO-Firm**. This company risk model comprises detailed modeling steps to assess how risk factors impact margins and capital expenditure viability at the company level.

c) **Valuation models – Kepler Cheuvreux.** The above impact on climate- and energy-related changes to company margins and cash flows can be used to feed discounted cash flow and other valuation models of financial analysts. Kepler Cheuvreux will pilot this application as part of their equity research.

d) **Credit risk rating models – S&P Global.** The results of the project will be used by S&P Global to determine if there is a material impact on a company's creditworthiness. S&P Dow Jones Indices, a S&P Global Division, will explore the potential for developing indices integrating transition risk.

FIG. 0.0: ASSESSING TRANSITION RISK ACROSS THE INVESTMENT CHAIN (SOURCE: AUTHORS)



ABOUT 2° INVESTING INITIATIVE

The 2° Investing Initiative [2° ii] is a multi-stakeholder think tank working to align the financial sector with 2° C climate goals. Our research work seeks to align investment processes of financial institutions with climate goals; develop the metrics and tools to measure the climate friendliness of financial institutions; and mobilize regulatory and policy incentives to shift capital to energy transition financing. The association was founded in 2012 and has offices in Paris, London, Berlin, and New York City.

ABOUT THE CO-FIRM

The CO-Firm GmbH is a boutique consultancy specialized in developing climate and energy strategies for financial services providers, industry, and utilities. Based on financial risk modelling under a range of climate and energy scenarios, the proprietary ClimateXcellence Toolset, and a dataset of more than 200.000 assets and more than 15.000 different technical mitigation measures, The CO-Firm supports its clients in identifying, evaluating and realizing their specific economic opportunities in the national and global climate transition. Specifically, the CO-Firm serves its clients in adjusting their strategies, setting Science Based Targets, creating new business models, and identifying cost savings in their operations and their supply chain. Additionally, the consultancy provides regulatory monitoring services.

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