Methodology Forecast & Scenarios

There are 4 sources of information that are used to feed the final output of the model:
1) OECD Data: used for calculating the Input-Output multipliers
2) Unido Data: used for feed the Output of MSR, First and End Uses and reciclyng of several applications and sectors
3) Cobalt Data (Provided): Basically, the same as Unido data but focused in the intake First and End Use and reciclyng applications of Cobalt
4) Cobalt prices (Provided): The variation of the price of cobalt splited into different primary products (metal, carboxylates, ...) per year

Basically, we can define the 4 sources above in two categories: historical data and future data
We can set the OECD and UNIDO into historical data, because we have just data from 2010 until YTD
With Cobalt Data and Prices, we have data from 2010 until 2030, so we have historical and a projection of future data for these sources

So, in simple terms, the forecasting component will be feeded by the sources (3) and (4), and not for OECD neither UNIDO. This means that for the final Roskill model final output,
the information that will be changed will be the PRICE or final outcome for each application if we change the period filtered.
In terms of the summary sheet, the final production and prices of Cobalt will be impacted by this filter (because these values are getting from sources (3) and (4)).

About Scenarios, there are 3 scenarios: LOW, BASE and HIGH. Basically, this scenarios are implemented inside "Cobalt prices" (source (4)), so it will affect only the final outcome of each application.
In this way, there isn't any scenario splitting about the final volume of production of Cobalt.

The scenarios are setting by default with weights, being the weights of LOW and HIGH scenarios 0.20 lower and upper the BASE scenario that represent the current projection of prices. These weights are setting by years, and the historical weights is 1.00 for all the scenarios. This information is currently inside the sheet "Cobalt Prices" (see the image below)

Escenarios weights		YEARS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
LOW	Cobalt metal	Metal Bulletin	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80
BASE	Cobalt metal	Metal Bulletin	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HIGH	Cobalt metal	Metal Bulletin	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20	1.20

Escenarios			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
LOW	Metal	USD/t Co	41,308	36,251	29,718	28,153	31,217	28,660	25,970	58,731	82,343	36,597	34,348	50,706	37,919	33,863	31,747	31,217	37,214	40,212	37,919
	Salts	USD/t Co	45,793	38,608	34,511	34,736	29,941	30,788	25,412	67,327	77,187	33,531	34,286	50,615	37,851	33,802	31,689	31,161	37,147	40,140	37,851
	Oxides	USD/t Co	47,252	39,891	36,181	35,020	32,692	32,693	27,340	76,046	80,461	34,953	35,740	52,762	39,457	35,236	33,034	32,483	38,723	41,843	39,457
	Carboxylates	USD/t Co	46,762	40,202	35,985	34,937	32,303	32,492	27,130	70,685	80,141	34,967	35,720	53,606	39,866	35,302	33,006	32,746	38,829	41,749	39,381
	Scrap	USD/t Co	37,963	33,015	26,419	24,717	28,193	25,945	23,342	55,732	79,475	33,794	31,295	47,778	35,527	31,496	29,367	28,844	34,837	37,837	35,543
	Chemicals	USD/t Co	46,062	39,610	35,490	34,342	31,577	31,668	26,346	69,009	78,640	34,285	35,029	52,411	39,017	34,604	32,369	32,062	38,055	40,954	38,629
	Average Without Scrap	USD/t Co	45,435	38,912	34,377	33,438	31,546	31,260	26,440	68,360	79,754	34,866	35,025	52,020	38,822	34,561	32,369	31,934	37,993	40,979	38,647
	Average With Scrap	USD/t Co	44,190	37,929	33,051	31,984	30,987	30,374	25,924	66,255	79,708	34,688	34,403	51,313	38,273	34,050	31,869	31,419	37,467	40,456	38,130

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
BASE	Metal	USD/t Co	41,308	36,251	29,718	28,153	31,217	28,660	25,970	58,731	82,343	36,597	34,348	50,706	47,399	42,329	39,683	39,022	46,517	50,265	47,399
	Salts	USD/t Co	45,793	38,608	34,511	34,736	29,941	30,788	25,412	67,327	77,187	33,531	34,286	50,615	47,314	42,252	39,612	38,951	46,434	50,175	47,314
	Oxides	USD/t Co	47,252	39,891	36,181	35,020	32,692	32,693	27,340	76,046	80,461	34,953	35,740	52,762	49,321	44,045	41,292	40,604	48,403	52,303	49,321
	Carboxylates	USD/t Co	46,762	40,202	35,985	34,937	32,303	32,492	27,130	70,685	80,141	34,967	35,720	53,606	49,833	44,128	41,258	40,933	48,536	52,186	49,226
	Scrap	USD/t Co	37,963	33,015	26,419	24,717	28,193	25,945	23,342	55,732	79,475	33,794	31,295	47,778	44,409	39,369	36,708	36,055	43,547	47,296	44,429
	Chemicals	USD/t Co	46,062	39,610	35,490	34,342	31,577	31,668	26,346	69,009	78,640	34,285	35,029	52,411	48,771	43,254	40,461	40,077	47,568	51,192	48,286
	Average Without Scrap	USD/t Co	45,435	38,912	34,377	33,438	31,546	31,260	26,440	68,360	79,754	34,866	35,025	52,020	48,528	43,202	40,461	39,917	47,492	51,224	48,309
	Average With Scrap	USD/t Co	44,190	37,929	33,051	31,984	30,987	30,374	25,924	66,255	79,708	34,688	34,403	51,313	47,841	42,563	39,836	39,274	46,834	50,570	47,663

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
HIGH	Metal	USD/t Co	41,308	36,251	29,718	28,153	31,217	28,660	25,970	58,731	82,343	36,597	34,348	50,706	56,879	50,794	47,620	46,826	55,821	60,318	56,879
	Salts	USD/t Co	45,793	38,608	34,511	34,736	29,941	30,788	25,412	67,327	77,187	33,531	34,286	50,615	56,777	50,703	47,534	46,742	55,720	60,210	56,777
	Oxides	USD/t Co	47,252	39,891	36,181	35,020	32,692	32,693	27,340	76,046	80,461	34,953	35,740	52,762	59,185	52,854	49,550	48,724	58,084	62,764	59,185
	Carboxylates	USD/t Co	46,762	40,202	35,985	34,937	32,303	32,492	27,130	70,685	80,141	34,967	35,720	53,606	59,799	52,953	49,509	49,119	58,243	62,624	59,072
	Scrap	USD/t Co	37,963	33,015	26,419	24,717	28,193	25,945	23,342	55,732	79,475	33,794	31,295	47,778	53,291	47,243	44,050	43,266	52,256	56,756	53,315
	Chemicals	USD/t Co	46,062	39,610	35,490	34,342	31,577	31,668	26,346	69,009	78,640	34,285	35,029	52,411	58,525	51,905	48,554	48,093	57,082	61,431	57,943
	Average Without Scrap	USD/t Co	45,435	38,912	34,377	33,438	31,546	31,260	26,440	68,360	79,754	34,866	35,025	52,020	58,233	51,842	48,553	47,901	56,990	61,469	57,971
	Average With Scrap	USD/t Co	44,190	37,929	33,051	31,984	30,987	30,374	25,924	66,255	79,708	34,688	34,403	51,313	57,409	51,075	47,803	47,128	56,201	60,684	57,195

Cobalt prices | Footprint - Sectoral analysis | Co_MSR | Co_MSR_Raw_Data | Co_First_Use_Distribution | Co_First_Use | Co_End_Use_Distribution | Co_End_Use | Co_R

With this settings, the model calculates the new prices for each scenario for MSR, First Use, End Use and Reciclyng, that will feed the Roskill model for spiting the output for each scenario. The methodolgy for each of the application categories is next:

MSR:

Basically, there will be two cases:
a) The data which source is CO_MSR that belongs to the "Representative Companies" Analysis
b) The data which source is UNIDO that belongs to the "Sectorial Analysis"

So for the case (a), it already exists a forecasting component until 2030. So, in this case, we have to calculate in some way the scenario's final prices.
In the case (b), there aren't any forecast and scenario prices. Because of that, it is necessary to calculate a forecast price before applying the modification factor applied to case (a)

The calculation is like:

1.a) The models calculates the average prices of each scenario (rows 44,55 and 66), considering the forecasting periods filtered (example, from 2022 to 2030)
1.b) The models calculates the average prices of the base scenario (row 55), considering the forecasting periods filtered (example, from 2022 to 2030)
1.c) The models calculates a factor for each scenario like (1.a) divided by (1.b)
2.a) The models calculates the average prices of the base scenario (row 55), considering the forecasting periods filtered (example, from 2022 to 2030)
2.b) The models calculates the average prices of the base scenario (row 55), considering the historical periods filtered (example, from 2010 to 2021)
2.c) The models calculates a forecasting factor like (2.a) divided by (2.b)
3.a) In the case the data belongs to "Company Analysis" vision (case (a)), the models apply the factor calculated in 1.c to the CO_MSR final price for completing the prices of each scenario of all the MSR application
3.b) In the case the data belongs to "Sectorial Analysis" vision (case (b)), the models apply the factor calculated in 1.c and 2.c to the UNIDO DATA final price for completing the prices of each scenario of all the MSR application

This is a simple forecasting method to modified the final forecasting price based on historical Unido price

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First Uses:

For First Uses, the model do the next:

1) We have the direct impact of each of the primary products (metal, carboxylates,salts,...) in each of the application. But we have this information as Global, and not splited per region. Also, this is historical information (until 2021). So, with this part, the model calculates the historical distribution of each of the primary products for each application for each year between 2010 and 2021. This will be a percentage distribution. An example:

For 2010, the distribution in primary products of the production of Batteries is the next:

Carboxylates	0%
Metal	5%
Oxides	6%
Salts	75%
Scrap	13%
Total	**100%**

Based on these distributions, the model makes a simple forecasting, taking the average of the distribution of the previos 3 years. For example:

	HISTORICAL			FORECAST								
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Carboxylates	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Metal	5.39%	5.61%	5.39%	5.46%	5.49%	5.45%	5.47%	5.47%	5.46%	5.47%	5.46%	5.46%
Oxides	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%	6.11%
Salts	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%	75.46%
Scrap	13.04%	12.82%	13.04%	12.97%	12.94%	12.99%	12.97%	12.97%	12.97%	12.97%	12.97%	12.97%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Finally, we have the distribution for each application and year between 2010 an 2030

2) The model calculates the final outcome of each of the application, multiplying the prices for each primary product with the distribution weight calculated in (1), with the volume of the production (projection provided in CO_First_Use)
Doint this, we can get a final outcome of each application, primary product and year, for each scenario, and also for each region, because the production data is splited by region. In here,
the main assumption is that the distribution in each primary product is the same for all the regions

3) The model calculates the average of outcomes calculated in (2) for each application, scenario and region, only considering the years in the forecasting period filtered.

End Uses:

Is exactly the same methology of First Use, but there is an additional complexity because the information is splited by year, primary product, end use application, and first use application. So, the main difference, is we add the first use application level
So, the calculations on the distribution wieghts and production volumes are splited by first use application also.
Without that, the methodology is exactly the same

Reciclyng:

Because the model has calculated the First and End Uses outcome for each application and scenario, and because this data was the original source of information for feeding the reciclyng prices in previous version of the model, then the model reproduces the same way of calculating the final reciclyng outcome for each scenario, and for periods between 2010 and 2030.
