HÉTFA Research Institute

Budapest,

31st July 2020

Macroeconomic impact of Pannonia Bio in Hungary between 2020 and 2024

Written for Pannonia Bio Zrt.

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Executive summary

1. The goal of our analysis has been to estimate the macroeconomic impacts of Pannonia Bio Zrt., a biorefinery. This is the second of two studies: this one focuses on an *ex-ante* analysis for the five-year period between 2020 and 2024. The previous study was an *ex-post* analysis for the five-year period between 2015-2019.

2. The overall impact is the sum of direct and indirect impacts. Pannonia Bio's direct impacts come from its plans of employment, value add, exports, and tax payments. Indirect impacts, by definition, are the sum of the other impacts that Pannonia Bio has on the rest of the economy. The indirect effects are estimated from a calibrated CGE model for Hungary for the 2020-2024 period.

3. The CGE model used is an updated version of the model Major used in 2016 to estimate the macroeconomic impact of the same company for the period 2010-2020, of which 2016-2020 was based on projections. Some changes were made since the first, ex-post study as the new Hungarian Convergence Programme came out in the meantime, which incorporated the expected effects of the COVID-19 pandemic.

4. Our results for the 2020-2024 period show a very large GDP impact: more than 4 billion euros, 86 percent of which is indirect. The total employment effect is 3,932 persons on average, 92 percent of whom are indirect. Tax revenues increased by little more than 1 billion euros, of which less than 7.2 percent comes from Pannonia Bio directly. The direct impact on trade balance is positive as Pannonia Bio’s exports are significantly higher than its imports. In the ex-ante case even the indirect impact on trade balance is positive as the increased import of manufacturing products is lower than the indirect export increase of other chemicals.

5. According to this, the GDP, employment and budget impact more than double in the next five-year period compared to the previous five-year period, except for the trade balance where the effects quadruple.

	2015-2019 Ex-post Effects	2020-2024 Ex-ante Effects		
	total ***	direct	indirect	total
GDP*	1947	550	3504	4054
Employment**	1725	279	3653	3932
Budget *	464	73	929	1002
Trade Balance*	988	3444	403	3847

*m€
**yearly average, persons
***results from previous, ex-post study

6. The impact of Pannonia Bio on GDP will be about 1 euro for each litre of bio-ethanol produced.

7. This study continues the efficiency scenario of the ex-post analysis in which we attributed the yield increase of Hungarian maize production to Pannonia Bio's ability to stabilize the demand for maize. Between 2015 and 2019 this meant in the model an additional yearly 0.45 percent increase for the efficiency of the whole agricultural sector. We are assuming that this yield increase continues with a slower pace in the future and that new investments help a catching up process to Austrian yield levels. So, for the next five years, we built in the model a yearly 0.221 percent efficiency increase for the agricultural sector.

8. This efficiency growth further increases Pannonia Bio's impact on the Hungarian economy. Its effect on GDP increases by 0.8 billion euros to 4.9 billion euros. The employment effect increases on average by 947 persons to 4,880 persons. The budget receives an additional 191 million euros (thus reaches 1,193 million in total). Trade balance also grows by 440 million euros. Taking this into account the effects double between the ex-post and ex-ante period, except for the trade balance where effects are fourfold.

	2015-2019 Ex-post Effects – efficiency scenarios ***	2020-2024 Ex-ante Effects – efficiency scenario		
	total	direct	indirect	total
GDP*	2314	550	4349	4900
Employment**	2149	279	4601	4880
Budget *	539	73	1120	1193
Trade Balance*	1162	3444	843	4287

*m€
**yearly average, persons
***results from previous, ex-post study

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1. Introduction

Pannonia Bio (previously Pannonia Ethanol) is a firm producing bioethanol and animal feeds, most of which is sold abroad. The factory was constructed mainly in 2010-2011, but expansion investments have been continuous ever since. The factory started production in 2012, and today almost half of Hungarian industrial processing of corn occurs in the Pannonia Bio factory.

Our goal is to estimate the macroeconomic impacts of this enterprise. The first study focused on an *ex-post* analysis for the five-year period between 2015 and 2019; this study will be an *ex-ante* analysis for the five-year period between 2020 and 2024.

HÉTFA Research Institute has carried out two previous analyses of Pannonia Bio. In an earlier *ex-ante* study by HÉTFA (*Szabó-Morvai* [2012]), Szabó-Morvai used a different method to calculate the expected impact of the building up of two bioethanol factories (in Dunaföldvár and Mohács), of which only one factory was actually built. In 2016, Klára Major also carried out a mixed analysis (*Major* [2016]) – which contained an *ex-post* and an *ex-ante* part – for the 2010-2020 period. Back then, the 2010-2015 period was considered as the past – which provided an opportunity for *ex-post* analysis - and the 2016-2020 was considered as a projection. In our 2016 study, we mentioned that the full capacity was not reached by the end of 2015. Now the plant is operating at full capacity. The present analysis employs an updated version of Major’s macroeconomic model to carry out an analysis of Pannonia Bio’s production – thus it relies heavily on that study.

This study is organized as follows: first we make a very short methodological summary, then we introduce the assumptions around the estimated scenarios. After that we show the results of the estimation. As in the first study, we calculate two scenarios: a baseline, and one where we assume that the yield of maize production increases due to investments fostered by the stability of the market (called efficiency scenario).

2. Methodological approach

In the following section we only give a very short summary of our methodology (as it was described in more detail in the first, *ex-post* study). To simulate the economic impact, we use an updated version of the HÉTFA CGE model. The main model assumptions are the same as they were in the model used in the 2016 study (*Major* [2016]); but several details are updated since the last estimation and even since the current ex-post estimations:

- The updated model uses a new social accounting matrix based mainly upon the input-output tables for the year 2015, which were released in 2018.

- In the previous version, macroeconomic parameters were calibrated only for the first period (then 2010), and those parameters were used in all the other simulation years. In the current version some exogenous time-series, like the GDP path, labour supply, government expenditure etc. are defined based on a Convergence Programme of Hungary (see later in more detail). Using these variables, the parameters are recalculated for each period during the simulation.

- The updated model has only one kind of labour (not skilled and unskilled like before) and uses a simplified saving behaviour for the households.

To isolate Pannonia Bio's impact in the model we had to make several assumptions:

- We assume that Pannonia Bio has two well distinguishable types of economic impacts: direct impacts (employees, investments and purchases of the company) and indirect impacts (for example employment and production in other, connected sectors);

- The indirect impacts of Pannonia Bio are the sum of five different sources:

    - *Investment channel:* half of the continuous investment is assumed to go to the construction industry, while the other half is assumed to go to buying equipment, machines and production facilities from the manufacturing sector;

    - *Production channel:* production requires a large amount of material inputs (of which the most important is maize), energy, chemicals, logistic services, etc.;

    - *Income channel:* employees of Pannonia Bio spend the non-saved part of their income and therefore increase the demand for consumption goods;

    - *Research channel:* the R&D expenses spent by Pannonia Bio can be implemented into the model as extra demand generated in the R&D sector, namely the "72. Scientific research and development" sector; and

    - *Solar channel:* Pannonia Bio will invest heavily into the energy sector in 2020 by constructing dozens of solar panel parks, which will generate 47,000 MWh per year. It is produced by an about 32 million euro worth of investment, which was implemented into the energy sector of the model. In our model it increases the global output of the energy sector, while also lowering the price of it;

- As Pannonia Bio can't be considered a representative firm of the chemical industry (see comparison in the previous study), we assume in this analysis that the costs of Pannonia Bio represent additional demand to certain industries.

The current simulation starts again in 2015, the year of the new social accounting matrix, and ends with 2024. But we only report the impacts for the 2020-2024 forecast period.

3. Assumptions and scenarios

As in all ex-ante analyses, we need to make assumptions about the future. In this chapter we present our main assumptions in detail: first we introduce the assumptions about the exogenous macroeconomic path, after that we turn to those connected to the scenarios.

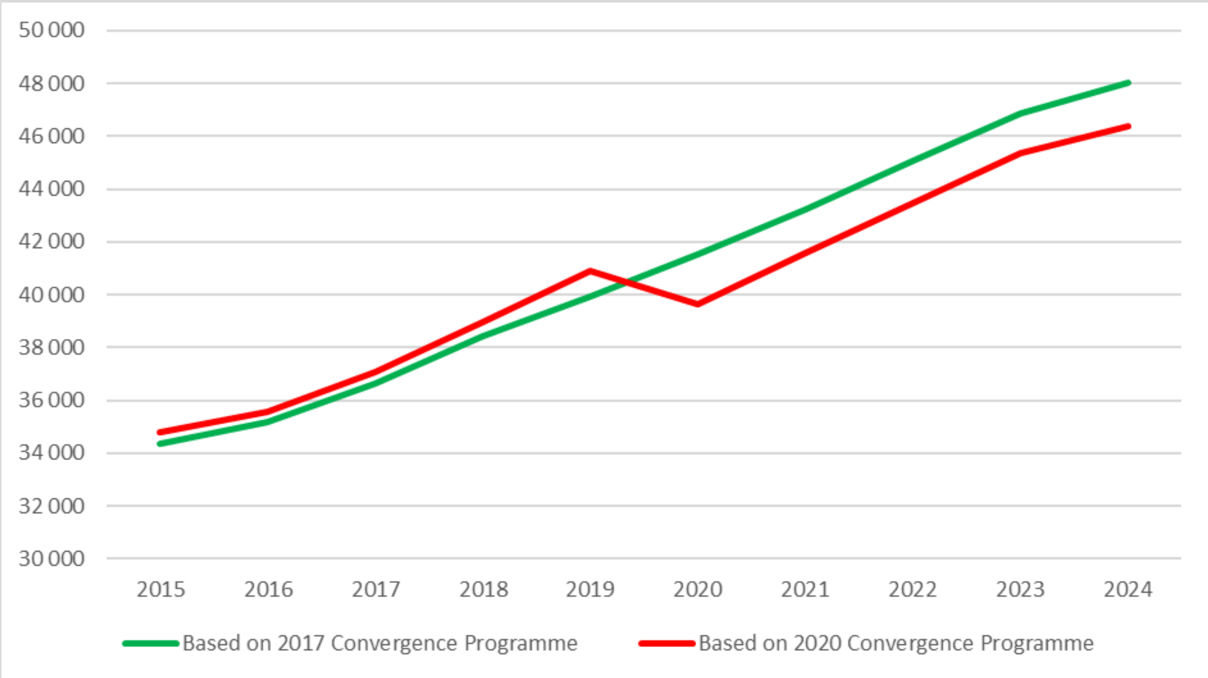
3.1. Macroeconomic paths

The Hungarian government updated its convergence programme and due to the economic impacts of COVID-19, the prospects changed significantly from the one already built into the model (based on the convergence programme from 2017) – thus we updated our model exogenous paths.

The pandemic also had direct and indirect effects on the economy. Indirect effects come from the healthcare and quarantine measures which aim to slow down the spread of the virus. During the baseline calculation of the macroeconomic path, the government assumes that the first wave of pandemic will be over Europe-wide in the second quarter of 2020, without a possible second wave, so the recovery can start in the third quarter.[1]

[1] The Convergence Programme of 2020 also contains two other scenarios, where the economy isn't restarted until the Q4 of 2020 or Q1 of 2021. However, the published variables of these two additional scenarios are not detailed enough to be used in the HÉFTA CGE model.

Figure 1. Exogenous GDP path in the model (bn HUF, 2015 prices)

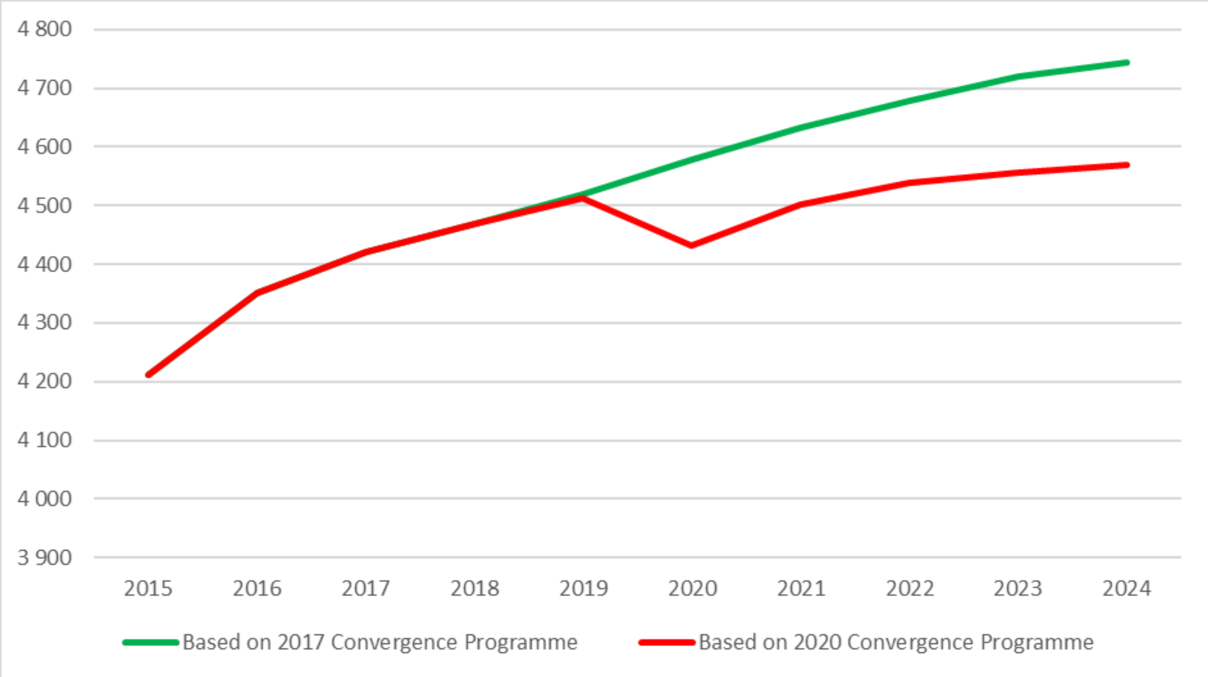


Data source: Hungarian Central Statistical Office, GoH [2017, 2020]

Note: between 2015 and 2017 the differences are due to data revisions by Hungarian Statistical Office

The government expects the Hungarian economy to shrink by 3 percent in 2020, followed by a more than 4 percent increase per year in the next 4 years (*Figure 1*). Moreover, the labour market conditions are expected to get worse as well in the short run, resulting in a significant drop in the number of employed (*Figure 2*) and an increase in the unemployment rate. According to the forecast, the pre-COVID state is reached in 2024 (the unemployment rate is expected to be 3.3 percent, which is already lower than the pre-COVID rate). Export also declines in the short run (by 8.3 percent in 2020) but recovers immediately in 2021 with a more than 10 percent increase, and grows by more than 6 percent every year between 2022 and 2024.

Figure 2. Exogenous employment path in the model (thousands of people)



Data source: Hungarian Central Statistical Office, GoH [2017, 2020]

We also had to recalculate the forecasts of Pannonia Bio based on the HUF/€ exchange rate of the Convergence Programme to be consistent with the macro path. The table below *(Table 1*) shows Pannonia Bio's and the government's forecast for the years 2020-2024. As seen, the government expects the HUF to be weaker in 2020 and 2021, than Pannonia Bio. However, Pannonia Bio expects the HUF to have a negative trend, while the governments expect the currency to keep its value on the international markets. In every following calculation, we will use the Government's forecasted exchange rate path.

Table 1. Exchange rate assumptions (HUF/€)

	2020	2021	2022	2023	2024
Pannonia Bio's	345.0	351.9	358.9	366.1	373.4
Government's	350.3	353.8	353.8	353.8	353.8

3.2. Scenarios

In this section we show the assumptions about the markets Pannonia Bio deals on and the assumptions connected to the efficiency scenario.

3.2.1. Market forecast

In the case of the microeconomic environment we relied on the forecasts Pannonia Bio calculated for us. On the raw materials side, they expect that the price of maize and barley will average around 150 € per ton in the next five years. On the product side, they assume that the price of ethanol will average around 530 € per 1000 litres in the next five years.

3.2.2. Efficiency scenario

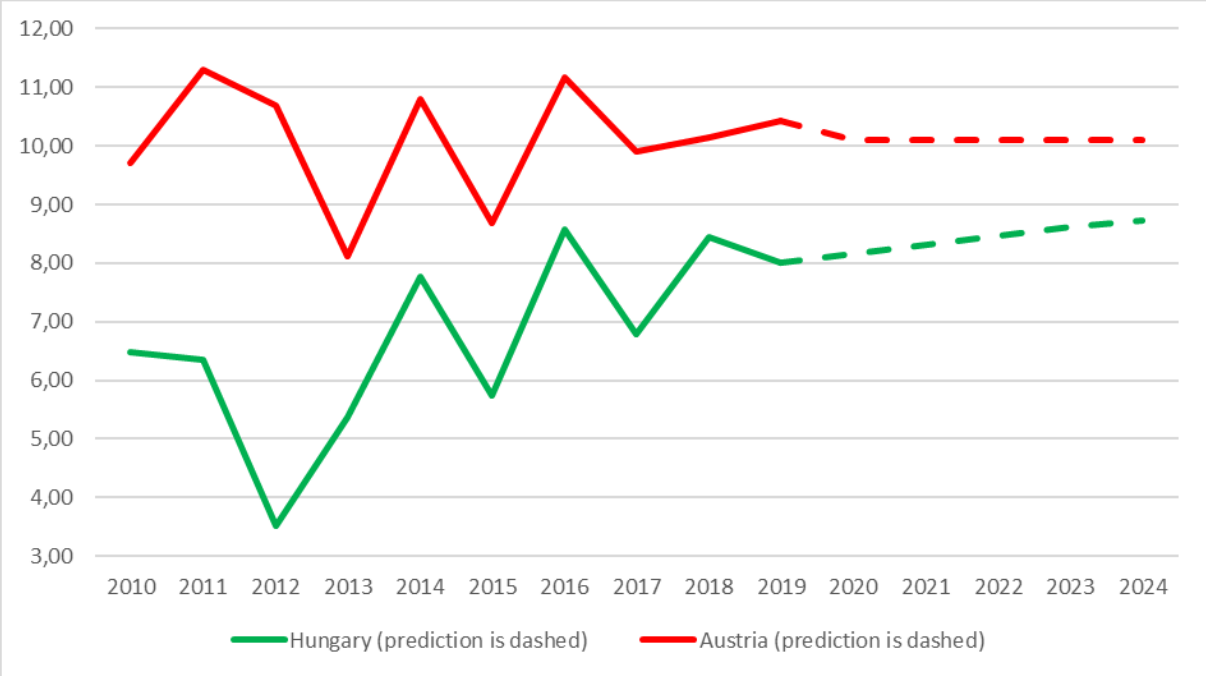
In the first, ex-post study we ran an alternative scenario. We assumed that due to the demand stabilizing force of Pannonia Bio, investments in the maize production sector increased - which led to increased efficiency and yields.

We also showed that yields of maize production had a positive trend between 2015 and 2019. The time series are really volatile (because the maize production is really sensitive to weather) but there is a yearly 6.5 percent increase in maize yields, which is 3 percentage points higher than for cereals as a whole. We used this yearly additional 3.5 percent increase to shock the total factor productivity of agricultural production. But as we could only shock the whole agricultural sector as a whole, we needed to make the yearly 3.5 percent additional increase in maize production relative to the whole sector. According to the Hungarian Statistical Office the maize production value was on average 13 percent of the whole agricultural production value for the period – which means that the additional 3.5 percentage point increase meant a 0.45 percentage point increase for the whole sector.

To continue this scenario, we have to make assumptions about the future of maize production in Hungary. The base assumption is that Hungarian maize yields are catching up to the yields of neighbouring Austria. [2] This an ambitious goal, as most years Austrian maize yields are the third highest in the European Union.

[2] It is not straightforward to compare yields of two different countries, because, in addition to differences in agricultural technology, there are many other factors that can differ (soil quality, climate, farm structure etc.). To mitigate some of the problems, it would be better to compare adjacent regions like Burgenland and Western Transdanubia, where the soil quality and the climate would be more similar, but for regions the time-series are shorter, making estimations much less reliable.

Figure 3. Maize yields facts and predictions (t/ha)



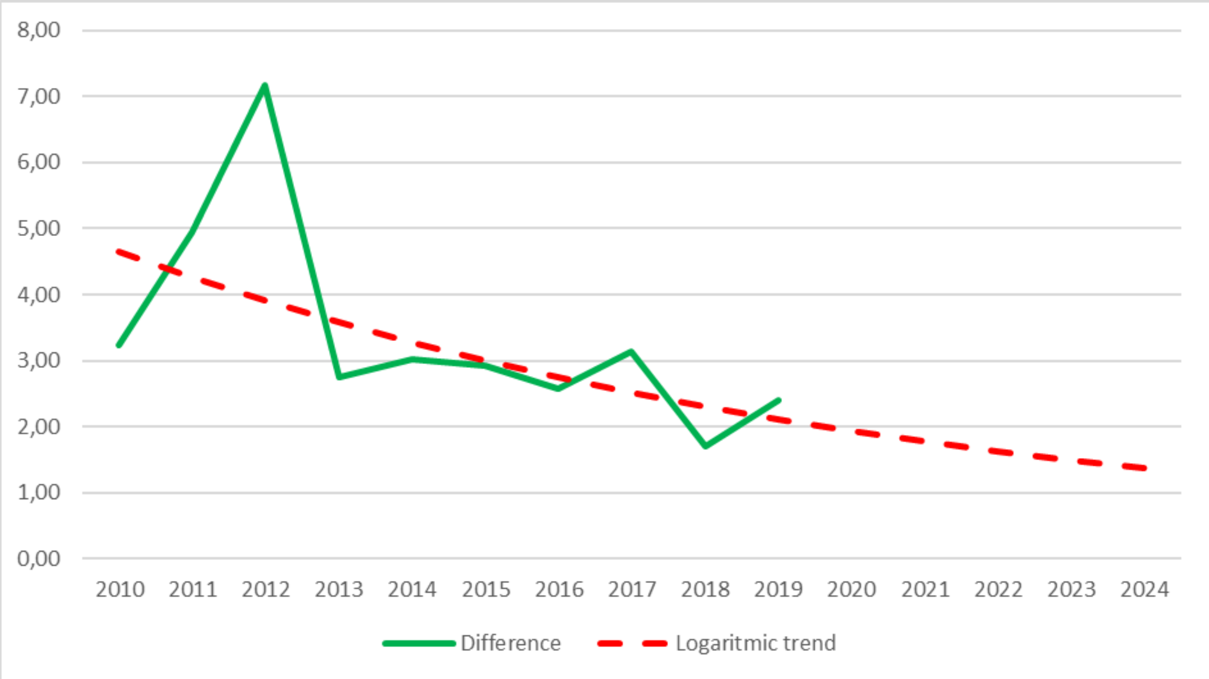
Source of data: Eurostat - apro_cpsh1 database

We show the Hungarian and Austrian yields in the figure above (*Figure 3*). As can be seen, the yields move together from 2013, but not before that. The difference between the two time series is decreasing, as shown in Figure 4, where we also show the estimated logarithmic trend. The difference decreases by 8.7 percent every year between 2010 and 2019 (this coefficient is significantly different from zero). We lengthened the trend until 2024 and used this forecasted catching-up process to predict the Hungarian maize yields, shown with dashed lines in Figure 3.

According to this, the yearly average 6.5 percent increase between 2015 and 2019 is followed by a yearly average 1.7 percent increase between 2020 and 2024. And because yields of cereals are already as high in Hungary as they are in Austria, there is no catching up process for cereals and the whole 1.7 percentage point growth in efficiency is incorporated into the model. This means a yearly 0.221 percentage point[3] increase in total factor productivity.

[3] Again, we must calculate what this 1.7 percentage point increase in yield would mean for the whole agricultural sector. Previously we used a 13 percent weight to make the efficiency growth proportional, this results 0.13*0.017=0.00221, namely 0.221 percentage point increase in efficiency.

Figure 4. Yield difference and logarithmic trend (t/ha)



4. Evaluation of impacts

In this chapter we show the results from the model after we built in the assumptions shown in the previous chapter.

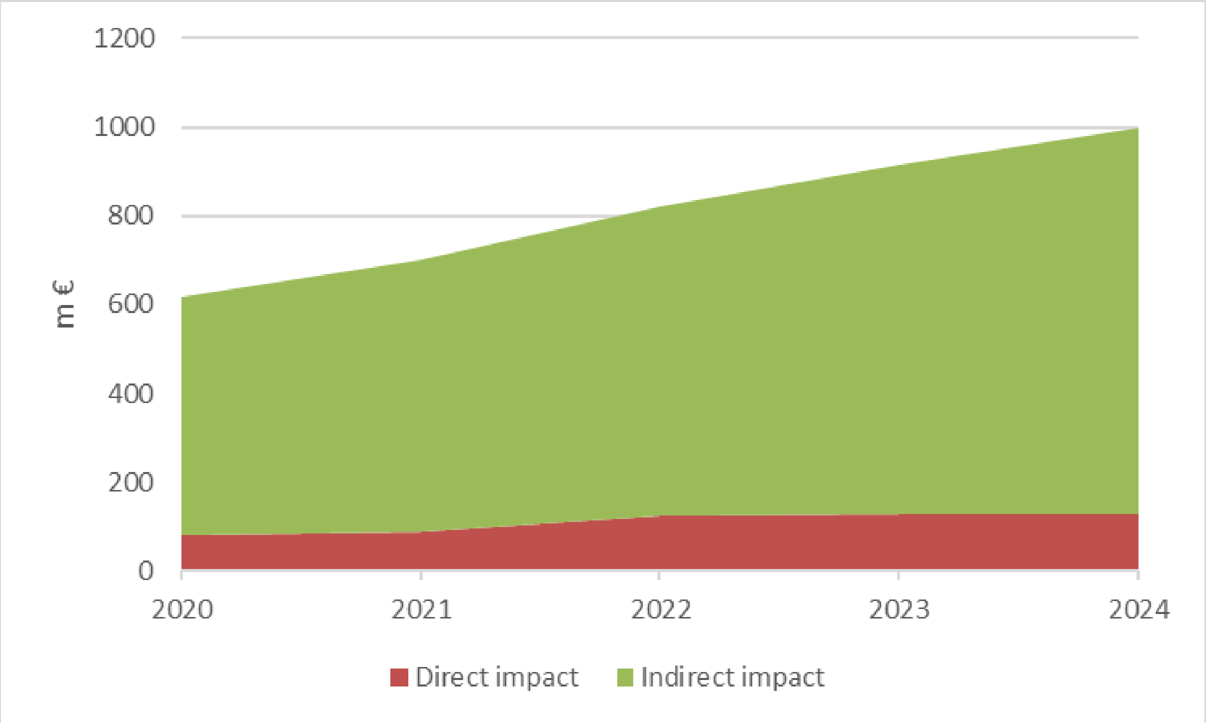
4.1. Baseline scenario

In this section we only introduce the direct effects and assume the five indirect channels shown in the methodological section.

4.1.1. Impact on gross domestic product

On the figure below we continue the previous GDP impact values. As seen, the trend of impact growth is about the same for the forthcoming years, with a slight rise starting in 2022 with the introduction of barley purchases. The direct impact grows less in 2020, due to the expected macroeconomic effects of COVID-19 pandemic.

Figure 5. Forecasted impact on GDP (m€)



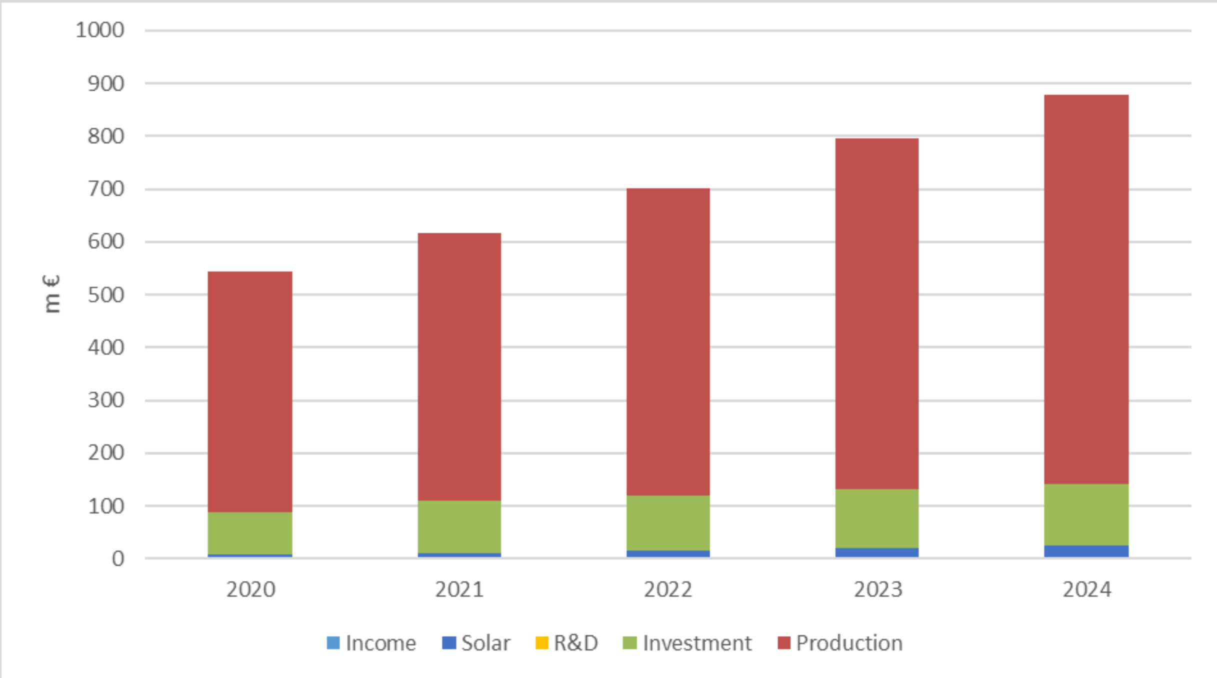
We also expect the per litre GDP impact to become higher, increasing to about 1.00 euro per litre – mostly through the growth of the indirect channel.

Table 2. Per litre GDP impact forecast

	2020	2021	2022	2023	2024	Total average (2020-2024)
Indirect (without construction)	0.88	0.92	0.88	1.01	1.12	0.96
Direct	0.15	0.16	0.19	0.19	0.19	0.18
Total	1.03	1.08	1.08	1.20	1.31	1.14

The increase of indirect effects comes mostly from the production channel, as seen in the figure below. The effects of production keep increasing with the growth of sales. Meanwhile, the size of the investment effect stays about the same throughout the forecasted period. The impact of the income and R&D channels are too small to be seen on the image.

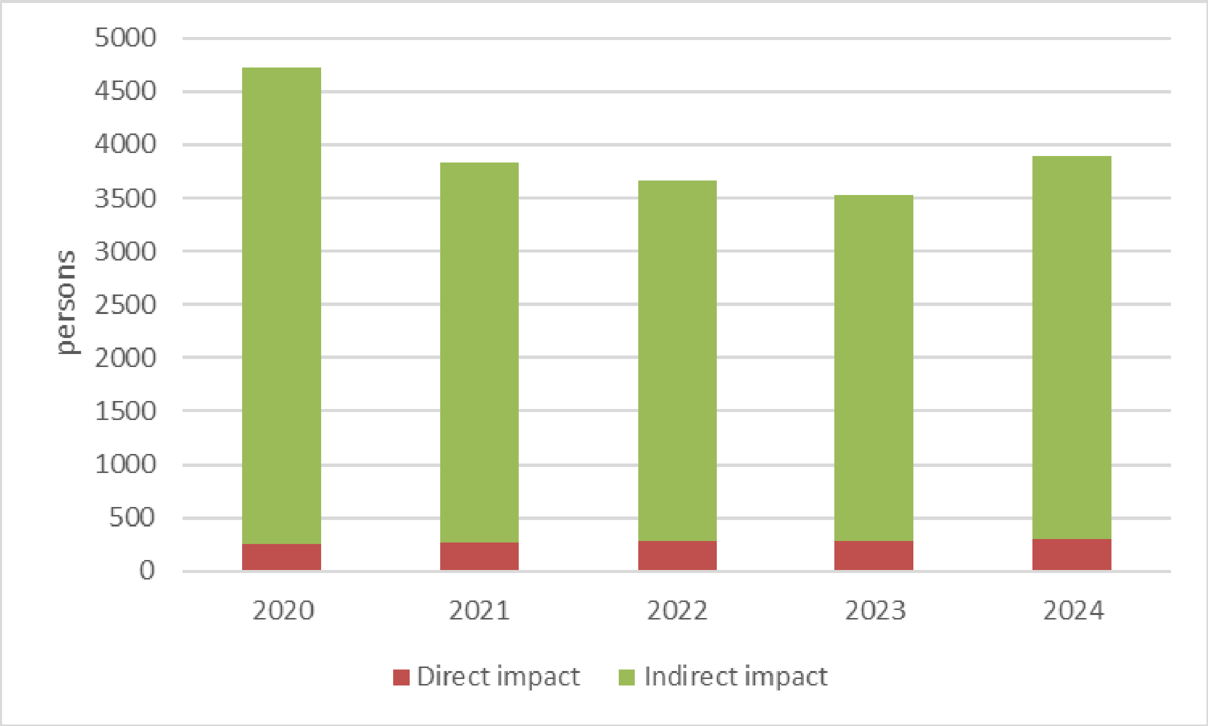
Figure 6. Disaggregation of indirect GDP impacts forecast (m€)



4.1.2. Impact on employment

Due to the worsening of the labour market conditions starting in 2020, the expected employment impacts are way higher. This is because the increased number of unemployed become easier to be incentivized to come back to the labour market. In the HÉTFA CGE model, they require less wage to start working again. As the economy stabilizes, the overall impact slowly decreases back to a lower amount.

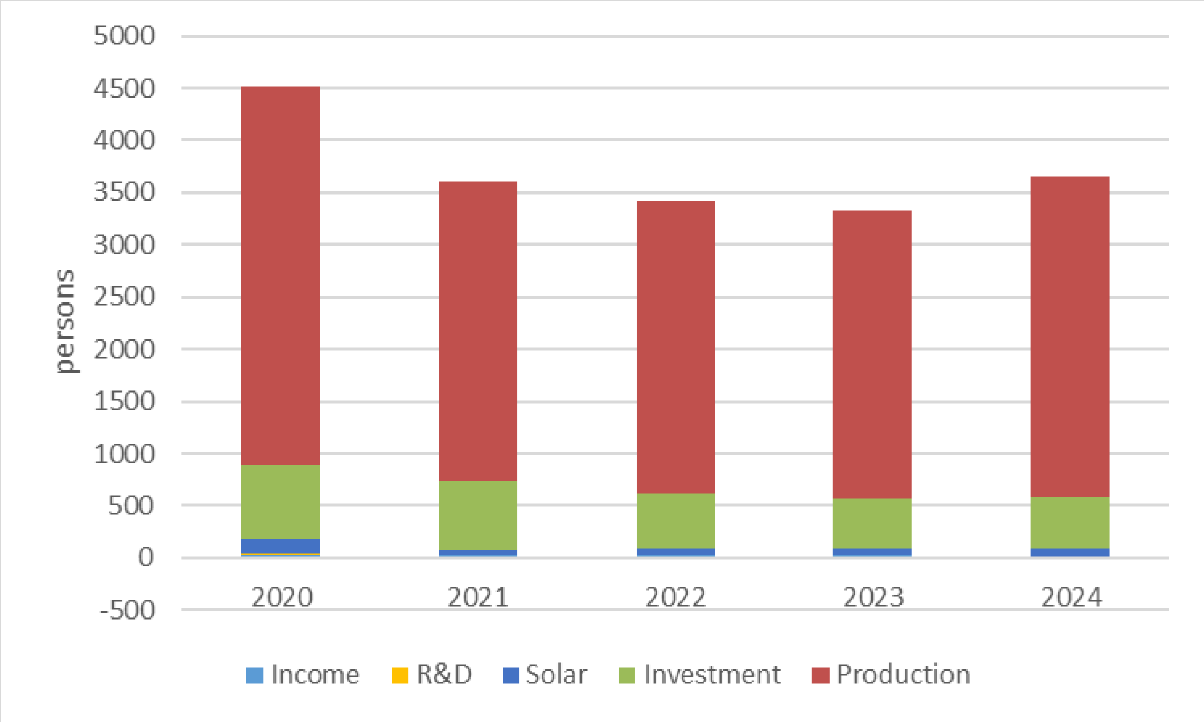
Figure 7. Employment impacts forecast (persons)



Most of the indirect employment effect comes from the production channel. The income and R&D channels are still hard to plot due to their relatively small sizes.

As can be seen in both figures, the indirect effect is the highest in 2020, then decrease till 2023, and in the last year in increases a little again. This is due to the increased unemployment caused by the COVID virus, where companies with increased production can easily find new employees. But as the economy stabilizes and unemployment decreases, new employees are harder to find, so the impact decreases.

Figure 8. Disaggregation of indirect employment impacts forecast (persons)



4.1.3. Relative impacts

In the table below we quantify the size of the shock and its impact in relative terms. The additional demand generated by Pannonia Bio is steadily increasing over the period, resulting in a constant increase in the relative impacts on the GDP. We see a smaller overall decrease on outputs, and a more significant one on the employment.

Table 3. Size of the Impact (%)

	2020	2021	2022	2023	2024
Demand shock to GDP	0.236	0.241	0.227	0.217	0.212
Impact on Output	0.445	0.510	0.579	0.646	0.710
Impact on GDP	0.472	0.515	0.558	0.604	0.651
Impact on Employment	0.101	0.079	0.075	0.071	0.079

4.1.4. Further outcomes

In this section, we delve deeper into our results, further exploring the macroeconomic effects of Pannonia Bio.

4.1.5. Sectoral impacts

The effects of Pannonia Bio on different sectors are not significantly different than in the *ex-post* calculations. The GVA increase for construction and manufacturing comes from the investment channel. However, the manufacturing sector is held back, because the other supplier sectors draw employees from manufacturing.

Table 4. Sectoral impact on value added (m€)

	2020	2021	2022	2023	2024	Total
Agriculture	205	244	305	323	329	1406
Manufacturing	-130	-164	-211	-238	-250	-992
Energy	58	70	84	96	104	412
Construction	58	67	60	66	71	321
Services	121	138	162	185	202	807

Note: these are the sectors that have significant added value changes.

4.1.6. Crowding out effect

The table below contains the size of the crowding out effect in the *ex-ante* period. The effect on private consumption shows no difference from the *ex-post* one in trend. However, the export increase will be higher than the import increase, resulting in a sign change in the trade balance. This positive trade balance effect will keep increasing in the forecast period.

Table 5. Crowding-out effect (m€)

	2020	2021	2022	2023	2024	Total
1. Extra demand of Pannonia Ethanol	619	700	821	915	999	4054
Impact on						
2. consumption	146	174	202	233	261	1016
3. investment	0	0	0	0	0	0
4. government expenditure	0	0	0	0	0	0
5. export	838	1052	1260	1515	1736	6401
6. import	847	1011	1199	1385	1557	5998
7. trade balance (5.-6.)	-9	41	61	130	180	403
Total indirect impact on GDP (1.+2.+3.+4.+7.)	756	915	1085	1278	1439	5473

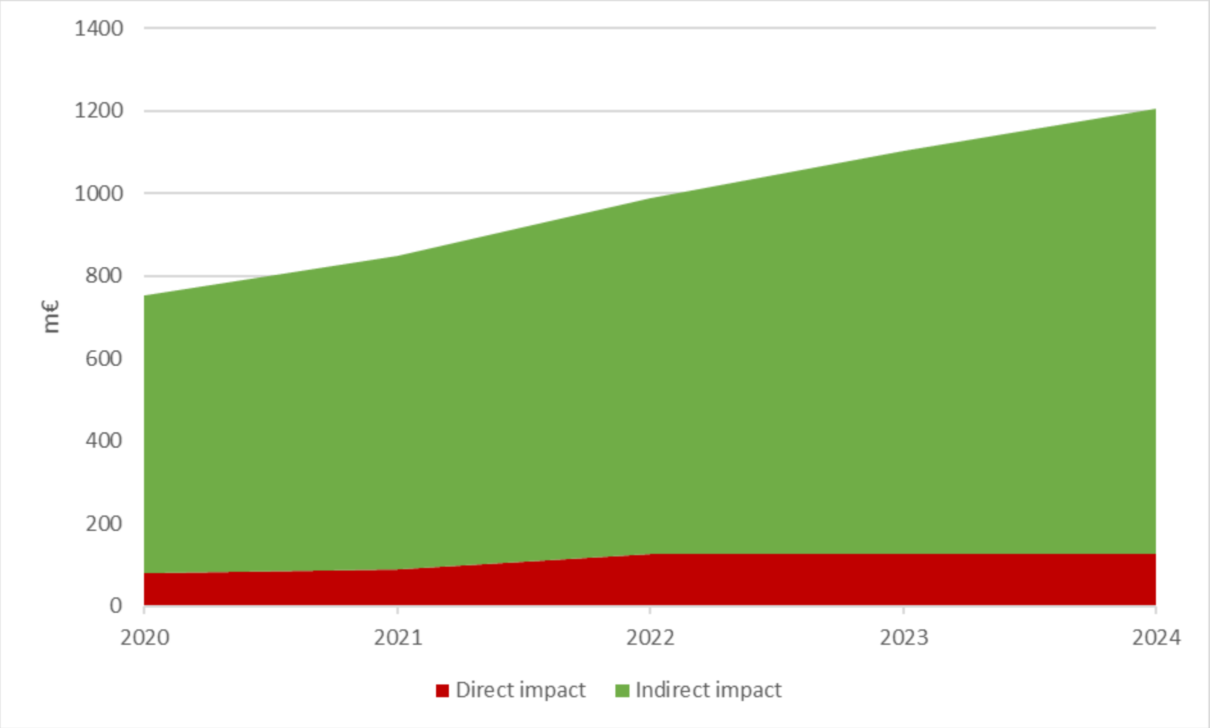
4.2. Efficiency scenario

Additional to the direct impacts and indirect channels, in this scenario we add a yearly 0.221 percent efficiency grow to agricultural production for years between 2020 and 2024, as explained in the previous chapter. This efficiency growth follows the 0.45 percent yearly increase between 2015 and 2019. The idea is that stability of demand created by Pannonia Bio in the maize market gives incentives to invest and develop production. We report the GDP and employment impact of this effect here; budgetary outcomes can be found in the Annex.

4.2.1. Impact on gross domestic product

In Figure 9 we show the GDP impact of Pannonia Bio, if yield increases are attributable to Pannonia Bio. The overall pattern is the same, but the increase in agricultural efficiency increases the total indirect GDP impact by 845 million euros. As efficiency shocks of different years add together in a multiplicative way, the difference increases over time (from 135 million in 2020 to 208 million in 2024).

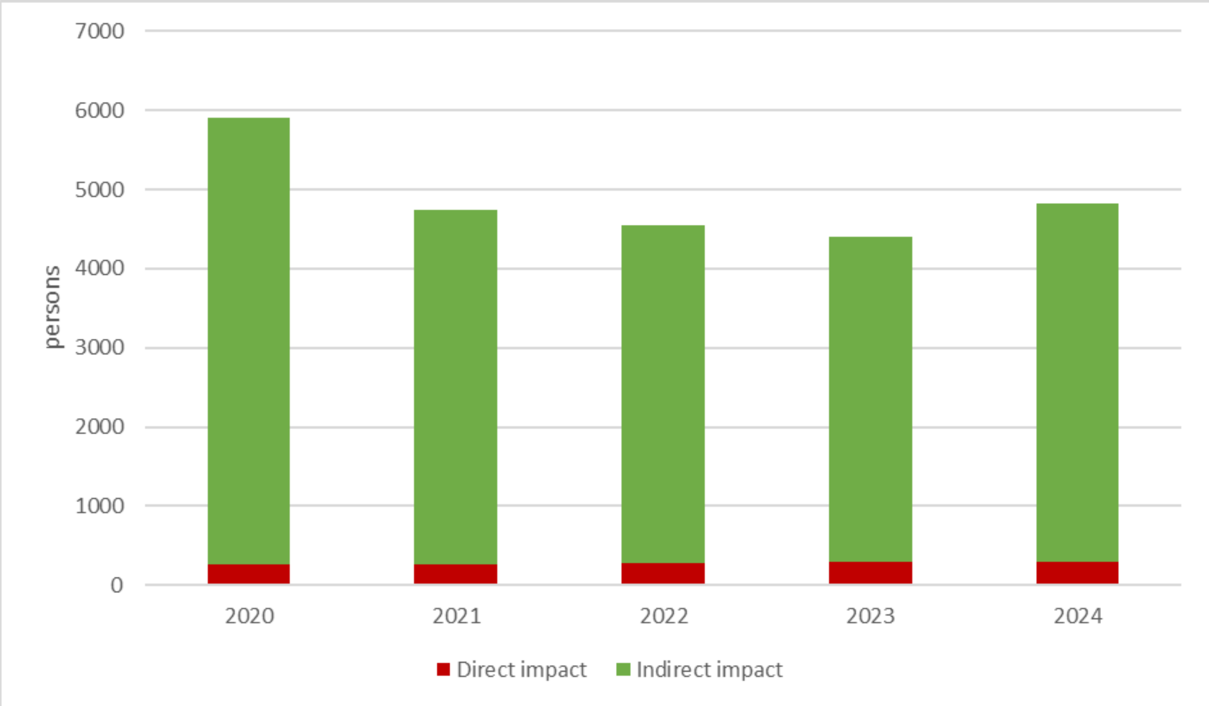
Figure 9. Forecasted impact on GDP in efficiency scenario (m€)



4.2.2. Impact on employment

The overall pattern of employment impacts is similar in the baseline scenario and in the efficiency scenario (Figure 10). The impact is highest in 2020 (when the unemployment rate is the highest) and decreases after that. The difference between the two scenarios decreases with time – from 2020's additional 1,171 employed to 916 additional employed in 2024, which means that the effect of the technological change has greater impacts with high unemployment.

Figure 10. Forecasted employment impact efficiency scenario (persons)



Annex 1. Additional tables and figures

Table 6. Sectoral additional demand, simulation parameters (m€)

Sectoral additional demand, simulation parameters						
	2020	2021	2022	2023	2024	Total
Investment demand (m€)						
Construction	27.59	26.00	13.00	13.00	13.00	92.59
Manufacturing	18.17	26.00	13.00	13.00	13.00	83.17
Intermediate materials for production (m€)						
Agriculture	166.09	177.68	221.18	221.18	221.18	1007.30
Chemistry	-3.22	-6.70	-0.41	-0.41	0.46	-10.28
Energy	23.05	21.59	27.55	27.55	29.08	128.82
Logistics	15.66	16.62	19.78	19.78	20.88	92.73
Services	32.40	14.34	21.73	22.14	22.57	113.17
R&D	1.50	1.50	1.50	1.50	1.50	7.50
Additional demand from salaries (m€)	9.50	10.75	12.40	14.13	16.08	62.87
Total demand shock (m€)	290.74	287.78	329.73	331.87	337.75	1577.86

Table 7. GDP impact (m€)

	2020	2021	2022	2023	2024	Total
Direct impact	80	89	126	127	128	550
Indirect impact	539	611	695	788	871	3504
Total impact	619	700	821	915	999	4054

Table 8. Employment impact (persons)

	2020	2021	2022	2023	2024
Direct impact	257	267	280	290	300
Indirect impact	4471	3565	3387	3244	3600
Total impact	4728	3832	3667	3534	3900

Table 9. Sectoral output impact (m€)

	2020	2021	2022	2023	2024	Total
Agriculture	32.3	35.5	44.2	45.7	47.0	204.8
Manufacturing	-107.8	-132.6	-164.7	-189.7	-208.7	-803.5
Energy	19.3	24.2	30.6	36.1	41.0	151.1
Construction	11.3	10.9	6.4	6.7	7.0	42.4
Services	-0.6	-8.2	-8.5	-10.7	-11.1	-39.2

Table 10. Impact on budget (m€)

	2020	2021	2022	2023	2024	Total
Direct impact	9	10	12	21	22	73
Indirect impact	127	160	181	218	244	929
Total impact	136	169	193	238	265	1002

Figure 11. Impact on budget (m€)

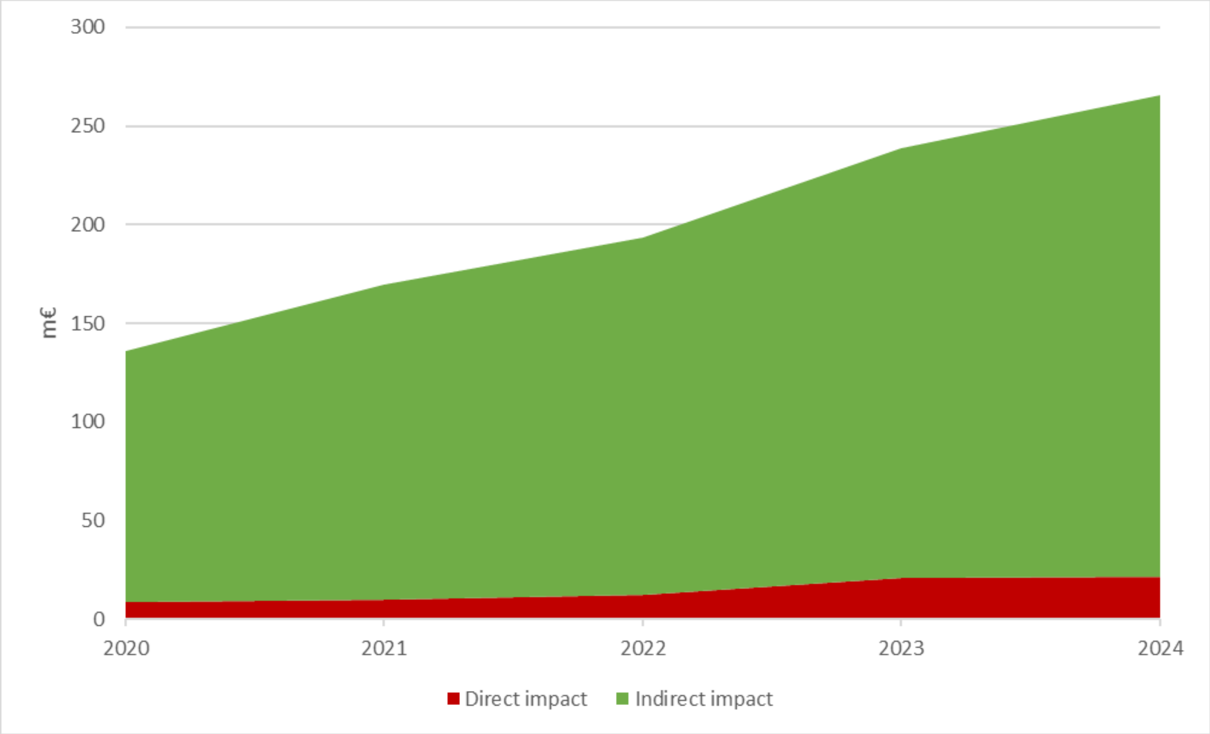


Table 11. GDP impact in efficiency scenario (m€)

	2020	2021	2022	2023	2024	Total
Direct impact	80	89	126	127	128	550

Indirect impact	673	759	862	976	1079	4349
Total impact	753	848	988	1103	1207	4900

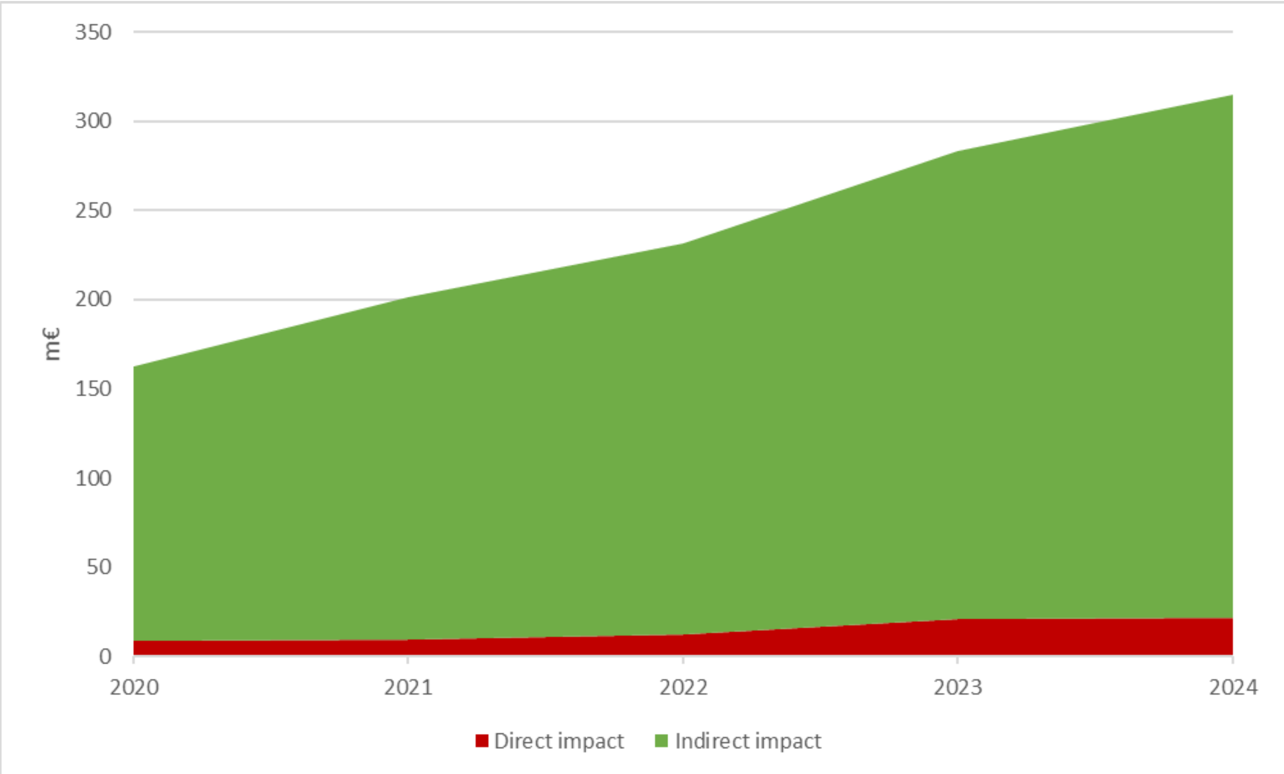
Table 12. Employment impact in efficiency scenario (persons)

	2020	2021	2022	2023	2024
Direct impact	257	267	280	290	300
Indirect impact	5642	4479	4262	4105	4516
Total impact	5899	4746	4542	4395	4816

Table 13. Impact on budget in efficiency scenario (m€)

	2020	2021	2022	2023	2024	Total
Direct impact	9	10	12	21	22	73
Indirect impact	154	192	219	262	293	1120
Total impact	163	201	232	283	315	1193

Figure 12. Impact on budget in efficiency scenario (m€)



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