INTERNATIONAL MONETARY FUND

IMF Country Report No. 23/234

REPUBLIC OF CROATIA

SELECTED ISSUES

June 2023

This paper on Republic of Croatia was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on June 7, 2023.

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International Monetary Fund
Washington, D.C.

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June 7, 2023

Approved By
European Department

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FIGURES

GOODS EXPORT DIVERSIFICATION AND COMPETITIVENESS IN CROATIA[1]

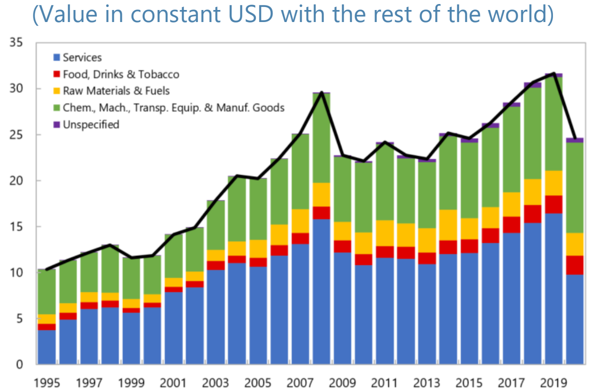
Croatia has demonstrated goods export competitiveness beyond the tourism sector. Over the past few decades, its share of exports of goods with comparative advantage has exhibited a positive correlation with Croatia's real income growth, while negatively correlated with its growth volatility. But Croatia's export structure indicates its relatively modest status in medium- and high-technology goods compared to other eurozone countries. A machine-learning-based analysis suggests that Croatia has potential in exporting a higher share of manufacturing goods in its export portfolio, especially technology-intensive ones. Raising productivity is important for Croatia to unleash the capacity for a higher and more resilient growth.

A. Introduction

1. **While tourism continues to contribute a sizeable share to Croatia's economic growth and employment, diversification within non-tourism sectors has helped bolster the economy and mitigate its over-reliance on the services sector (Box 1).** Since the Global Financial Crisis (GFC), Croatia's merchandise exports have outpaced services exports —underpinned by machinery and vehicles, chemicals, and material manufactures—in terms of real gross export values (Figure 1).[2] Merchandise goods exports accounted for 51 percent of total exports in 2022, compared to 41 percent two decades ago, and featured less volatility compared to exports of services (Figure 2). Moreover, contributions of various sectors under merchandise goods suggest that the structure of goods exports has been broadly stable over time (Box 2).

Figure 1. Export Value by Sector

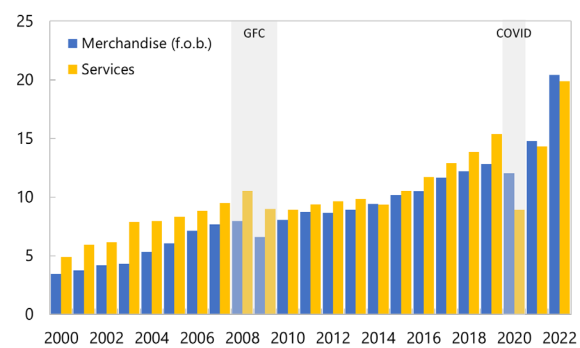
(Value in constant USD with the rest of the world)



Sources: UN Comtrade and Atlas; and IMF staff calculations.

Figure 2. Exports of Merchandise and Services

(Billion euros)



Sources: CNB; and IMF staff calculations.
Note: 2022 data from preliminary balance of payment data release as of March 31, 2023.

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[1] Prepared by Xuege Zhang. The author would like to thank counterparts at the Croatian National Bank (CNB), Ministry of Finance, Ministry of Tourism and Sports, and the World Bank's local office in Zagreb, for their helpful comments and seminar participants at the CNB for insightful feedback.

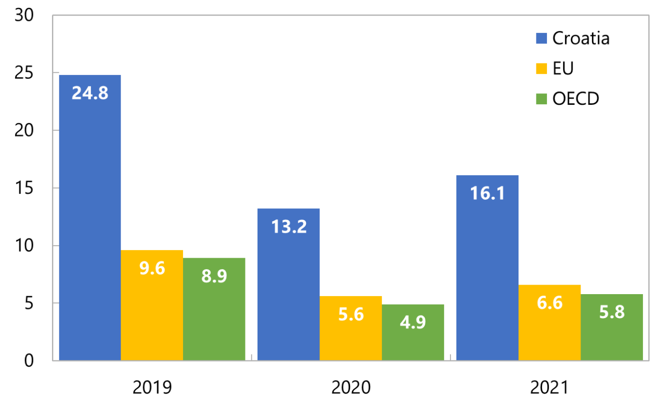
[2] Sector refers to SITC 1-digit level, where the services sector includes travel and tourism, transport, ICT, and other services (including financial services).

Box 1. Croatia: Tourism Sector

Tourism is an important sector for Croatia. The travel and tourism industry accounts for a large share of Croatia's GDP[1], surpassing that of EU and OECD countries, despite the pandemic. Compared with other tourism-intensive countries in the EU, Croatia's tourism contribution to GDP relative to tourism employment share is high. In 2019, Croatia's tourism GDP (direct, see Note 1) as a share of the total reached 11.8 percent in 2019, second only to Spain (Figure 3, left panel, Box 1 Note 2). Entering the eurozone and Schengen area is expected to make Croatia a more attractive destination for both European and global tourists. On the other hand, the tourism employment (direct) as a share of total employment was 6.8 percent.[2] This means the (direct) tourism GDP per (direct) tourism employment is higher than that of many peers (Figure 3 right panel).

Total Contribution of Travel & Tourism to GDP

(Percent)



Source: World Travel and Tourism Council.

However, the uncertainties concerning the sustainability of Croatia's tourism model could pose a challenge to its long-term growth. Studies suggest that Croatia's growth can be unsustainable for its overreliance on a "sea and sun" tourism model - concentrated in coastal areas during the summer months (Orsini and Ostojić, 2018; World Bank, 2023). Furthermore, its tourism sector faces various challenges, such as a lack of workers, seasonality, an unbalanced spatial distribution, and insufficient innovative and high-quality products, despite its abundance of natural and cultural resources (OECD, 2020).

Note 1: Tourism GDP corresponds to the part of GDP generated by all industries in response to internal tourism consumption. OECD statistics adopt the direct measure of tourism GDP, which refers to the GDP generated by industries directly in contact with tourists.

Note 2: This figure shows 2019 available data for both tourism GDP share and tourism employment share. There are only 21 available observations for 2019 (less in 2020 and 2021, the most recent availability). Croatia ranks the second among available OECD and selected non-OECD countries in the key tourism indicators dashboard.

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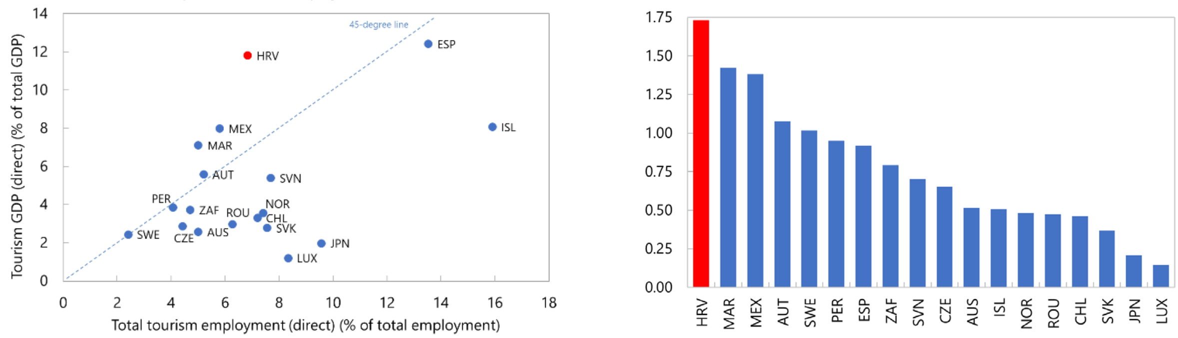
[1] Data comes from World Travel and Tourism Council (WTTC). WTTC/Oxford methodology applies the UN WTO Statistics Division-approved TSA methodology (TSA: RMF 2008) to quantify the direct contribution of Travel and Tourism. It reflects tourism-characteristic sectors such as hotels, airlines, airports, travel agents and leisure and recreation services that deal directly with tourists.

[2] This statistic could be underestimated because of Croatia's composition of the accommodation sector. About 40 percent of accommodation in Croatia consists of private accommodations.

Figure 3. Tourism Output and Employment in Croatia

Tourism Employment and GDP, 2019 (Percent of total GDP; percent of total employment)

Tourism Output and Employment Share, 2019 (Percent)



Source: OECD.

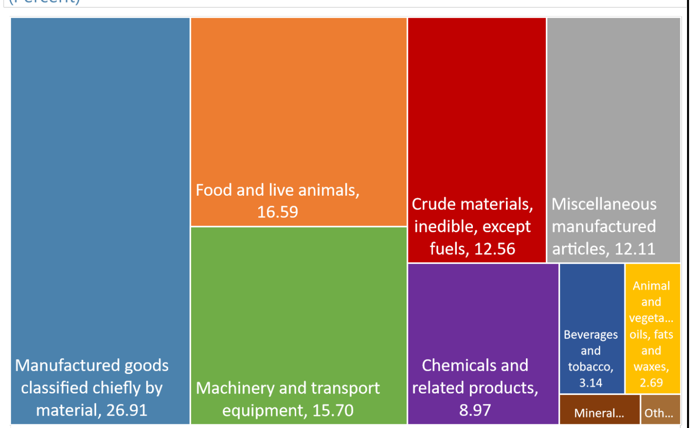
Sources: OECD; and IMF staff calculations.

2. **This paper examines the competitiveness of Croatia's goods exports and predicts its goods export diversification potential.** Section II discusses the goods export competitiveness using Revealed Comparative Advantage (RCA) with cross-country comparison. Section III uses a machine-learning approach to worldwide product-level data to forecast Croatia's goods export portfolio. Section IV concludes with a summary and some reflections on reforms for the way forward.

Box 2. Croatia: Goods Export Structure

Croatia has a diversified goods exports basket. As shown in next figure, in 2020, manufacture goods classified chiefly by material accounted for the largest share (26.9 percent), followed by foods and live animals (16.6 percent), and machinery and transport equipment (15.7 percent).[1]

Goods Export Basket, 2020
(Percent)



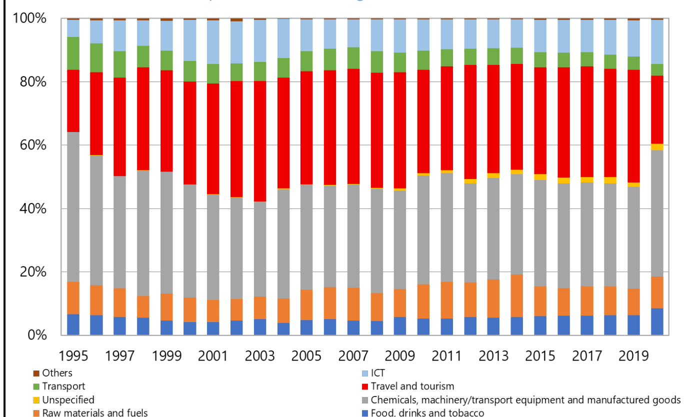
Sources: UN Comtrade and Altas; and IMF staff calculations.

[1] Using the 2018 or 2019 data does not change the export basket structure significantly.

Box 2. Croatia: Goods Export Structure (Concluded)

Over time, the travel and tourism sector has been a volatile factor among Croatian sectoral export performances. As shown in next figure the sector (at SITC 2-digit level under the broad service category) accounted for 35 percent of total exports in 2019 but only 20 percent in 2020 due to the pandemic. Other large sectors, especially machinery and vehicles, material manufactures, chemicals, and miscellaneous manufactured articles in total accounted for a combined 39.7 percent of total exports in 2020, highlighting the importance of Croatia's merchandise trade sector in addition to the services sector.

Export Share by Sector in Croatia
(Service sector decomposed at SITC 2-digit level)



Sources: UN Comtrade and Atlas; and IMF staff calculations.

B. Goods Export Comparative Advantage

3. **Methodology.** To measure an economy's relative export competitiveness for a specific product (compared to the rest of the world), this paper employs a standard metric in the trade literature initially proposed by Balassa and Noland (1965) by calculating the annual Revealed Comparative Advantage (RCA) at the country-product level:

$$RCA_{ijt} = \frac{E_{ijt} / \sum_j E_{ijt}}{\sum_i E_{ijt} / \sum_i \sum_j E_{ijt}}$$

where E_{ijt} is the export value of product j by country i in year t.

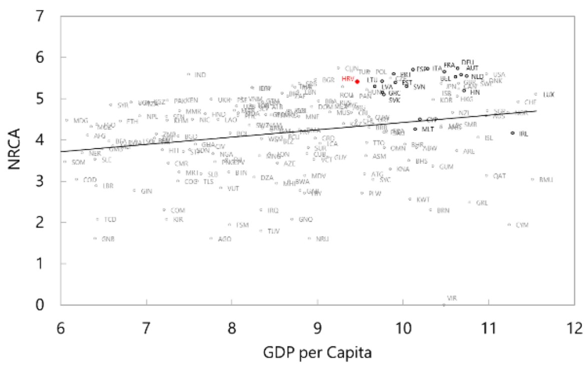
4. **Croatia has a relatively broad range of products exhibiting comparative advantages.** We calculated the number of Croatia's highly competitive products across sectors from its actual goods export basket, with high-RCA products defined as $RCA_{ijt} > 1$, in line with the trade literature. The number of high-RCA products is referred as "NRCA" hereafter. Figure 4.1 (left panel) shows the relationship between NRCA and per capita income[3] in economies around the world, with the euro

[3] Cross country evidence suggests that more developed countries (measured by GDP per capita) tend to have higher NRCA (Che and Zhang, 2022).

area (EA) countries including Croatia highlighted (in black and red respectively, with other economies in gray). Figure 4.1 (right panel) zooms in the NRCA in 2020 across the EA countries. Croatia's NRCA stands relatively high in the world and is approximately the median among its EA peers[4], in contrast with Croatia's relatively low standing in terms of per capita income in the eurozone.

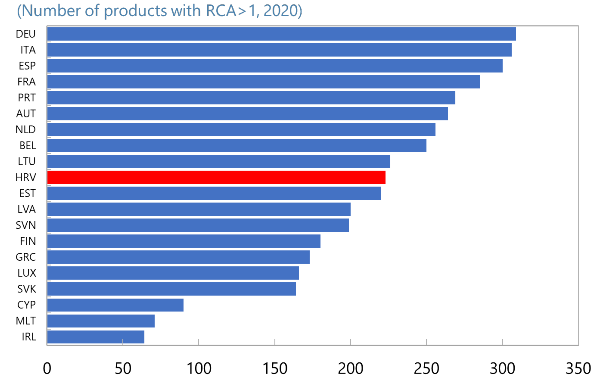
Figure 4.1. Goods Export Competitiveness: Croatia and EA

NRCA and Income Level, 2020
(Log scale for both axis)



Source: UN Comtrade and Atlas; World Bank WDI; and IMF staff calculations.

NRCA, Croatia and EA Countries
(Number of products with RCA>1, 2020)



Sources: UN Comtrade and Atlas; and IMF staff calculations.

5. **Compared to other tourism-dependent countries, Croatia stands out in its range of goods exports with revealed comparative advantages**. Figure 4.2 (left panel) presents the NRCA in tourism-intensive economies, where the tourism share is measured by international tourism receipts as a percentage of total exports.[5] Tourism countries tend to have a lower number of goods exports with revealed comparative advantages, reflecting their reliance on resources and natural endowment.[6] However, Croatia stands out among these tourism-intensive countries, boasting the highest number of high RCA products in its goods exports.

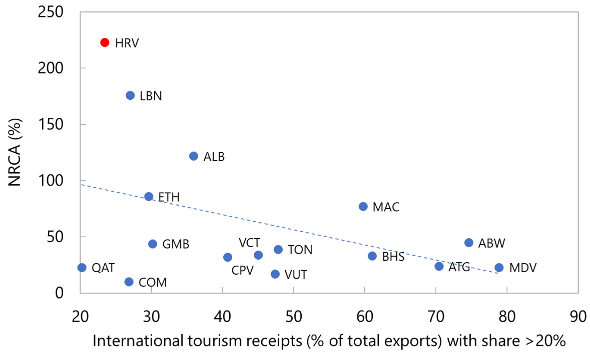
[4] Note that European countries have high NRCA in general. The world average NRCA is 94.4 in 2020.

[5] In Figure 4.2 (left panel), tourism share uses the World Bank WDI data. As robustness check, an alternative measure is used and shown in Figure 4.2 (right panel) where the "Tourism" countries refer to the top ranked economies by 2020 international tourism revenue as share of GDP in the world (based on World Tourism Organization data), with reference to World Travel & Tourism Council for top 30 economies relying on travel and tourism industry of their total share of employment. The major results hold. PRT has larger number of NRCA because of the revenue measure, followed by Croatia, which still stands high.

[6] Note that the tourism-based economies we analyze here are different from the resource/commodity-driven (either agricultural or minerals/fuels economies, where the literature on the so-called "natural resource curse" documents these patterns for various countries and time periods. See surveys by Frankel (2010) and Harvey et al (2018).

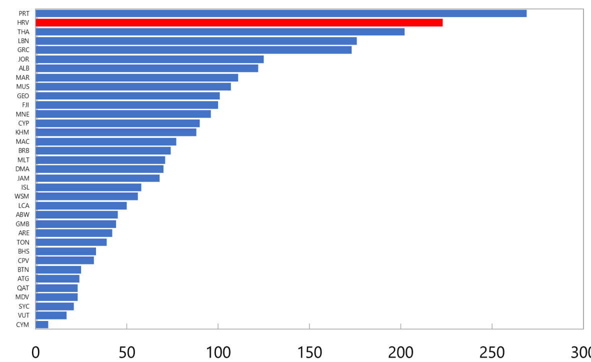
Figure 4.2. Goods Export Competitiveness: Croatia and Tourism Economies

NRCA, 2020 in Croatia and Tourism Economies
(Percent; percent of total exports)



Sources: UN Comtrade; Atlas; World Bank WDI; and IMF staff calculations.

Number of High RCA in Tourism-Intensive Economies
(Tourism-intensity ranked by World Tourism Organization)

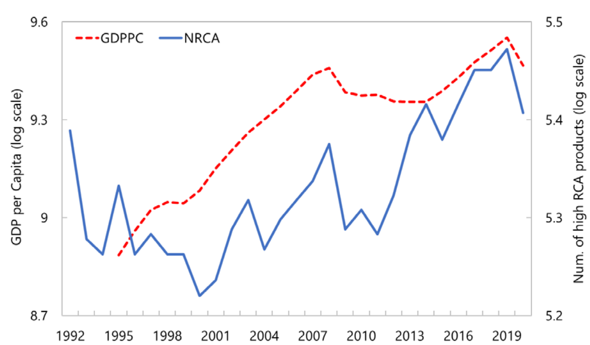


Sources: World Tourism Organization; WTTC; and IMF staff calculations.

6. **The number of goods exports with comparative advantages is positively correlated with the growth of Croatia.** To further examine Croatia's growth performance in relation to its goods export competitiveness, Figure 5 and Figure 6 show the evolution of real GDP per capita and its volatility (5-year moving window) over time.[7] Since the mid-1990s, the number of products with high RCA has displayed a positive correlation with real GDP per capita (Figure 5) and a negative correlation with income volatility (Figure 6). Notably, Croatia's number of high RCA products has experienced a significant uptick since the early 2010s post-GFC, during which its growth volatility experienced a sharp decline until the onset of the pandemic.

Figure 5. NRCA and Real GDP Per Capita in Croatia

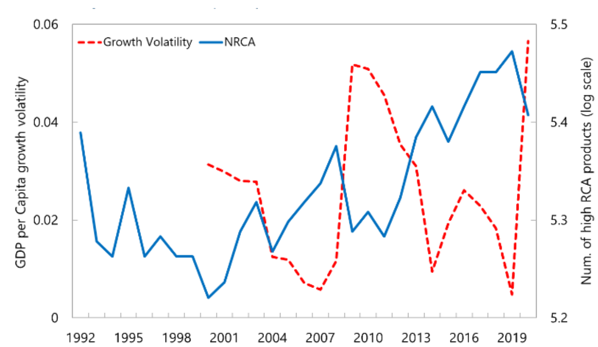
(NRCA: Number of High-RCA Export)



Sources: UN Comtrade and Atlas; World Bank WDI; and IMF staff calculations.

Figure 6. NRCA and Growth Volatility in Croatia

(Volatility: SD of real GDP per capita)



Sources: UN Comtrade and Atlas; World Bank WDI; and IMF staff calculations.

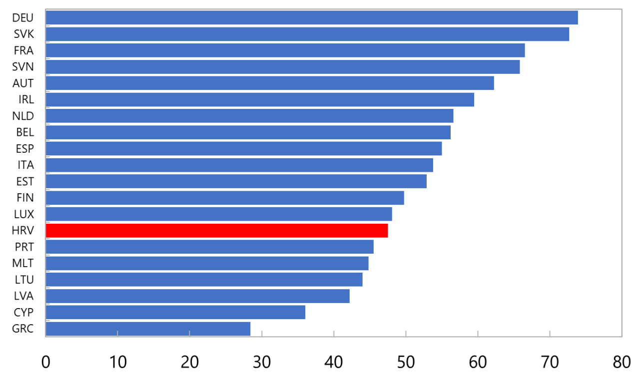
[7] Hausmann et al. (2007) finds that countries that export more sophisticated, or knowledge-intensive products, tend to grow faster, controlling for initial income levels.

Medium- and High- Technology Exports Are Still Lagging…

7. **Although Croatia has a relatively high number of export products with RCA, the share of medium-and-high technology exports is still relatively low compared to the EA average**. A higher number of exports with RCA does not necessarily imply that a country is more competitive in medium- and high-tech goods. Decomposing export products by technology levels based on R&D intensity[8] shows that Croatia's share of medium- and high-tech exports in all manufactured exports (47.5 percent) is relatively low compared to that of other EA countries (Figure 7). In other words, products driving Croatia's goods exports primarily situate at a lower stand in the value added.

Figure 7. Medium-and High-Tech Exports in EA Countries

(Percent of manufacture exports, 2019)

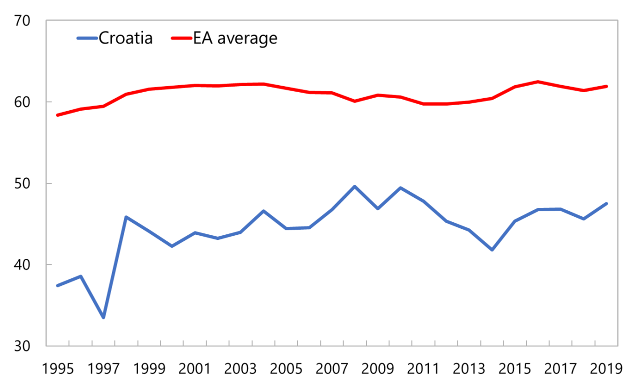


Sources: World Bank WDI; and IMF staff calculations.

8. **Croatia's share of medium- and high-technology products in total exports has been consistently below the EA average**. It increased by around 10 percentage points over the past 25 years. However, this level has been much lower than the EA average,[9] with a substantial decline following the GFC[10], notably between 2010 and 2014 (Figure 8). This, coupled with the increase in the number of high-RCA products, suggests that Croatia has relied disproportionately on low-tech exports. Although the country seems to be catching up since 2014 after joining the EU, its share of medium- and high-technology products has not

Figure 8. Medium-and High-Technology Exports

Percent of manufacture exports)



Sources: World Bank WDI; and IMF staff calculations.

[8] The categorization of high-technology products is proposed by OECD in collaboration with Eurostat. According to OECD statistical methodology, examples of high-technology industries are aircraft, computers, and pharmaceuticals; medium-high-technology includes motor vehicles, electrical equipment, and most chemicals; medium-low-technology includes rubber, plastics, basic metals and ship construction; low-technology industries include food processing, textiles, clothing and footwear.

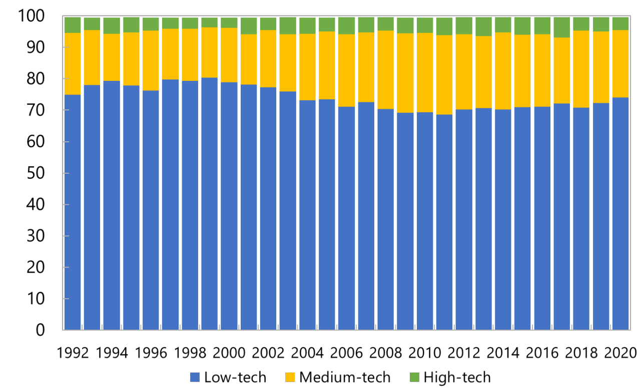
[9] The EA average is weighted by GDP. Croatia's level was also below the world GDP-weighted average.

[10] The decline in medium-tech exports partly reflected domestic industrial restructuring during the EU accession. The sharp decline in medium-tech product exports is related to a significant drop in ship exports, partially offset by increased shares of chemical products and industrial machinery. (Čardić and Šelebaj, 2021)

recovered to the pre-GFC level. And the distance with the EA average has not decreased compared to that prior to the GFC.

9. Low-technology products have dominated Croatia's export basket with revealed comparative advantage, although the share of medium-technology goods exports has been increasing. Looking at the technology intensity of Croatia's goods exports with high RCA, we found a relatively high share of low-technology products, while medium-technology products have accounted for an increasing share over the past two decades.[11] However, the share of high-tech products has been stagnant at low levels.

Figure 9. High-RCA Products by Technology Group
(Percent)



Sources: UN Comtrade and Atlas; and IMF staff calculations.

C. Export Products Potential

10. A machine-learning approach is applied to predict export products potential for Croatia. This paper applies a machine learning method, collaborative-filtering algorithm, to provide insights on product-level[12] goods exports for Croatia (Box 3). The intuition behind this algorithm is that products related to a country's existing goods export structure and export portfolios of similar countries offer useful information about the country's latent comparative advantages, which cannot always be neatly expressed quantitatively. We aim to predict where an economy might have competitiveness in goods products, by leveraging the country-product export data worldwide. With cross-country estimation, we show that improving towards the predicted export structure[13] could potentially boost growth and macroeconomic stability. Economies with export portfolios more aligned with our recommended ones are found to have experienced higher and more resilient growth. When considering greater accession to the global market, small open economies often confront trade-offs about what products to diversify into. Large emerging markets could face challenges associated with either short-term or long-term bottlenecks, including suboptimal structural policies. The algorithm-based predictions can help inform a broader and deeper reform agenda, as well as product-level export diversification and/or specialization strategies.

[11] This was partly due to the growing share of medical and pharmaceutical products in total exports.

[12] Sector-level refers to SITC (Rev. 2) 1-digit, and product-level refers to SITC 4-digit hereafter.

[13] We call these predictions "recommendations" interchangeably throughout the paper, in light of the design and usage in the wider recommendation system context. Note that these "recommendations" are algorithm-based predictions, instead of any direct industrial/product-specific policy recommendations, while it could serve as a reference in understanding the evolution of products and export portfolios.

Box 3. Croatia: Methodology Overview[1]

Our export product recommendation system employs a product-based K-nearest neighbor (KNN) algorithm. KNN is widely used in the collaborative filtering recommendation systems in many businesses decision-making scenario. The intuition of KNN is learning by analogy, i.e., classifying the test sample by comparing it to the set of training samples the most similar to it. Different KNN implementations vary in terms of their choices of how the similarity between input vectors is calculated. In this paper, the cosine similarity score is used as the similarity measure.

The key input in the recommendation generating process when modelling the country-product space is the actual RCA matrix. In particular, we first write the actual RCA score matrix $\boldsymbol{R}$ as:

$$\boldsymbol{R} = [\boldsymbol{p_1}, \boldsymbol{p_2}, \dots, \boldsymbol{p_n}]$$

where $\boldsymbol{p_j}$, an arbitrary element in $\boldsymbol{R}$, is a vector of length m that represents the RCA scores of product j for all the m countries, namely,

$$\boldsymbol{p_j} = \begin{bmatrix} r_{1j} \\ r_{1j} \\ \vdots \\ r_{mj} \end{bmatrix}$$

Note that in our implementation, m is effectively the cross-sectional country numbers. In machine learning terminology, each product in the sample has m features. The cosine similarity between products j and j' is equal to, which ranges from -1, when the two vectors are the exact opposite, to 1, when the two are exactly the same. The intuition behind this is that by comparing the two sets of countries that export i and j, and how important the products are in the countries' export baskets, information can be inferred regarding how closely related the two products are.

The implementation of the product-based KNN recommender for country $\boldsymbol{i}$ in year t involves the following steps:

1. Represent each product in the SITC 4-digit product space as a vector of RCA scores, $\boldsymbol{p_j}$.
2. Select the set of products that country i has a revealed comparative advantage, i.e., $r_{ij} > 1$ which will be referred as the high-RCA product set of country i.
3. For each $j \in [1, n]$ calculate the predicted value of r_{ij} as a weighted average RCA score of the high-RCA product set, weighted by the cosine similarity between product j and the products in the country's high-RCA set.
4. The recommended products for country i are the $\widehat{K}_{RCA,it}$ products with the highest predicted r_{ij} values (i.e., recommendation scores), where $\widehat{K}_{RCA,it}$ comes from the estimation in the first stage.

We then calculate the similarity score between recommended and actual export structure for each of the sample years. We define the export structure of a country's actual exports as the number of high RCA exports (at SITC 4-digit level) that belong to each SITC 1-digit sector, as a share of total number of high RCA exports. Similarly, we define the recommended export as the vector for the number of recommended products that belong to each SITC 1-digit sector as a share of the total number of recommended export products. The similarity score between the actual and the recommended export portfolio then calculated as the distance between the two vectors of actual and recommended structures.

We show that portfolios more aligned with the predicted ones are associated with a higher and more resilient growth. Specifically, the system GMM estimation shows that a 0.1 increase in the similarity between actual and predicted goods export portfolios is associated with a 0.22 percentage point increase in the annual growth rate of GDP per capita and a 0.0015 decrease in the growth volatility (standard deviation of growth rate in a 5-year window). These results are robust by varying forward-looking horizons and standard winsorization.

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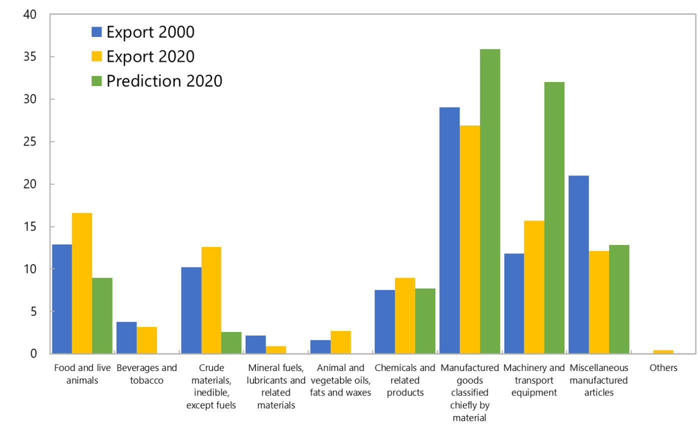
[1] Che and Zhang (2022) provides further details.

Figure 10. Export Portfolio by Sector in Croatia

(Percent, Actual Export vs. Algorithm Prediction)



Sources: UN Comtrade and Atlas; and IMF staff calculations.

11. **Our analysis suggests that Croatia has export potential in manufactured goods.** Using a large economy-product space covering more than 700 products of over 190 economies during 1980-2020, our analysis presents where Croatia may have latent comparative advantages in goods exports. While Croatia's export structure has remained relatively stable between 2000 and 2020 ("Export 2000" and "Export 2020" bars in Figure 10), we predict that Croatia could have a higher export composition in the manufacturing sector, especially in material-related manufactured goods, machinery, and transport equipment sub-sectors.[14] As shown in Figure 10, the *predicted* shares in total exports ("Prediction 2020") are higher than the *actual* shares in 2020 ("Export 2020") for these sub-sectors, in comparison to the lower predicted shares in agricultural and resource-based products. A further decomposition of exports into medium- and high-technology products reveals that Croatia's goods export potential is especially high in the machinery and transport equipment sector, which accounts for more than half of the medium- and high-technology products across all sectors.[15] Notably, Croatia's exports from the machinery and transport equipment sector accounted for 15.7 percent of Croatia's total export basket in 2020, whereas our predicted share of this sector is 30.8 percent.[16]

D. Conclusions

12. **To maximize its potential in merchandise goods exports, Croatia would benefit from comprehensive structural reforms aimed at enhancing productivity to help Croatia ascend further the technology ladder**. Our algorithm-based analysis indicates that Croatia exhibits potential in certain medium- and high-technology manufacturing sectors. Productivity in Croatia still lags behind its EU peers despite progress in recent years, as well as the global value chain participation (World Bank, 2023). Higher productivity will be key to realizing these potentials and fostering faster income convergence.

[14] The Rimac Group and DOK-ING are two examples (as automotive parts manufacturers).

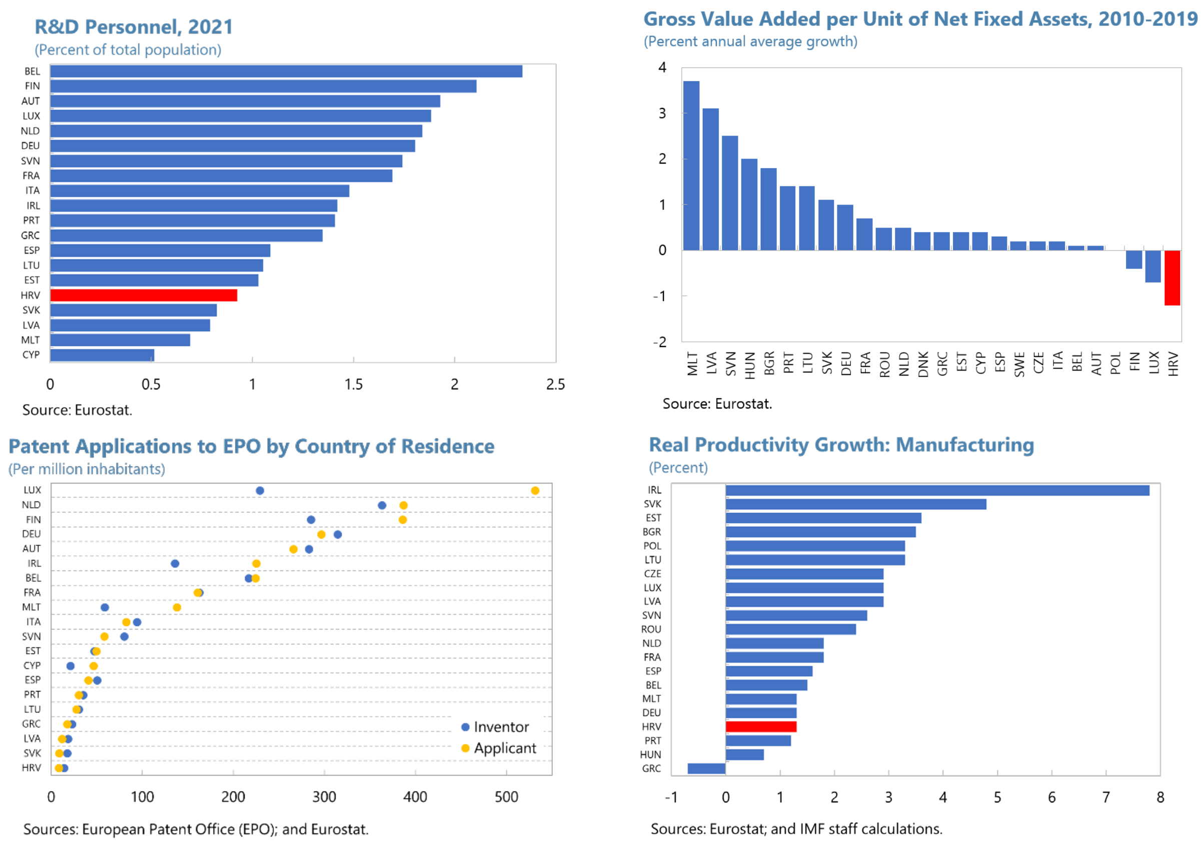
[15] According to the Technology Classification of Manufacturing Exports and Production by the United Nations Industrial Development Organization, the machinery and transport equipment sector accounts for more than half of medium- and high-technology products across all sectors (The 2017 version is based on SITC Rev. 3. A crosswalk was established to be consistent with SITC Rev. 2 for the analysis in this paper).

[16] Among the top 20 predicted products, 15 products have high actual RCAs. Among the 5 products with actual RCA less than 1, four are medium- or high-technology products (two are in the chemical sector and two are in machinery and transport equipment).

13. Addressing structural bottlenecks will reinforce Croatia's competitiveness and help to propel merchandise goods export forward. Croatia needs more comprehensive structural reforms to reinforce a deeper integration into the European trade and investment network. These reforms should involve strengthening institutional efficiency, enhancing labor productivity, promoting labor market matching and on-the-job training, and improving the business environment to attract investments and talents to compete in the global market. Specifically,

- R&D personnel as a percentage of the population was below 1 percent in 2021 (Figure 11, upper left panel).
- The number of patent applications to the European Patent Office by applicants' and inventors' country of residence per million inhabitants is 7.2 and 6.7, respectively. These are significantly lower than the EU average of 151.9 for inventors and 151.4 for applicants and are the lowest among the EA countries (Figure 11, lower left panel).
- Croatia exhibits the second lowest gross value added per unit of fixed assets among the EA, suggesting low investment efficiency (Figure 11, upper right panel).
- Real productivity growth in manufacturing is also relatively low among the EA countries (Figure 11, lower right panel).

Figure 11. Structural Bottlenecks for Competitiveness



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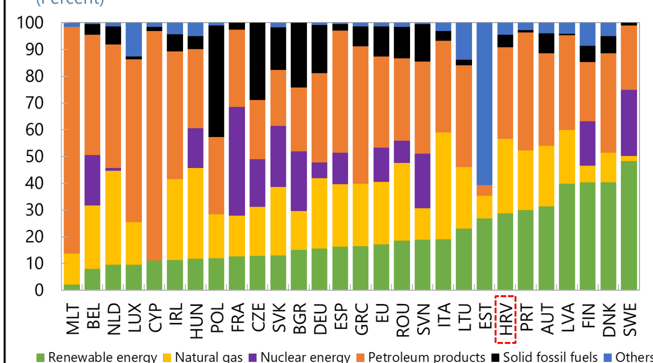
ENERGY SECURITY AND CLIMATE CHANGE: CHALLENGES AND OPPORTUNITIES FOR CROATIA[1]

Despite vast potential and recent expansion of renewables, Croatia's energy consumption mix is still dominated by fossil fuels. Croatia is increasingly exposed to climate change and natural disasters and climate adaptation is a priority. Furthermore, with a high energy intensity and low energy efficiency relative to EU peers, its national climate strategy is moderately ambitious and only partially integrated with its energy strategy. Reaching its mitigation goals will require economy-wide carbon pricing reinforced by sectoral policies and targeted support to the vulnerable. A carbon tax that progressively increases for sectors not covered by the existing EU Emissions Trading System (ETS) could be phased in through the current excise regime as international energy prices fall and ahead of the EU-wide ETS for buildings and transportation (Fit-for-55), with fiscal revenues recycled to compensate vulnerable households. A domestic price floor could be considered for sectors covered by the existing EU ETS, equal to the non-ETS sector carbon tax. Feebates for the power, transportation, and building heating sectors could also be considered to achieve a deep decarbonization and speed up electrification, thus further reducing GHG emissions. Energy efficiency improvements need to be prioritized. Finally, the existing energy price caps should be removed to allow price signals and promote energy efficiency and savings.

A. Croatia's Energy Mix and Efficiency

1. Despite vast potential for renewables and their recent expansion, Croatia's energy consumption mix is still dominated by fossil fuels. Croatia has one of the highest amounts of solar radiation in Europe and potential for substantial increase in all types of renewable energy sources (RES), however it still relies on more conventional energy sources (oil, petroleum, and natural gas). One reason is the underdevelopment of RES technologies which only progressively took off with increased EU funding and the depletion of domestic conventional energy sources. Some major economic sectors remain large energy consumers. Two thirds of Croatia's final energy consumption are equally spent in the households and transportation sectors, with industry, services and other sectors making up for the rest.

Energy Products in Gross Available Energy, 2021
(Percent)



Source: Eurostat.
Note: For Croatia, the chart does not include nuclear energy from Krško Nuclear Power Plant in Slovenia, providing about 15% of Croatia's power.

[1] Prepared by Irina Bunda, with assistance from Estefania Cohn-Bech and Giovanni Borraccia.

The analysis has benefited from useful comments and suggestions from Nate Vernon (FAD), staff from the Ministry of Economy and Sustainable Development, Croatian National Bank (CNB), the World Bank's local office in Zagreb, and participants at the CNB seminar on May 19, 2023.

Households' consumption consists of solid biofuels, electricity, and natural gas. The transportation sector, essential for a tourism-oriented country like Croatia, uses predominantly diesel and motor gasoline.

2. Croatia is exposed to surging wholesale energy prices and energy disruptions in Europe. Croatia is a net exporter of renewables and biofuels but still imports more conventional sources of energy. Its import energy dependence was 52 percent in 2021, slightly below the EU average, meaning that Croatia imports more than half of its annual energy consumption, in net terms. Petroleum products, crude oil, and natural gas are the main imported energy products. More than ¾ of crude oil used was imported at end-2021, with diesel oil and motor gasoline being the main refinery outputs. As for natural gas, 2/3 of production comes from imports. Croatia also imports about 1/3 of total electricity supply (which also includes electricity from the nuclear plant shared with Slovenia), slightly below the EU average. Electricity is produced mainly from renewables (60 percent, mainly hydro) and partially imported fossil fuels. The dependence on hydropower means Croatia's electricity generation fluctuates considerably. Finally, Croatia fully depends on imports for solid fossil fuels (anthracite, other bituminous coal, and lignite), although their share in total consumption is relatively low.

3. Croatia sourced only a modest share of its energy from Russia prior to 2022, thanks to its extensive renewable energy capacity and expanding energy import infrastructure. Given Russian's limited share in the imports of natural gas, oil and petroleum products, and solid fossil fuels, Croatia's total dependence on energy from Russia is about 18 percent, which is much less than the EU average.

Energy Mix and Russia's Share–Croatia

	Energy Mix 1/	Import dependence	Russia's share in Imports 2/	Russia's Share in Supply	Russia's share in Energy Mix
	A	B	C	D=B x C	E=A x D
Natural gas	28.3	66.4	69.3	46.0	12.9
Oil and petroleum products	35.8	76.3	16.2	12.4	4.4
Solid fossil fuels	4.9	107.3	8.9	9.6	0.5
Renewables and biofuels	24.9	-6.7	…	…	…
Non-renewable waste	0.3	0	…	…	…
Electricity and derived heat	6.1	32.5	…	…	…

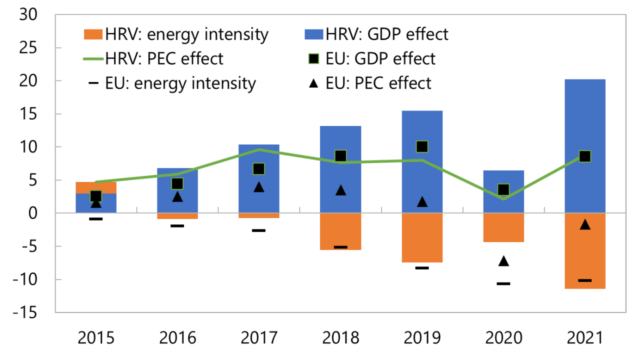
Source: IMF calculations based on Eurostat energy data for 2019.

1/ Percentage of total supply (production plus imports minus exports).

2/ This indicator recalculates the ultimate origin of imports, aiming to remove transit of fuels.

4. Croatia's improvements in sectoral energy efficiency are slower than in its EU peers given the systematically higher energy intensity, with negative consequences for GHG emissions and energy security. A measure of energy efficiency, energy intensity has declined at a slower pace than the EU since 2010 (and even increased in 2020) and remains elevated. As of 2021, energy intensity, an important indicator of how much energy is used by the economy and the main tool to reduce GHG and ensure energy security, was 1.4 times the EU average. As Croatia's real GDP has been growing faster than the EU average and technical efficiency improvements have been slower to materialize, energy consumption (primary or final) has thus increased faster. With a higher energy intensity, Croatia thus consumes more imported fossil fuels and has higher GHG emissions than explained by its GDP expansion. Imported fossil fuels are still heavily used in the building heating and transport sectors. The transport and households' sectors have high potential for efficiency improvement. Private road transport dominates for both passenger and freight transport; rail transport makes up only 2.4 percent of inland passenger transport and less than one quarter of inland freight transport. Old and inefficient buildings are responsible for 40 percent of energy consumption and 36 percent of CO_2 emissions (with wood and gas heating predominant); most of the worst performing buildings are not up to standards for protection against earthquakes, fire or health protection, therefore requiring a comprehensive renovation, including for the large damage caused by the 2020-21 earthquakes (Croatia NRRP, 2021).

Contribution of Different Effects to the Variation in Primary Energy Consumption
(Percent relative to 2014)



Sources: Eurostat; and IMF staff calculations.

5. Croatia has expanded the share of renewable energy sources (RES) in total energy consumption, but some sources remain underused, and some sectors have not benefited from this expansion. Croatia currently outperforms the EU average in terms of the share of renewables in energy consumption but could do more given its favorable starting position and potential. The share of RES in transport[2] is well below the EU average. Croatia has more wind and solar connected to the grid than its regional peers and a relatively high level of electricity interconnections, which facilitate renewables development. About ¼ of total energy consumption is currently covered by renewables. Although Croatia has made some progress in using its wind potential, photovoltaic (PV) solar and solar thermal energy are underused.[3] Croatia has significant cost-competitive wind and

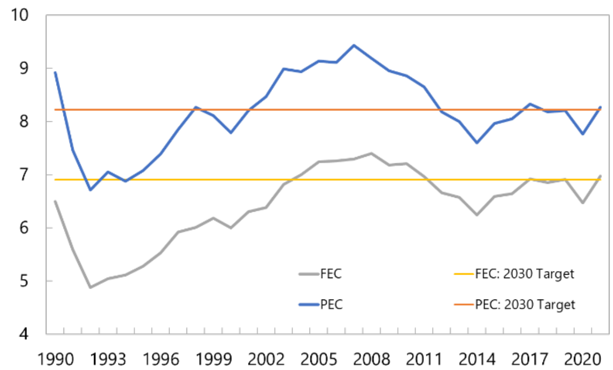
[2] Defined as the share of all types of energy from renewable sources (compliant biofuels (liquid and gaseous), renewable electricity, hydrogen and synthetic fuels of renewable origin, and other forms of renewable energy relative to total energy sources supplied to all modes of transportation, including aviation (EC Shares).

[3] Croatia, a country with high solar irradiation, does not invest much in solar, which could be due to an insufficient legal framework and infrastructure and a low priority in the previous national energy strategy, which led to insufficient support schemes (EC, 2022).

Solar PV potential, some room for further development of hydro and, to a lesser extent, biomass and geothermal (IRENA, 2017).

6. Croatia's national energy and climate plan 2021-30 was assessed by the EC (2019) as "moderate," with high ambitions on renewables (except in the transport sector) and low ambition on energy efficiency. Croatia's 2030 national target for RES in gross final consumption is ambitious (36.4 percent) and surpasses EU's goal of 32 percent; with a longer-term goal to have more than 65 percent of renewables in final production. Most of the increase in the renewable energy production (photovoltaics, wind, and biofuels) is expected in the electricity sector. The target for the share of renewables in transport is set at 14 percent by 2030, which will still be difficult to reach, given that, as of 2021, Croatia was at 7 percent. The target for energy efficiency (primary and final energy consumption) was set at an unambitious level considering Croatia's efficiency gap and the efforts needed to achieve the EU level 2030 target of 32.5 percent relative to baseline, and does not fully exploit opportunities for economic modernization and job creation.

Primary and Final Energy Consumption–Croatia
(Million tonnes of oil equivalent, distance to 2030 target)



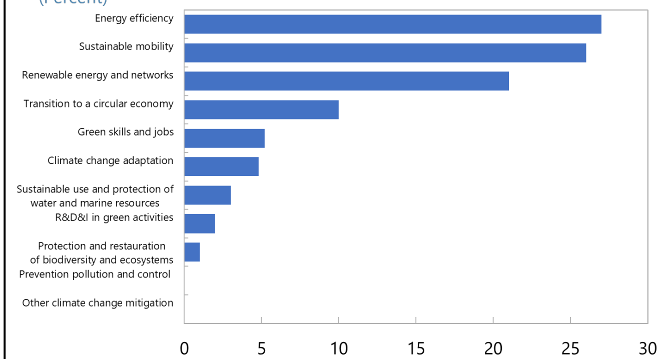
Source: Eurostat.
Note: FEC: Final energy consumption; PEC: Primary energy consumption.

7. Several public monopolies or concessions are active in Croatia's energy sector. Hrvatska elektroprivreda (HEP Group), the national energy company, is the dominant player. HEP's core activity is electricity generation, transmission, distribution, supply, and trade, accounting for slightly more than ¾ of the Croatian electricity market as of 2021. In addition, HEP Group is engaged in the generation, distribution and supply of heat energy, natural gas wholesale and retail supply and gas distribution. HEP is also the public corporation most involved in building public infrastructure and the largest developer of renewable energy projects in Croatia. INA Industrija Nafte (predominantly owned by the Croatian government and Hungary's MOL Group) is the sole oil and gas producer, holding 28 percent of the natural gas import and production as of 2021 (a 45 percent decline relative to 2020). INA extracts gas in the Adriatic Sea and oil and gas inland. Natural gas is produced onshore from Pannonian Basin exploitation fields and three exploitation areas in the Adriatic, meeting about 1/3 of total domestic demand and declining rapidly. In January 2021 an environmentally controversial new floating liquefied natural gas (LNG) terminal was inaugurated at Omišalj on the island of Krk. Offshore gas and oil production is expected to rise further until 2035-40. Under the provisions of the Gas Market Act (2018), the energy entity HEP was designated as the supplier on the wholesale market and is obliged to sell gas to suppliers at a reference gas price agreed annually. While oil prices are close to the EU average, electricity and gas prices for households are significantly lower than the EU average.[4]

8. To ensure energy security, Croatia aims to decarbonize the energy supply and reduce reliance on fossil fuels, while promoting renewable energy. Boosting investment in clean energy, part of the 2021-26 National Resilience and Recovery Plan (NRRP) aims at also enhancing energy security. Nearly 40 percent of the EUR 5.5 billion grants contribute to climate targets. Several reforms and investments under the NRRP aim at decarbonizing the energy and transport sectors, including the development of innovative technologies. The immediate reforms consist of legislative initiatives to (i) remove barriers and administrative procedures restraining the RES uptake; (ii) finalize the certification of the gas transmission system operator; and (iii) promote the use of alternative fuels in transport. Measures to improve energy efficiency feature prominently in the NRRP-funded green transition (¼ of green investments, mainly related to the building stock renovation and energy efficiency obligation schemes for energy suppliers). The new national hydrogen strategy also plays an important role in Croatia's low-carbon transition process. The growth of renewable energy sources is expected to stimulate employment, through the creation of jobs in new "green" technologies and the environmental goods and service sector, still underdeveloped relative to EU peers. It is important to ensure effective absorption of RRF grants and other EU funds and given the significant remaining investment cost[5] of reaching the medium-to-long term climate goals, to prepare a climate strategy to reach mitigation goals.

NRRP Breakdown of Expenditure Supporting the Green Transition per Policy Area–Croatia

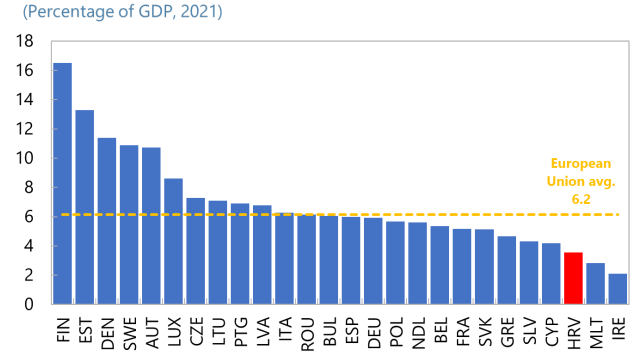
(Percent)



Source: European Commission – Recovery and Resilience Scoreboard.

Environmental Goods and Services Sector

(Percentage of GDP, 2021)



Sources: Eurostat; and IMF staff calculations.

Note: Goods and services that either reduce environmental pressures or help maintaining the stock of natural resources, or are designed to be cleaner and more resource efficient than conventional products (e.g., electric cars, zero-energy buildings).

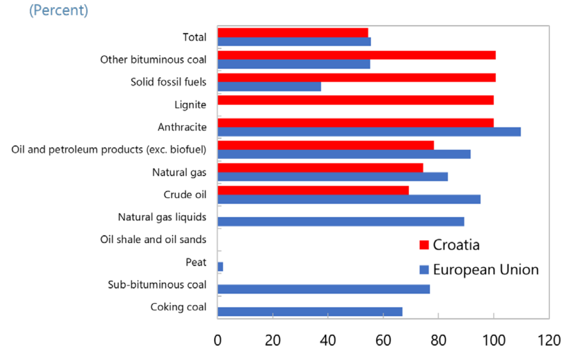
[4] Prior to the introduction of energy support packages (2021H1), electricity and natural gas prices paid by households were 41 percent below the EU average. Electricity prices are 46 percent, and natural gas prices are 52 percent below EU average after the 2022 energy support packages (2022H1).

[5] Under the baseline scenario and current legislation, additional investment needs across all sectors to achieve greater reductions in GHG emissions by 2030 and climate neutrality in 2050 are estimated at €20.5 bn (Croatia NECP).

Figure 1. Energy Security

Croatia is heavily reliant on energy imports…

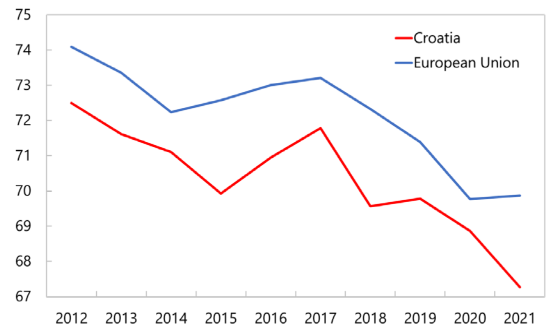
Energy Imports Dependency by Fuel, 2021
(Percent)



Source: Eurostat.

…and its energy mix remains dominated by fossil fuels.

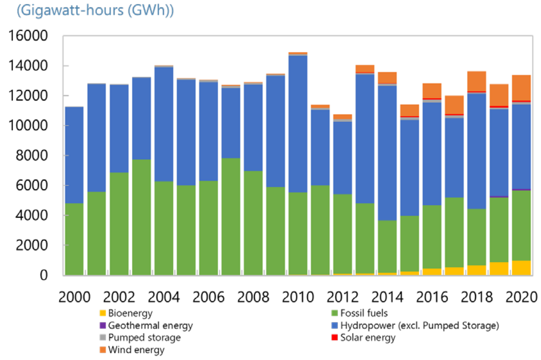
Share of Fossil Fuels in Gross Available Energy
(Percent change relative to 2012)



Source: Eurostat.

Power generation uses diverse technologies, with hydropower, and in the last decade, bio and wind energy partially replacing fossil fuels.

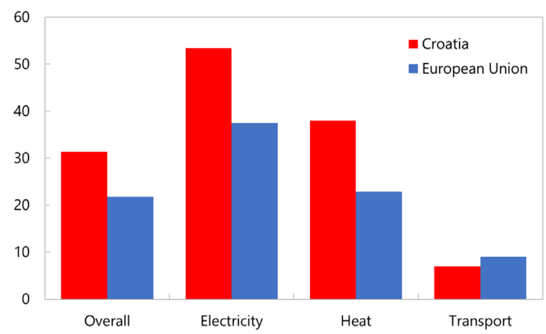
Power Generation by Technology–Croatia
(Gigawatt-hours (GWh))



Sources: International Renewable Energy Agency (IRENA); and IMF staff calculations.

Renewable energy sources are mainly used to produce electricity and thermal energy, less so for transport.

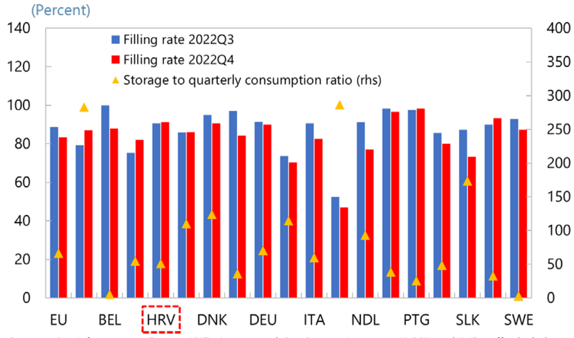
Share of Renewable Energy in Gross Final Energy Consumption: Sectors
(Percentage, 2021)



Source: Eurostat.

During 2022 the underground gas storage facilities had among the highest fullness rates in the EU.

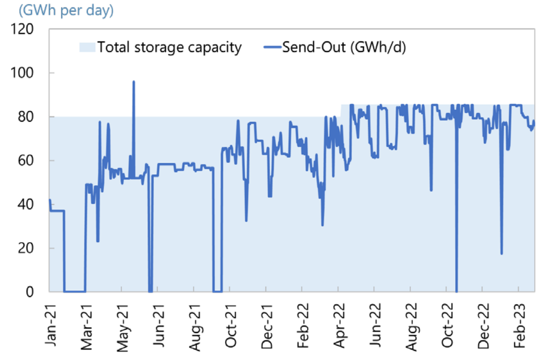
Gas Storage Levels as Share of Gas Storage Capacity
(Percent)



Sources: Gas Infrastructure Europe (GIE); Aggregated Gas Storage Inventory (AGSI); and IMF staff calculations.
Note: Data extracted on March 19, 2023. 2022Q3 and 2022Q4 refer to September 30, 2022 and December 31, 2022, respectively.

Since 2021, LNG imports (mainly from the US) are used to meet growing domestic and regional gas demand.

Krk LNG Send-Out–Croatia
(GWh per day)

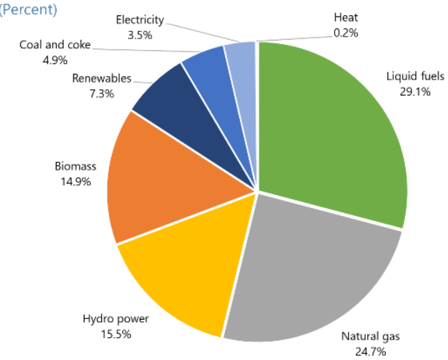


Sources: Gas Infrastructure Europe (GIE); Aggregated LNG Storage Inventory (ALSI); and IMF staff calculations.

Figure 2. Renewable Energy Sources (RES) in Croatia

RES accounts for about 1/3 of total energy supply in Croatia, mainly hydropower, biomass, and wind power…

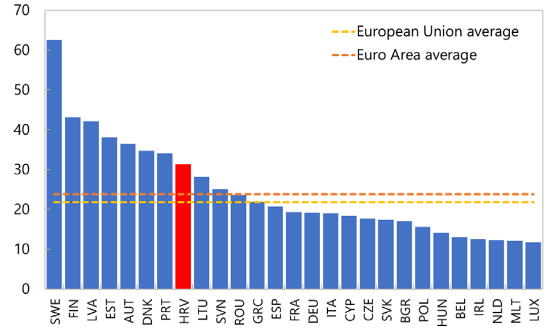
Total Primary Energy Supply, 2021–Croatia
(Percent)



Source: Eurostat.

…above the EU and EA average, with a vast potential for diversification…

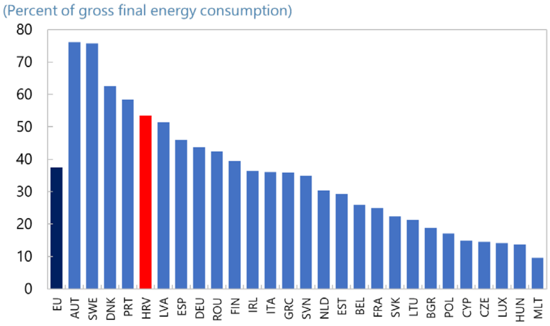
Share of Energy from Renewable Sources, 2021
(Percent of total; average)



Source: Eurostat.

RES is mainly used for electricity generation (mainly hydropower and biomass thermal plants)…

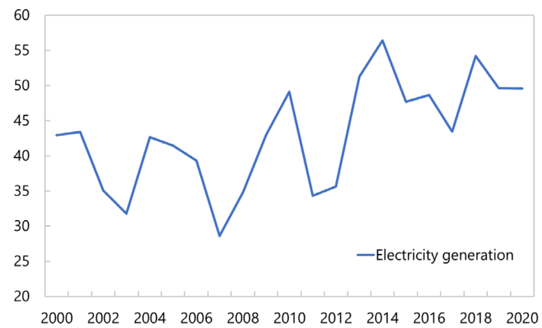
Share of Energy from Renewable Sources in Gross Electricity Consumption, 2021
(Percent of gross final energy consumption)



Source: Eurostat.

…but the use of hydro energy can have disadvantages (weather-related fluctuations, environmental impact).

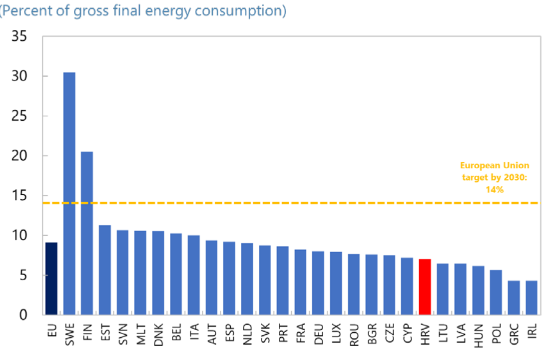
Renewable to Total Energy Ratio
(Percent ratio)



Sources: International Renewable Energy Agency (IRENA); and IMF staff calculations.

The average share of RES energy in transport fuel consumption is among the lowest in the EU…

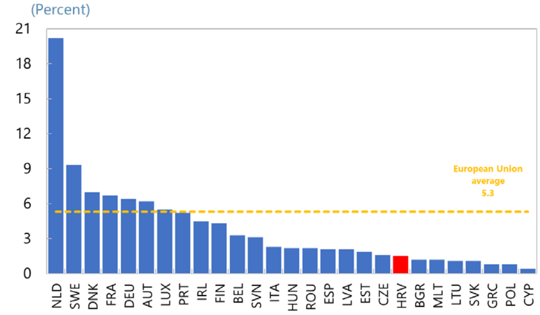
Share of Energy from Renewable Sources in Transport, 2021
(Percent of gross final energy consumption)



Source: Eurostat.

…so is the share of newly registered vehicles using clean energy.

Share of Zero Emission Vehicles in Newly Registered Passenger Cars, 2020
(Percent)



Sources: Eurostat; European Alternative Fuels Observatory (EAFO), Directorate-General for Mobility and Transport (DG MOVE).

B. Croatia and Climate Change

9. Croatia is increasingly exposed to climate change and natural disasters. Over the last two decades, the frequency of natural disasters has increased, with droughts, floods, landslides, heat waves, storms, and wildfires becoming the main natural disasters. Urban coastal areas are the most exposed to extreme weather events. Between 1980 and 2021, weather and climate-related extreme events incurred damages of USD 2.9 billion (EEA). On average, a natural disaster is estimated to have caused damages of about 0.7 percent of GDP and affected 382 per 100,000 inhabitants every year. Based on a sample of all natural disasters in Europe between 1980 and 2021, Croatia has a large probability of being hit by a severe natural disaster in the region.[6]

Natural Disasters in Croatia and Selected Countries

	Natural Disaster (Total)	Damage 1/ (Percent of GDP)		Population Affected 1/ (per 100,000 inhabitants)	
	Average per year	Mean	Max	Mean	Max
Croatia	0.7	3.3	20.9	382	5,617
Greece	2.1	0.6	2.9	74	1,074
Italy	3.3	0.1	0.8	7	95
Portugal	1.3	0.4	1.3	60	1,440
Spain	2.7	0.2	2.3	262	15,437
Slovenia	0.3	0.4	1.1	544	2,431
France	3.4	0.1	0.8	82	5,815
EU-27	1.1	0.6	2.4	139	1,985

Sources: The EM-DAT database; and IMF Staff calculations.
1/ Descriptive statistics of mean, median and maximum cost and population affected per occurrence.

10. The intensity and frequency of severe weather events and natural disasters related to climate change are expected to increase further. As part of the Mediterranean basin, temperature in Croatia is projected to rise faster than other regions of the world. Projections indicate that the mean annual temperature in Croatia would further increase between 1.3°C and 1.5°C by 2040 and by up to 2.2°C and 2.5°C by 2070, along with the frequency of extremely high temperatures.[7] Some of the more salient impacts include more frequent and intense droughts and heat waves, increases in air and sea surface temperature, and unstable precipitation patterns. Sea level rise will also pose a serious threat to Croatian coastal areas and islands. Projections show an expected increase in the global mean sea level of 19-38 cm by mid-21st century (2046-65) and by 32-82 cm by end-21st century.[8]

11. The adverse impacts from climate change will be felt across all geographic regions and economic sectors. About a quarter of the Croatian economy is based on sectors potentially vulnerable to climate change and extreme weather, including tourism and agriculture. Tourism infrastructure is at risk due to coastal flooding. Increased aridity coupled with rising temperatures and uncertain precipitation patterns affects forests, agricultural zones and crop yields, hydropower generation, tourism areas, and water resource management, as well as population's health. Accelerating climate change has been found to disproportionately affect vulnerable groups of society (IMF, 2022).

[6] Data on frequency of natural disasters, number of affected, and size of damage are from the Emergency Events Database (EM-DAT). Probabilities are backward-looking.
[7] Republic of Croatia, Climate Change Adaptation Strategy for the period up to 2040 with a view to 2070 (2020).

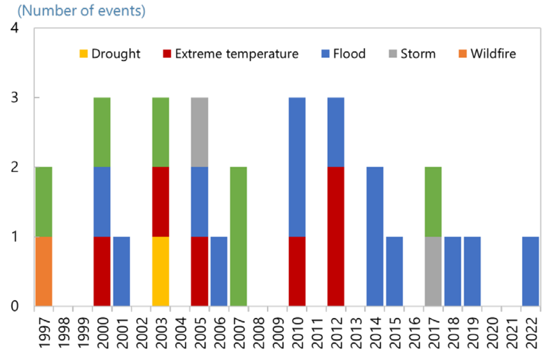
[8] Republic of Croatia, Ministry of Environment and Energy, 2018.

12. **To increase its resilience to climate change, Croatia has developed comprehensive adaptation strategies and plans.** The National Adaptation Strategy (2020) is implemented through priority measures and activities that are published in the National Adaptation Plans, updated every five years. The country's adaptation priorities include availability and accessibility of water for drinking and irrigation uses, coast and coastal zones, forestry and land use change, agriculture, biodiversity, and human health. Given climate change macro criticality for Croatia, it is important to implement the 2020 National Adaptation Strategy and finalize the incomplete legislative framework to enable faster deployment of renewables.

Figure 3. Impact of Climate Change on Croatia

Croatia has been increasingly vulnerable to natural disasters…

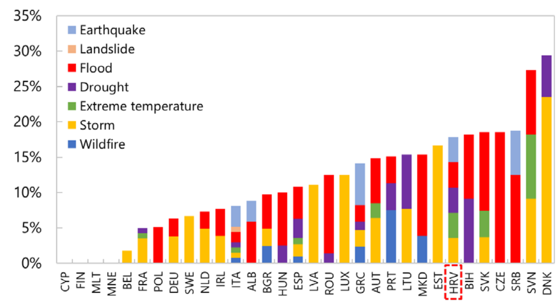
Frequency of Natural Disasters
(Number of events)



Sources: The Emergency Events Database (EM-DAT) – International Disaster Database. CRED/UCLouvain.

…with an average of more than one severe natural disaster happening each year since 1996.

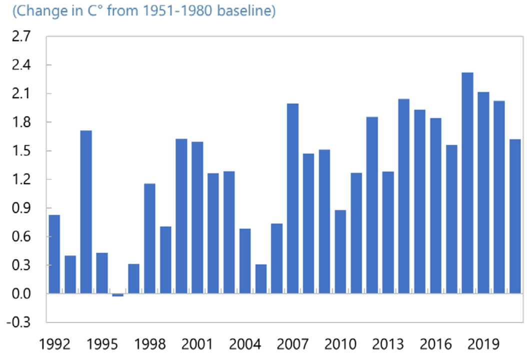
Frequency of Severe Natural Disasters by Type
(Percent)



Sources: The EM-DAT database; and IMF staff calculations.
Note: Severe Disasters are defined by their impact on GDP (larger than the 90th percentile of all the natural disasters in European countries).

Mean temperature has increased over time, which impacts Croatia's tourism industry…

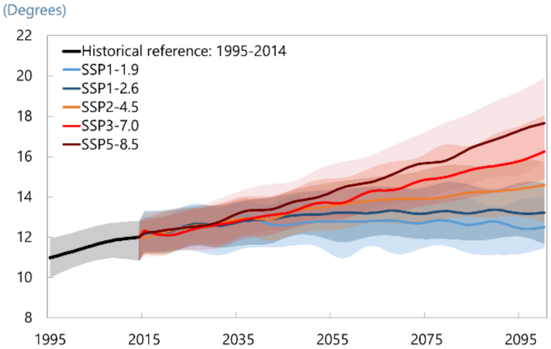
Mean Temperature Change of Meteorological Year
(Change in C° from 1951-1980 baseline)



Source: FAO Temperature Change.

…and without further action the frequency and intensity of natural disasters is expected to grow.

Project Mean-Temperature, Multi-Model Ensemble–Croatia
(Degrees)



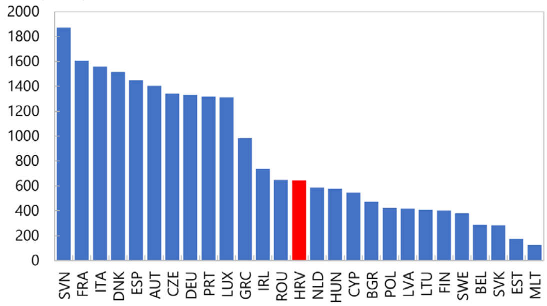
Source: World Bank.

Figure 3. Impact of Climate Change on Croatia (Concluded)

The economic damage caused by extreme events has been significant…

Economic Damage Caused by Weather and Climate-Related Extreme Events

(Loss per capita in Euro; 1980-2020)

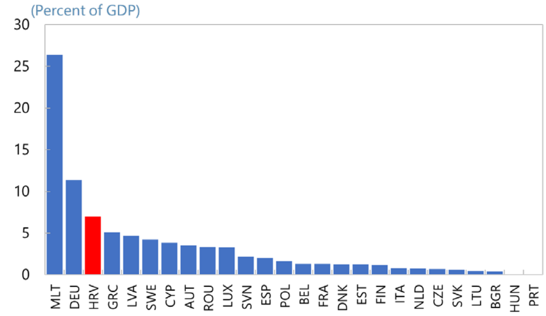


Source: European Environment Agency.

…and Croatia is facing a large climate adaptation cost for infrastructure.

Estimates of the Annual Costs to improve Public Infrastructure for Climate Change Adaptation

(Percent of GDP)

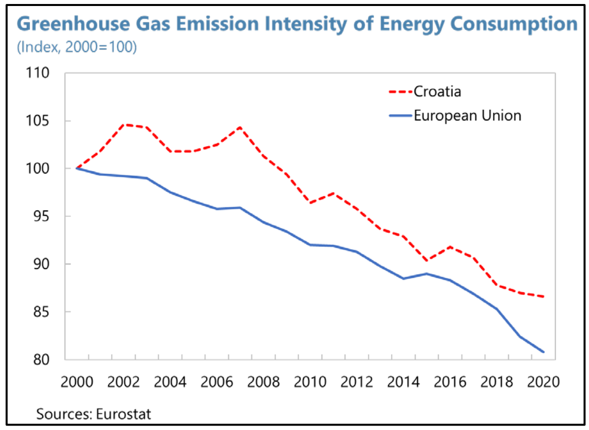


Source: IMF Fiscal Monitor, October 2020.
Note: Data not available for Ireland.

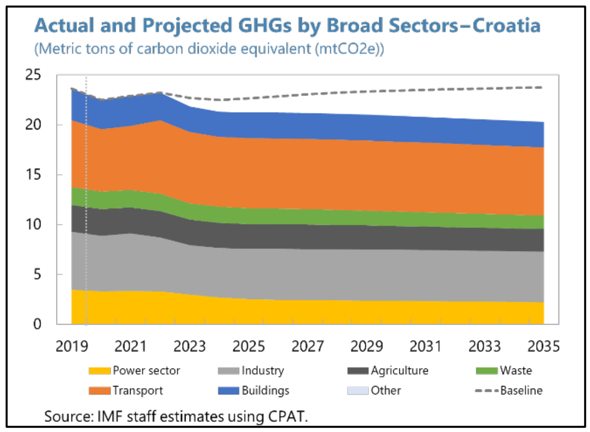
13. Climate adaptation is not integrated into public investment management institutions and budgetary processes in Croatia. Line ministries, extra-budgetary units, or subnational governments are not provided with ex-ante technical guidance from the center on how climate-related risks and opportunities should be incorporated into planning domestically financed public investments. There is no framework to ensure that climate change is an integral part of their capital spending decision-making and climate impact is not an explicit criterion in the selection of budget-funded projects. Moreover, climate-related public investment expenditures are not identified in the budget. There is no explicit requirement for ex-post audits or review of the climate impacts of all public investments, although the ex-post monitoring of GHG emissions is conducted for some public assets. A methodology for estimating maintenance needs that will arise from climate damages to public infrastructure assets is missing and asset registers do not include information on climate risks. Croatia's financial strategy for managing the costs of natural disasters primarily focuses on absorbing costs once they occur. The Ministry of Finance (MOF) does not publish a fiscal risk statement that includes climate-related fiscal risks, nor are climate risks included in fiscal sustainability analysis. Finally, budget and fiscal strategy documents and guidance do not refer to climate change policy and risks.

C. Croatia's Greenhouse Gas (GHG) Emissions and Climate Goals

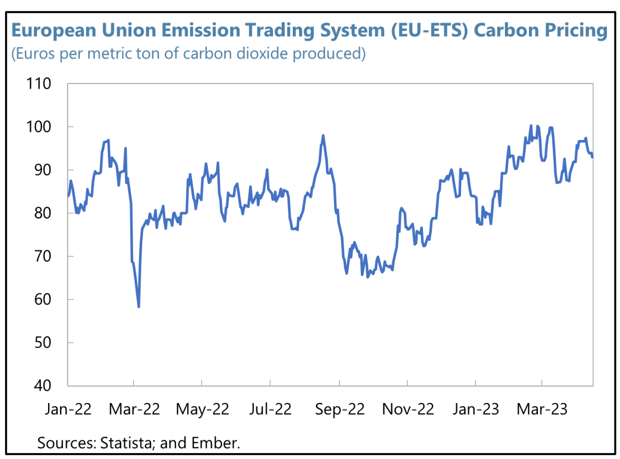
14. Although Croatia's GHG emissions account for less than 1 percent of the EU's total, they have declined at a slower pace than the EU average given high emission intensity of energy consumption. Croatia's total emissions accounted for 0.7 percent of the EU total in 2019 and fell by 17 percent between 2005 and 2019. This is slightly below the EU-wide emissions reduction of 19 percent during the same period. In 2021, Croatia had the sixth highest GHG emissions per unit of GDP in the EU. Albeit on a steady downward trend, emission intensity (i.e., emitted tCO2e of energy related GHGs in the economy per unit of consumed energy) is significantly higher than the EU average, reflecting the energy mix still dominated by fossil fuels, with a higher reliance on oil and petroleum products and lower share of electricity in final energy consumption than the EU average, and especially because of lower sectoral energy efficiency. The transport sector accounts for 29 percent of Croatia's total emissions, higher than the EU average, and has proven difficult to decarbonize. Industry and building stock are also responsible for a significant share of total emissions (25 percent and 13 percent of the total, respectively). Croatia's land use, land-use change, and forestry ecosystem (LULUCF), which provides a significant carbon sink capacity, declined by 35 percent between 2005 and 2019.



15. In line with the EU climate policy action, Croatia aims to significantly reduce its total GHG emissions across all economic sectors. The Paris Agreement (2016) aims to limit global temperature rise to well below 2°C, while pursuing efforts to further limit it to 1.5°C. Under the Paris Agreement, parties submit new or updated NDCs every five years, starting in 2020, and communicate long-term low GHG emissions development strategies. Moreover, the EU member states, including Croatia, have pledged to reduce net emissions by at least 55 percent by 2030, compared to 1990 levels under the European Green Deal (2021), which translates into more ambitious targets relative to 2005 when the EU-ETS was created (more below). The first European Climate Law sets a legally binding target of net zero GHG emissions by 2050.



16. The cornerstone of the EU climate policy action is the ETS, which covers large emissions sources from energy, industry, and within-EU aviation. Set up in 2005, the EU ETS has been the key tool to cut GHG emissions in the sectors covered (about 41 percent of EU total). Croatia joined the ETS in 2013, and its 2030 target for GHG emissions has been at least -43 percent relative to 2005, in line with EU objectives. The ETS works on the "cap and trade" principle, where a cap is set on the total amount of GHGs that can be emitted at the EU level, while companies buy or sell allowances, which establishes the emissions price (currently about €90/mtCO$_2$). The EU scheme currently covers about 40 percent of Croatia's total GHGs. The cap declines every year (currently by 2.2 percent), creating financial incentives to cut emissions-with most reductions taking place in the power sector. The Fit-for-55 package of reforms to be rolled out



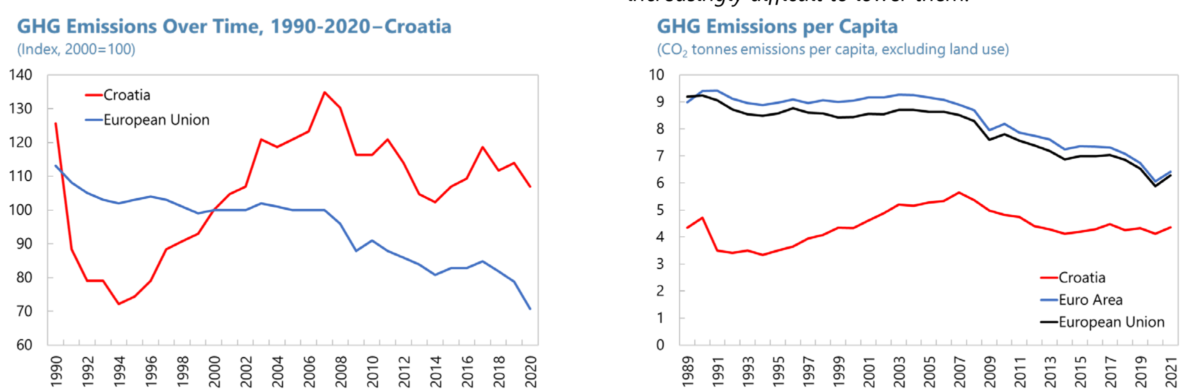
in 2027-28 will bring a faster reduction of the cap (4.4 percent during 2028-30) and fewer allowances on the market to reach the more ambitious target of 61 percent in 2030 compared to 2005 levels (instead of the currently 43 percent), thus bringing the EU closer to climate neutrality. Moreover, a new carbon pricing system for energy-intensive products imported into the EU will be introduced (Carbon Border Adjustment Mechanism, CBAM). Free allowances for the ETS will be phased out as CBAM is phased in.

17. The EU effort-sharing legislation covers emissions from sectors not included in the ETS, such as transport, buildings, agriculture, and waste. The Effort-sharing Decision (ESD) for the 2013-2020 period allowed Croatia, as the then newest EU member, to increase its non-ETS GHG emissions by 11 percent, compared with 2005, and it remained below its allocated emissions. During 2021-2030, Croatia must reduce its emissions by 7 percent, relative to 2005 levels, although this is not a binding national target. The recently agreed upon Fit-for-55 envisages an extension of the EU ETS to maritime transport (gradually introduced between 2024-26) and a separate new ETS for buildings, road transport, and fuels for additional sectors to achieve the more ambitious overarching targets. Fit-for-55 requires more ambitious targets for member states, with Croatia's reduction target expected to increase from 7 percent to 16.7 percent in non-ETS sectors. Hence additional efforts will be needed in the non-ETS sectors at the national levels to reach the EU overall targets. Croatia does not currently have a detailed sectoral strategy to reduce emissions or binding targets for the non-ETS sectors with large GHGs multiplier (transport and buildings), which will make it difficult to reach the overall EU targets.

Figure 4. GHG Emissions

Croatia's GHG emissions have been on a declining path since 2005, although at a slower pace than the EU.

GHG emissions per capita had declined since 2005 before picking up in the mid-2010s. Population decline makes it increasingly difficult to lower them.



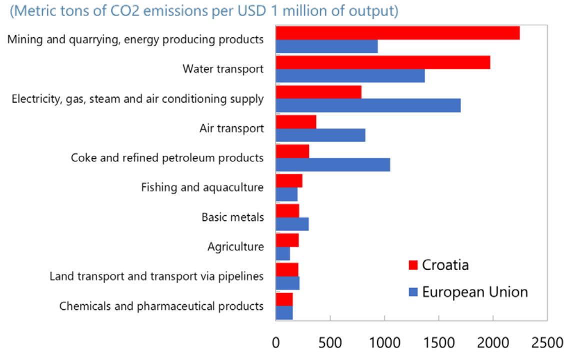
Source: Eurostat.

Sources: Our World in Data; IMF World Economic Outlook; and IMF staff calculations.

Figure 4. GHG Emissions (Concluded)

Energy sectors are the biggest CO_2 emission multipliers, with mining and transport above the EU average.

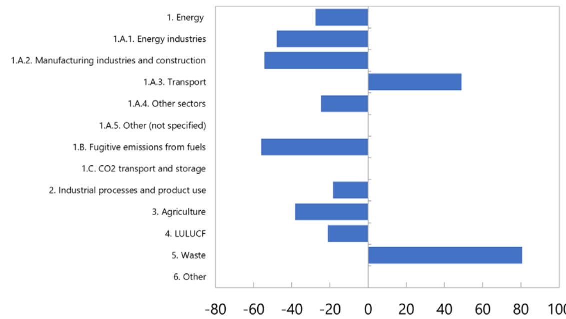
CO2 Intensities, 2018-Top 10 Industries, Croatia vs. EU
(Metric tons of CO2 emissions per USD 1 million of output)



Sources: OECD; and IMF staff calculations.

Emission reductions have been realized in all major sectors except for transport and waste.

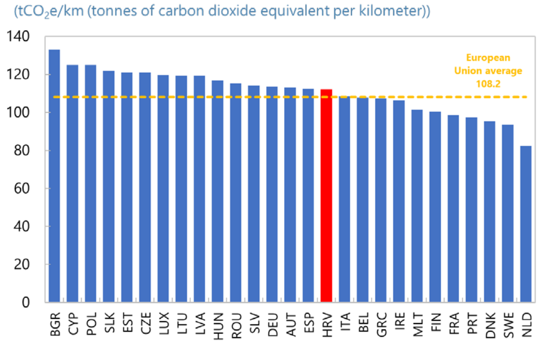
Change in GHG Emissions/Removals 1990-2020–Croatia
(Percent)



Source: United Nations – Framework Convention on Climate Change.
Note: LULUCF=Land use, land-use change and forestry.

Transport continues to be the largest sectoral GHG emitter.

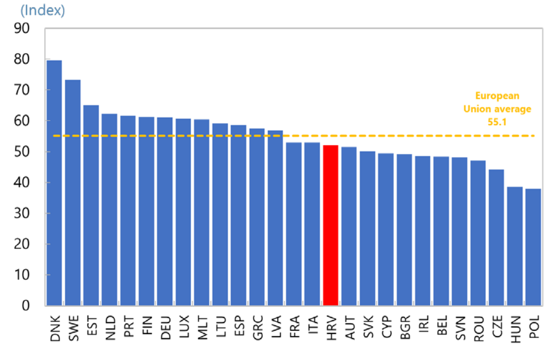
Average CO_2 Emissions per Km from New Passenger Cars
(tCO_2e/km (tonnes of carbon dioxide equivalent per kilometer))



Sources: Eurostat – European Environment Agency; European Commission – Directorate-General for Climate Action (DG CLIMA).

Croatia has recently dropped in the Climate Change Performance Index and is slightly below EU average.

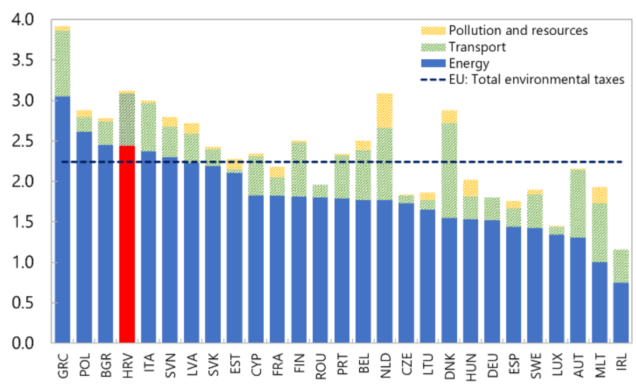
Climate Change Performance Index, 2023
(Index)



Source: Climate Change Performance Index.
Note: The index takes into account GHG emissions, renewable energy, energy use and climate policy.

18. **Croatia's 2021-2030 National Energy and Climate Plan (NECP) adopted in 2019 lays out its energy and climate objectives, although the quantitative targets can be revised periodically.** Croatia's overall emission reduction targets are in the range of [34,37] for 2030 and [57,73] for 2050, relative to 2005 depending on the level of ambition of the green transition scenario (NECP). Croatia's 2030 target for the non-ETS sectors is a 7 percent reduction relative to 2005, as set by ESD, and Croatia projects to overachieve it with a continuation of current policies. The NECP and other key national and sectoral strategies aim at

Environmental Taxes, 2021
(Percent of GDP)



Source: Eurostat.

decarbonizing the economy[9] and highlight the potential for further GHG emission reductions in transport, building, and agriculture sectors, without setting sectoral targets or elaborating on the policies needed to reach the targets and on other relevant sectorial measures. Croatia has lowered its fossil fuel phase-out ambitions and targets can be revised annually. Although Croatia joined the Powering Past Coal Alliance, a fossil fuel phase-out plan for coal or for oil and gas is missing. Croatia's long-term climate strategy does not include a net-zero target for 2050.

D. Mitigating and Adapting to Climate Change

19. Croatia has reduced its infrastructure vulnerability somewhat in recent years, through improved disaster preparedness and better planning of electricity generation infrastructure but needs to do more to adapt to heightening climate risks. The National Disaster Risk Management Strategy was adopted in 2022 and an annual contingency allowance in the budget is currently available to manage the exposure of public investment stock to climate and natural disaster risk. Addressing climate risks through climate-resilient public infrastructure would help avoid future economic costs, but also ensure sustainable economic growth. Given the macro criticality of climate change for Croatia, climate-relevant public investment management institutions ought to be strengthened along four priorities: (i) project appraisal and selection; (ii) identifying climate-relevant public capital spending projects by ministries, subnational governments, and public corporations (PCs); (iii) maintenance needs for climate damages to public assets; and (iv) climate change fiscal risk analyses. Climate change considerations should be included in central government budget guidelines for project development and appraisal prepared by the MOF and line ministries. The framework for selection for prioritization of public investment projects should also include consistent criteria on climate impacts. Best practices suggest that climate-related performance targets are best integrated into PCs management agreements and PCs required to include climate change elements in their strategic and financial plans. Finally, strategy to identify and estimate the climate change-related damage to public assets need to be developed and include the information into asset registers. Croatia would benefit from an analysis of the aggregate sensitivity of the budget to climate change risks facing public assets, so that fiscal risks from climate change can inform Croatia's fiscal strategy.

20. Climate adaptation and mitigation require additional revenues, aligned with the carbon content of the tax base. Croatia's environmental taxes stood at 3.1 percent of GDP in 2021 or 8.7 percent of its total tax and social contributions revenue, compared to the EU average of 2.2 percent of GDP. Progressively raised before 2021, excise taxes on energy (including fuel for transport) are the biggest category, accounting for 80 percent of the total. Since the Russia's war in Ukraine and the sharp increase in oil prices, the government has provided extensive support to fossil fuels roughly until end-March 2024, at odds with decarbonization goals. VAT rates were reduced on natural gas and thermal energy, and on pellets, briquettes, and firewood. The prices of unleaded gasoline and diesel for motor vehicles as well as the heating oil price have been capped, mainly via

[9] Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050," "Long-Term Strategy to Encourage Investment in the Renovation of the National Building Stock of the Republic of Croatia by 2050," Low-Carbon Development Strategy until 2030 with a View to 2050

reductions in excise taxes. The green levy paid by petrol and diesel fuel distributors/suppliers for the minimum share of biofuels was reduced to almost zero. The revenue loss from cuts in energy-related taxes is estimated at about 0.8 percent of GDP, with subsidies to offset the rise in energy prices at about 3 percent of GDP during 2022-24 (see 2023 Croatia Article IV Staff Report). The current system of excises, although heavily reliant on transport as the biggest emitter, is not aligned with the GHGs intensity of the tax base.

21. Excise taxes on energy are Croatia's main domestic instruments to put a price on carbon emissions, but current rates result in substantially different carbon prices across fuels and activities. Natural gas, coal, and electricity are lightly taxed compared with oil derivatives. Excises on oil derivatives are €130-260/tCO_2, when the fuels are used for transportation; however, they are significantly reduced to €7-24/tCO_2 when used as heating fuels for businesses and households. Heating using natural gas and coal and coke is the least taxed, even less than oil derivatives. Diesel motor fuel is less taxed than petrol. The VAT is also applied to energy consumption and impacts prices paid by household and business consumers—the standard VAT rate is 25 percent but was reduced to 13 percent for electricity, and to 5 percent for gas and district heating in April 2022 as part of the first energy support packages.

Excise Rates and Effective Carbon Prices in Croatia, April 2023

Product		Excise tax rate	Effective CO_2 price	CO_2 intensity in kgs CO2e
Oil derivatives				
	Petrol	€597.25 per 1,000 l leaded petrol	€258.5/tCO_2e	2.3/ l
		€406 per 1,000 l unleaded petrol	€175.8/tCO_2e	2.3/ l
		€597.25 per 1,000 l aviation spirit	€186.6/tCO_2e	3.2 / l
		€353 per 1,000 l Diesel -motor fuel	€130.7/tCO_2e	2.7 /l
		€21 per 1,000 l Diesel -heating fuel	€7.8/tCO_2e	2.7 /l
		€0.0 per 1,000 l Blue diesel (agricultural vehicles, ships)	€0/tCO_2e	2.7 /l
	Gas oil	€406.13 per 1,000 l if used as propellant	€176.6/tCO_2e	2.3/ l
		€56.14 per 1,000 l heating fuel for business/households	€24.4/tCO_2e	2.3/ l
		€330 per 1,000 l reduced rate applied for railways	€143.5/tCO_2e	2.3/ l
		€330 per 1,000 l commercial gas oil used as propellant	€143.5/tCO_2e	2.3/ l
	Kerosene	€353.04 per 1,000 l jet fuel	€141.2/tCO_2e	2.5 /l
		€232.53 per 1,000 l heating fuel	€93/tCO_2e	2.5 /l
	Heavy fuel oil	€21.24 per 1,000 kg heating fuel for business/households	€6.7/tCO_2e	3.15 /kg
	LPG	€13.27 per 1,000 l motor fuel or heating fuel	€8.8/tCO_2e	1.51 /l
Natural gas		€0.0 for use as propellant	--	0.185 /kWh
		€0.54 per MWh heating business use	€2.9/tCO_2e	0.185 / kWh
		€1.08 per MWh heating non business use	€5.8/tCO_2e	0.185 / kWh
Coal and coke		€0.31 per GJ heating fuel business/non-business use	€3.0/tCO_2e	104 /GJ
Electricity		€0.50 per MWh business use	€3.5/tCO_2e	0.142 /kWh
		€1.00 per MWh non-business use	€7/tCO_2e	0.142 /kWh
		€0.00 reduced rate for public transport	--	0.142 /kWh

Source: Staff calculations based on Taxes in Europe database (EC) and Croatia MoF Customs Adminstration.

22. Croatia should better align its fossil fuel taxation (and indirect support) with EU's decarbonization goals. Fossil fuel subsidies,[10] such as reduced excise rates and untargeted energy price caps, result in a large fiscal cost and run counter to decarbonization goals. Fossil fuel subsidy intensity increased faster in Croatia than in the EU, by about 0.9 percent of GDP from 2015 to 2020, relative to 0.35 percent of GDP for the EU average (EC, 2022). Energy subsidies are projected to increase further, especially the implicit ones, for which prices paid by consumers are below efficient levels (Figure 5). The energy price caps currently in place further distort prices. If there is a need for further support, measures should be directly targeted to vulnerable households and firms. The current system of excise taxes reduces externalities underpricing, albeit at an uneven pace. Hence the current system may not fully incentivize firms and households to reduce energy consumption, promote energy efficiency, and shift to cleaner energy.

[10] Explicit subsidies reflect subsidies due to supply costs being greater than the retail prices, whereas implicit reflect subsidies due to the efficient price being greater than the retail price. See Parry et al. (2021) for details on the methodology.

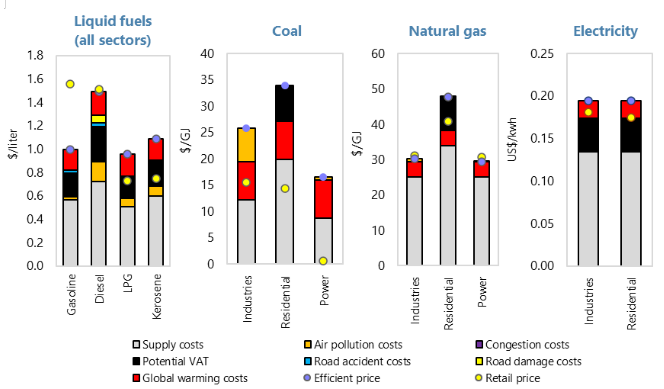
23. Electrifying transportation and building heating along with further decarbonization of electricity generation is important for reducing emissions. Croatia could do more to decarbonize its energy sector and reduce the overall dependence on fossil fuels. Supported by NRRP investments, the decarbonization of the transportation sector will be stepped up. New renewable sources can be explored. Croatia has started to invest more in solar for transportation (passenger ships, cable ferries), and electricity generation – this trend should continue. The introduction of renewable energy (wind, solar, geothermal) in small systems and the development of energy communities will need to be accelerated under the NRRP, by simplifying approvals of permits and procedures. To reconcile energy security and climate goals, the REPowerEU funds could be used not only for expanding the LNG terminal and gas network, but also for accelerating renewables rollout, reducing fossil fuel consumption in industry and transport, and ramping up smart investment, including in gas connectivity. Both electrification and decarbonization of electricity need to happen in tandem and government policy can play a role in promoting this switch.

24. Croatia should strive to reverse the decline in its carbon sink capacity to stem climate change and offset GHG emissions. Croatia's goal is to maintain the carbon sink capacity constant, that is maintaining the intensity of forest management at the current level. Principles for the use of wood mass (e.g., cascading principle) should be incorporated in national development plans. The land information system should be finalized, to provide accurate and appropriate data on the country's LULUCF resources. The other NECP objectives for 2030, e.g., afforestation (including in urban and peri-urban areas)[11] and the assessment of options to turn abandoned farmland into new forest areas should be accelerated.

Figure 5. Explicit and Implicit Subsidies for Fossil Fuels Before Excise Taxes

Explicit fuel subsidies (retail price lower than supply cost, as in the case of coal for residential heating) and implicit subsidies (retail price lower than efficient price, as in the case of LPG, kerosene, coal, and natural gas for residential use) hamper decarbonization efforts.

Energy Baseline Externalities and Prices–Croatia



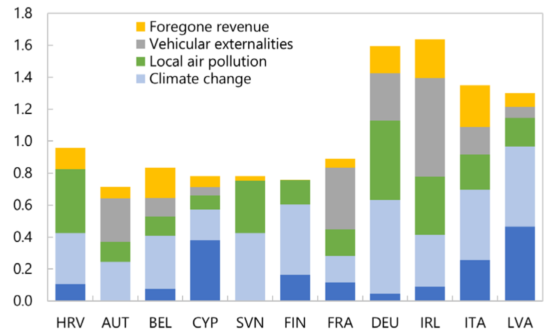
Source: IMF staff estimates using CPAT.
Note: Potential VAT assumes general rate. Global warming costs are national damages only.

[11] 36.8 percent of Croatia's continental territory is covered by Natura 2000.

Figure 5. Explicit and Implicit Subsidies for Fossil Fuels Before Excise Taxes (Concluded)

In addition to explicit subsidies, climate change, local air pollution, vehicular externalities, and foregone revenues are not priced in…

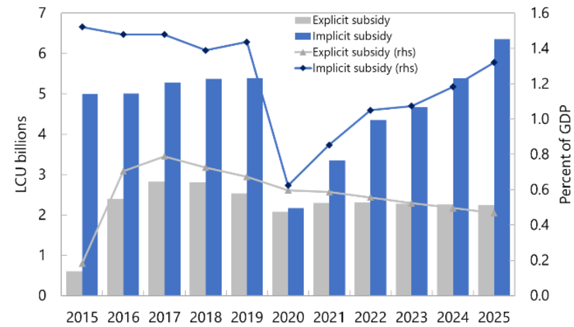
Subsidies by Component, 2021, Selected EU Countries
(Percent of GDP)



Source: IMF Energy Subsidy Template, 2021.

Without further action, subsidies are projected to increase from the 2020 trough.

Subsidies by Year
(Local currency unit (LCU) billions; percent of GDP)

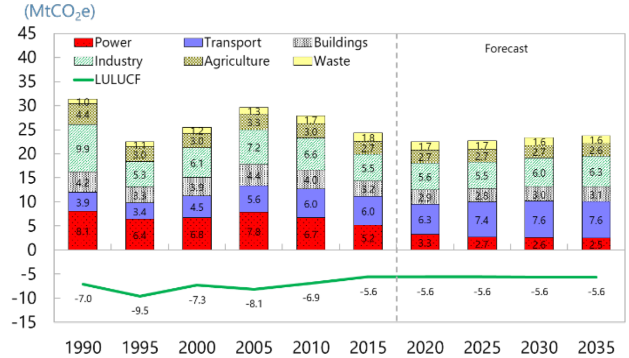


Source: IMF Energy Subsidy Template, 2021.

E. Fiscal Policy Options to Accelerate GHG Emissions Reduction in Croatia

25. Applying the IMF/World Bank's Carbon Price Assessment Tool (CPAT),[12] staff analyzes energy externalities and emission projections under business-as-usual policies and simulates the impact of a carbon pricing reform. We find that price-based reforms could bring Croatia significantly closer to its mitigation targets with manageable costs. In Croatia, there is scope to increase effective carbon tax rates for diesel, road transportation, and all heating fuels as these are currently low and do not reflect the associated externalities. There is less scope to increase effective carbon pricing for petrol (given the already high levels) and power and industrial sector (given that they are covered, to a large extent, by the

Total GHG Emissions by Sector: Historical and Projections under BAU Policies in Croatia
($MtCO_2e$)



Sources: UNFCC; and IMF staff estimates using CPAT.
Note: Power includes energy industries and fugitive emissions from fuels, while Industry includes manufacturing and Buildings refer to Other energy sectors in the UNFCC classification.

[12] The Carbon Pricing Assessment Tool (CPAT) was developed by IMF's Fiscal Affairs department and the World Bank. The tool allows for simulation of the impact of carbon taxation as well as other complementary measures. CPAT uses a reduced-form model of fuel consumption based on income and price elasticities, deriving quantities under a baseline and a policy scenario broadly in line with more complex models (IEA's World Energy Model, Enerdata POLES). The main drivers of the emissions projections are GDP growth (including GDP-per-capita and population), income elasticities, and rates of technological change. Fuel use responses to policies are driven principally by proportional changes in fuel prices caused by projected market dynamics and government policies (including carbon prices). The changes in energy consumption from the base year are driven by energy prices and real GDP. Real GDP (the primary driver of the baseline) adjusts to changes in fiscal policy through multiplier effects. Exogenous changes to efficiency and the price of renewable energy are also drivers of fuel use and composition. At the sectoral level, the response to additional carbon pricing depends on how the pricing affects future energy prices and assumptions about the price responsiveness of the use of fuel and electricity in each sector. For more details on the model and its parameterization, see Black et al. (2023).

EU ETS). A coordinating tax approach for heavy-duty vehicles could be pursued with the neighboring countries to avoid that freight transportation shifts to neighboring countries if diesel taxes increase relative to others.

26. Croatia's emissions are projected to decline by less than one percent under business-as-usual policies (i.e., no tightening of existing policies or additional policies). By 2030, total emissions are estimated to decline by less than one percent below the 2019 levels. Waste will decline by 7 percent, energy-related and agriculture by less than 2 percent, whereas industrial emissions are projected to increase by almost 8 percent. In line with other advanced EU economies, the energy-intensity of GDP is expected to fall, partly due to increased energy efficiency improvements induced by higher natural gas and oil prices and the introduction of newer, more efficient technology. It is worth noting that CPAT finds a higher growth in transportation and waste emissions than do EEA and NECP.

27. A carbon tax in the non-ETS sectors is the most cost-effective instrument for emissions reduction, with environmental, fiscal, economic, and administrative advantages over other mitigation instruments (IMF 2019b and Stern-Stiglitz 2017). The non-ETS sector (primarily buildings and transportation) in Croatia is relatively large and expected to increase further. Explicit carbon taxation can promote saving and encourages the shift to clean energy only based on the carbon content or cost of CO_2 emissions. It also automatically minimizes mitigation costs by equalizing the marginal abatement cost across fuels and sectors (i.e., the cost of GHG emissions

Summary of Mitigation Targets–Croatia"

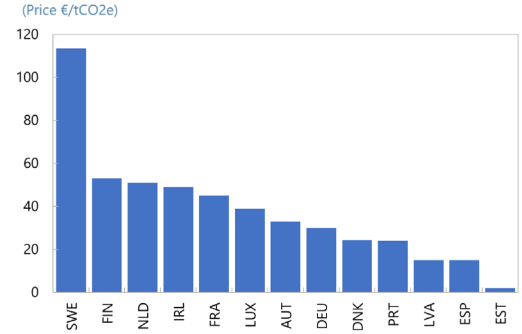
Scope, emissions	Target (relative to 2005)	Assessment (relative to 2005) 1/	
		2019	2030
ETS sectors	NECP: -43%; EU Ff55: -61%	-33%	CPAT: -43% (WEM), EEA: -44% (WEM), -47% (WAM)
Power	NECP: no explicit targets	-43%	CPAT: -67% (WEM) 2/, EEA: -49% (WEM), -53% (WAM)
Manufacturing and construction	NECP: no explicit targets	-35%	CPAT: -17% (WEM), EEA: -36% (WEM), -38% (WAM)
Non-ETS sectors	NECP: -7%; EU Ff55:-16.7%	-5%	CPAT: 2% (WEM), EEA: -9% (WEM), -15% (WAM)
Transport	EU Ff55: -55% 3/; NECP: no explicit targets	18%	CPAT 4/: 36% (WEM), EEA: 14% (WEM), 6% (WAM)
Buildings	NECP: no explicit targets	-30%	CPAT:-33 % (WEM), EEA: -26% (WEM), -33% (WAM)
Agriculture	NECP: no explicit targets	-18%	CPAT: -19% (WEM), EEA: -20% (WEM), -25% (WAM)
Economy-wide	NECP: no explicit targets	-17%	CPAT: -21% (WEM), EEA: -24% (WEM), -29% (WAM)
Share of RES in gross final energy consumption	EU Ff55: 40%; NECP: 36.4% (2030); 53.2%-65.6% (2050)	28.5%	CPAT: 76% of power generation (WEM)
Share of RES in gross final energy consumption in transport	13.20%	5.9%	
Primary energy consumption	EU Ff55: -39%; NECP: 447.9 PJ (2020), 344.4 PJ (2030), 287.4-251.0 PJ (2050)	343.7 PJ	CPAT: 314.9 PJ (WEM)
Final energy consumption	EU Ff55: -36%; NECP: 293.1 PJ (2020), 286.9 PJ (2030), 225.6-189.6 PJ (2050)	289.3 PJ	CPAT: 294.4 PJ (WEM)
Methane (CH4)	NECP: -30% (2030, relative to 2020)		CPAT: -5% (WEM)

Sources: Croatia NECP (2019); European Environment Agency 2022; and IMF staff estimates using CPAT.
1/ WEM refers to the 'existing measures' scenario, which reflects existing policies and measures; whereas WAM refers to the 'with additional measures' scenario, which considers the additional effects of planned measures reported by Croatia to EEA.
2/ Power in the EEA analysis includes petroleum refining and manufacture of solid fuels, while these activities are included in industry for the IMF analysis.
3/ Reflects proposals in the Fit for 55 package.
Note: EU Ff55 reductions refer to 2030 relative to 2021; NECP reductions refer to 2030 relative to 2005.
4/ On transport, CPAT follows a slightly different approach from EEA

reduction per tonne of CO_2),[13] mobilizes fiscal revenues that can finance the greening of the economy and compensate the most vulnerable users for higher energy costs; and generates domestic environmental benefits (e.g., reductions in local air pollution morbidity and mortality). Carbon pricing is administratively straightforward and can build on the existing excise tax system.

28. Introducing a carbon price for non-ETS sectors, combined with the EU ETS, would ensure that fossil fuel emissions in Croatia are well priced in. Currently effective carbon tax rates in Croatia vary greatly by sector and fuel and underpricing is common (Figure 6). Carbon taxes are the best way to ensure that these costs are internalized but, as experience shows, as administrative capacity improves over time, more fine-tuned instruments, such as congestion charges and other distance-based taxes, could be considered. The non-ETS carbon price can be accompanied by a price floor for ETS sectors, to ensure the equalization of abatement costs across the economy. A carbon tax progressively increasing along a pre-announced path would allow households and businesses to adjust their behavior and spending decisions and promote investment in clean technologies. Carbon pricing also raises fiscal revenue, which can be used for support of both vulnerable households and firms and improve energy efficiency. It would also support energy security through reducing fossil fuel use, imported to a large extent. Several other European countries have carbon pricing of non-ETS sectors. Currently, explicit carbon tax prices for non-ETS sectors vary from €29 to €387/tCO_2e Some countries have carbon taxes that increase progressively until 2026, when it is planned to transition to the new EU ETS system, and others have already introduced a floor price for the ETS sectors in preparation for the Fit-for-55 implementations. Although Croatia is expected to incorporate the new EU legislation into its national development and legislative documents in 2027, introducing a carbon tax ahead of the Fit-for-55 package rollout would smooth out the transition. This would preempt more abrupt decarbonization efforts at a later stage, potentially at a higher cost, to meet its climate goals–while, at the same time, consolidating energy

Carbon Taxes in the EU
(Price €/tCO2e)



Sources: WB carbon pricing dashboard; and IMF staff calculations.

Carbon Pricing Schemes in Selected European Countries

Country	Year introduced	Type	Price EUR per tCO2e	Sectors	GHGs coverage (percent)
Austria 1/	2022	Tax	35 (2023) to 55 (2025)	Heat, Tran.	40
Denmark	1992	Tax	24 (2022), 47(2025), 101(2030)	All 2/	35
Finland	1990	Tax	77 (2022, Tran.), 53 (2022, other)	Heat, Tran., Ind.	36
France	2014	Tax	45 (2020-21)	Heat, Tran., Ind. 3/	35
Germany	2021	Tax	30 (2023) to 100 (2030)	Heat, Tran. 4/	40
Ireland 5/	2010	Tax	41-49 (2022) to 100 (2030)	Heat, Tran., Ind. 6/	48
Portugal	2015	Tax	Previous year's avg. ETS price	Heat, Tran., Ind.	36
Sweden	1991	Tax	110	Heat, Tran.	40
Norway	1991	Tax	66	All 7/	63

Source: World Bank, Carbon Pricing Dashboard
1/ Under national ETS, not covered by EU ETS; fixed price until 2025, market phase from 2026, subject to a review in 2024.
2/ Lower rate for ETS sectors, 10 (2025), 50 (2030). In practice it mainly captures emissions from the buildings and transport sectors.
3/ ETS sectors are exempt.
4/ Emissions from coal combustion by entities not covered by EU ETS are included (2023). Extended to waste incineration (2024).
5/ Diesel and petrol are taxed at a higher rate than other fossil fuels. Rates progressively increasing since 2021.
6/ Other sectors are covered but with several exemptions.
7/ With some exemptions for some sectors.

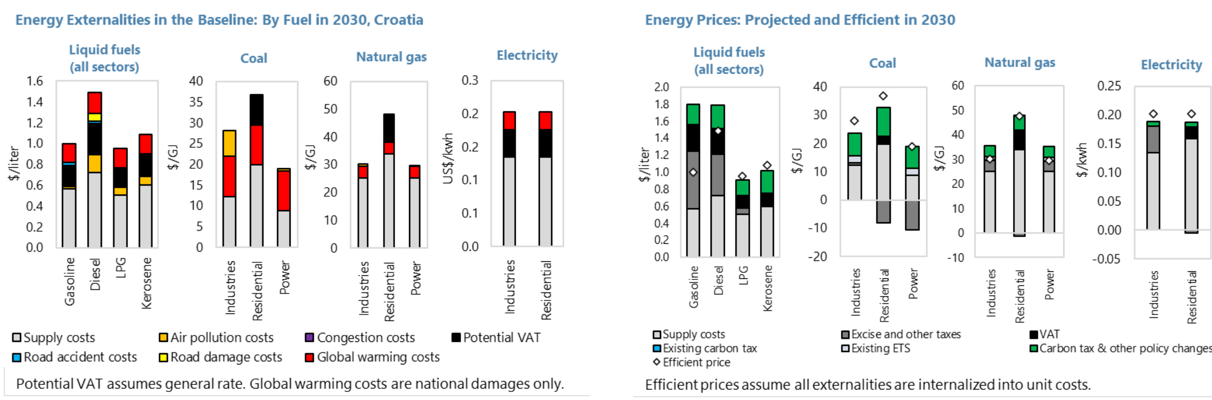
[13] Equalizing mitigation costs across the whole economy would be achieved with a non-ETS carbon price equal to that of the EU ETS. Since this is administratively and politically difficult (due to price volatility in the EU ETS), hence a second-best option is to ensure that the carbon price faced in buildings and transportation is equivalent.

security through a reduced dependence on fossil fuels.

Figure 6. Addressing Externalities with a Carbon Tax

Externalities from fuel consumption by sector are typically not entirely priced in.

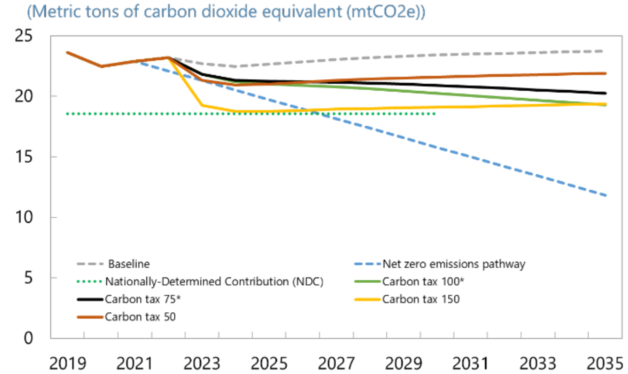
A carbon tax would bring final prices closer to efficient levels, especially for coal, natural gas, LPG, and kerosene.



Source: IMF staff estimates using CPAT.
Note: Efficient prices are defined as the sum of all externalities from fuel uses; they include supply costs, local air pollution, climate, transportation externalities in the case of road transport fuels (congestion, road damage, and accidents).

29. A carbon tax would promote significant emission reductions to reach the overarching EU-wide mitigation objectives, with revenues recycled to compensate vulnerable households. A carbon tax via the existing excise system would bring Croatia significantly closer to its mitigation targets with manageable costs. Our results show that, for example, a tax progressively reaching €75/tCO2e by 2030 reduces overall emissions to 30 percent below 2005 levels in 2030 or 11 percent below a Business-as-Usual (BAU) scenario, while raising fiscal revenues of 5 percent of GDP and not making people worse off. Emissions decline by 12 percent (buildings), 9 percent (power), 8 percent (transportation), 10 percent (agriculture, waste), and by 15 percent (industry), compared to BAU levels. The tax should be phased through the current excise regime in as international energy prices fall and ahead of the EU-wide ETS for buildings and transportation (Fit-for-55). The carbon tax could be initially set at €30/tCO2e for the sectors not covered by the existing EU ETS (transportation, buildings, agriculture, and excluded industrial emissions) and progressively rise each year, before the new Fit-for-55 rules will come into effect in 2027-28. Such a policy would promote cost-effective emissions reductions, bring Croatia closer to meeting mitigation commitments and act as a domestic price floor for the upcoming EU-wide ETS

Distance to Climate Mitigation Objectives Based Under Various Carbon Taxes Scenarios
(Metric tons of carbon dioxide equivalent (mtCO2e))



Source: IMF staff estimates using CPAT.

for buildings and transportation. However, as carbon pricing needs to be raised considerably (above €100/tCO2) to achieve mitigation targets, accompanying sectoral policies could have a more targeted impact, with manageable costs.[14]

30. Distributional effects[15] should be carefully considered to reduce energy poverty risks.[16] The authorities should be aware of the immediate fiscal incidence across (vertical distribution) and within (horizontal distribution) income groups and focus on consumption effects and compensatory schemes. A portion of revenue can be recycled to support the poorest households via lump-sum transfers (generally about 20 percent of revenue to compensate the bottom 40 percent of households) and then using the rest to reduce direct taxes (corporate or personal income tax), thus positively affecting productivity. The impact on firms should be also considered. The policies proposed focus on heating and transportation, hence a more limited impact.

Sectoral Emissions Outcomes, 2030

(Percent relative to 2005 levels)

Scope	2030 Target	2019	Carbon price (€ per tonne of CO_2e)				
			BAU	50	75*	100*	150
Non-ETS	-7%	-2%	2%	-5%	-8%	-11%	-15%
Transport		21%	36%	29%	26%	23%	17%
Buildings		-29%	-33%	-39%	-41%	-44%	-48%
Agriculture		-18%	-19%	-25%	-27%	-30%	-33%
Waste		31%	22%	13%	10%	6%	0%
ETS	-43%	-38%	-43%	-48%	-50%	-52%	-55%
Power		-56%	-67%	-69%	-70%	-71%	-72%
Industry		-20%	-17%	-26%	-29%	-32%	-37%
Economy-wide	[-34%,37%]	-20%	-21%	-27%	-30%	-32%	-36%
Revenue raised *(percent of GDP)*			4%	4%	5%	5%	5%
Efficiency costs *(percent of GDP)*			0%	0%	0%	0%	-1%
Welfare benefits *(percent of GDP)*			0%	0%	0%	0%	0%
Deaths averted *(cumulative)*			0	218	312	416	551

Source: IMF staff estimates using CPAT.
* Progressive carbon tax from €30 in 2023

[14] The CPAT outcome for various carbon taxes assumes they apply to all sectors, ETS and non-ETS alike, which does not change the results for the non-ETS sector. However, the ETS sector is overtaxed in the various scenarios, only a residual tax relative to the ETS price (price floor) should apply on top of the ETS price. Hence the required carbon tax should be set at a higher level in the non-ETS sector to deliver the same overall outcome.

[15] CPAT's distribution module estimates the carbon tax incidence on consumption, considering the direct effect from the use of fuels, as well as the indirect effect from the consumption of other, non-fuel/-energy goods and services. Several modes of direct and indirect transfer schemes can be simulated: (i) new or existing targeted transfers; ii) transfers towards public investment in infrastructure access; and iii) scaling up an existing social protection scheme, and (iv) reforming countries' personal income tax (PIT) schemes.

[16] Also see EU Climate Mitigation Policies, IMF, 2020 for EU-wide recommendations.

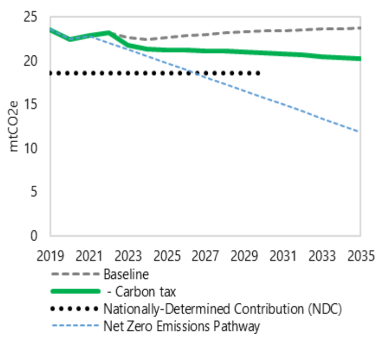
Figure 7. Carbon Pricing: Effects of a €75 Carbon Tax

(Introduced progressively from €30, economy-wide)

A carbon tax that progressively increases up to €75/tCO2e by 2030 for sectors not covered by the existing EU ETS could encourage savings and reduce emissions, thus bringing Croatia closer to its nationally determined contribution by 2030.

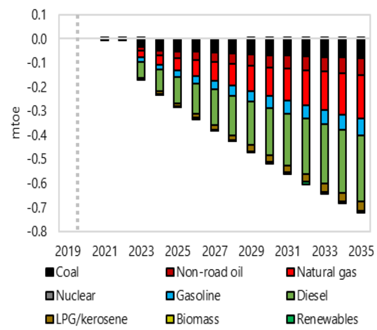
GHG Emissions vs. Paris Pledge–Croatia

('NDC'; mtCO2e exc LULUCF)



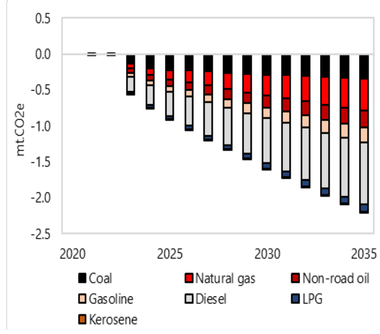
Change in Primary Energy Consumption by Fuel

(Metric tons of oil equivalent (mtoe))



Change in Energy CO2 Emissions by Fuel

(Metric tons of carbon dioxide equivalent (mtCO2e))



Significant tax-induced increases in the price of coal, oil, and kerosene are expected (reflecting the carbon content and pre-existing price distortions (e.g., subsidies), with the most affected sectors being transport and agriculture.

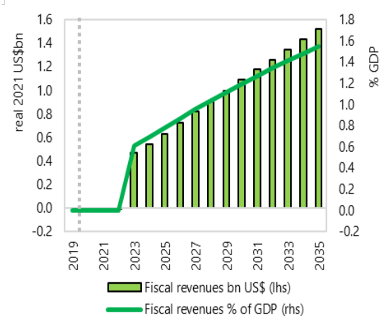
Energy Price Changes for $83/tCO2 in 2030

(Weighted by consumption)

Fuel	Unit	Baseline	Baseline + Carbon tax	% change
Gasoline	US$ per liter	1.55	1.80	15.7%
Diesel	US$ per liter	1.51	1.78	18.1%
LPG	US$ per liter	0.73	0.91	25.3%
Kerosene	US$ per liter	0.75	1.02	35.9%
Oil	US$ per barrel	72.61	111.71	53.9%
Coal	US$ per gigajoule (GJ)	12.13	20.05	65.3%
Natural gas	US$ per gigajoule (GJ)	33.18	38.09	14.8%
Electricity	US$ per kwh	0.18	0.19	4.3%

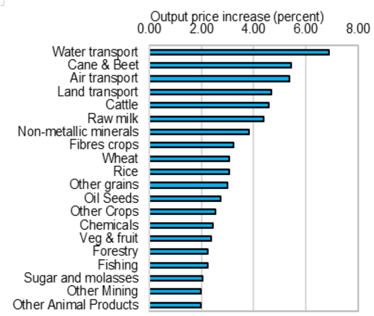
Additional Fiscal Revenues from Fossil Fuel Excises (against the baseline)

(USD billion real 2021; percent of GDP)



Top 20 (of 59) Most Affected Sectors–Croatia

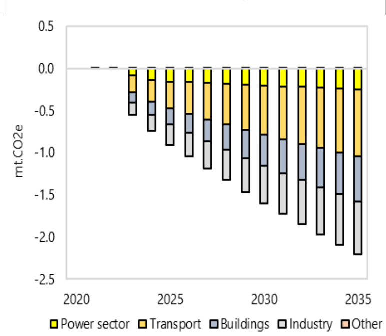
(Percent change in output prices for $83 - Carbon tax per tCO2e in 2030)



Energy emissions will decline in all sectors, with mainly road-related CO_2 emissions declining in the transport sector, bringing about a whole host of welfare benefits.

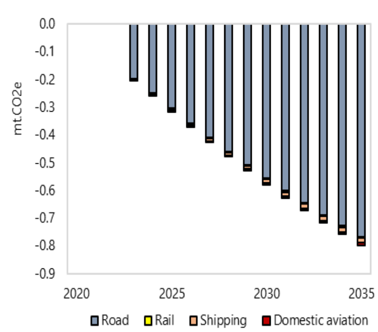
Change in Energy CO2 Emissions by Sector

(Metric tons of carbon dioxide equivalent

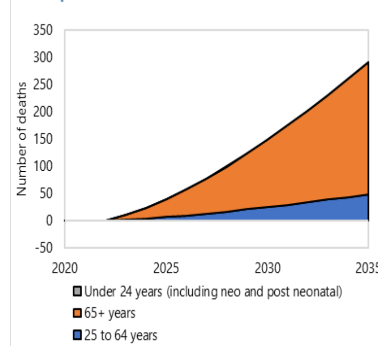


Change in Transport CO2 Emissions

(Metric tons of carbon dioxide equivalent (mtCO2e))



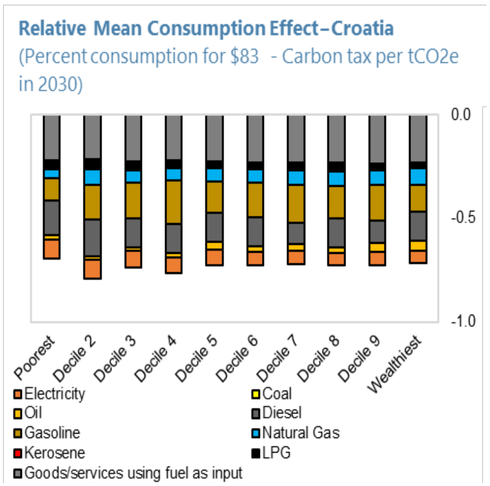
Cumulative Averted Deaths by Age Group–Croatia



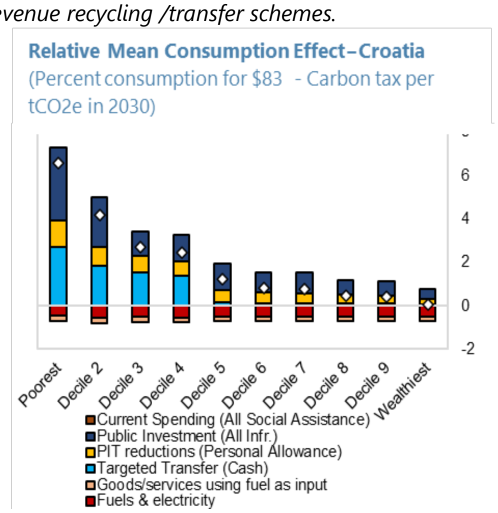
Source: IMF staff estimates using CPAT.

Figure 8. Distributional Impact of a €75 Carbon Tax
(Introduced progressively from €30 during 2023-30, economy-wide)

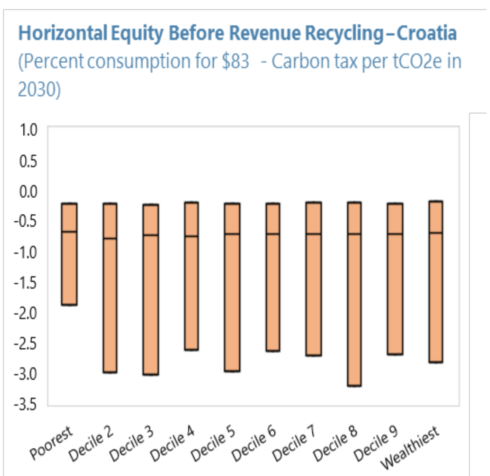
The incidence on consumption, before transfers, is different across income groups, with the poorest experiencing a smaller relative decline in gasoline and natural gas consumption.



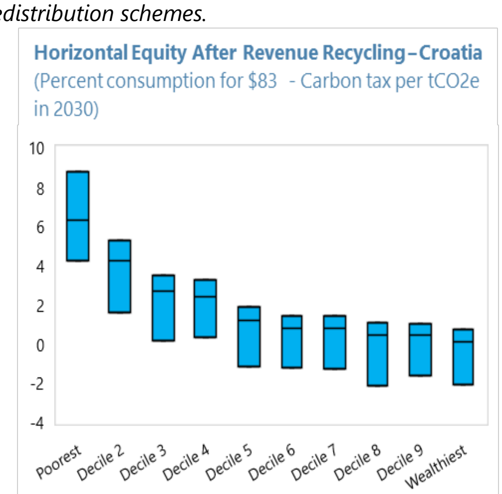
The direct impact on households (via fuel price increases) and indirect (from the consumption of other, non-fuel/-energy goods and services) are more than offset by revenue recycling /transfer schemes.



A carbon tax also leads to greater variation in household-level effects within income groups…



…the authorities should be mindful of these impacts as they tend to be more difficult to remedy through typical redistribution schemes.



Source: IMF staff estimates using CPAT.

31. Carbon pricing could be reinforced with feebates and other sectoral policies. In Croatia, sectoral policies are especially important to reduce emissions in power, buildings, and transportation sectors, while keeping carbon prices (i.e., consumer price impacts) at politically manageable levels since quite high carbon prices are needed to achieve deep emissions reduction in buildings and transport. Feebates provide a revenue-neutral, sliding scale of fees on activities (e.g., power generation) or products (e.g., vehicles).[17] Activities or products with above average emission rates pay a net tax; activities or products with below average emission rates get net revenues.

32. The electrification of transport and buildings plus decarbonization of electricity (especially as electricity demand increases as more energy efficient vehicles and electricity-based heating systems are installed) are crucial for achieving deep decarbonization, which the EU has committed to. Policies to promote both electrification of transport and buildings and low-carbon electricity generation are both needed to be pursued in tandem. They are complements and can be promoted through feebates at the sectoral level and non-ETS sector carbon pricing.

33. Energy efficiency improvements need to be prioritized. While energy efficiency gains can be achieved by carbon pricing, it needs to be complimented by feebates in transportation and buildings to induce the level of efficiency improvements needed to achieve lowest-cost, deep decarbonization. For instance,

- **Feebates in the power generation (electricity production) sector could be instrumental in promoting the shift toward renewables, provided the institutional framework in Croatia becomes more conducive to renewables expansion**.[18] A feebate with price €100/tCO2e would have applied a fee equivalent to 8.4 cents/kWh for coal, 2.1 cents/kWh for natural gas, and a subsidy of 1.4 cents/kWh for renewables in 2022. The feebate would promote more energy efficient technologies and disincentivize coal power generation. Feebates can significantly reduce the emissions-intensity of electricity as compared to the business-as-usual scenario. Moreover, switching from coal and oil to natural gas can significantly lower emissions—in Croatia coal and oil power generation account for about 28 percent of gross production of electricity and heat from combustible fuels.

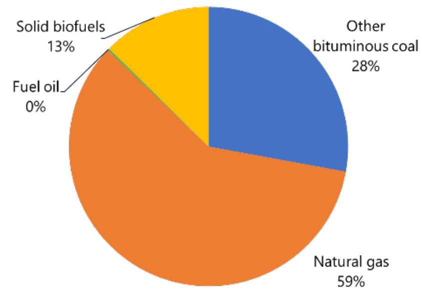
- **In the buildings sector, feebates could be used to incentivize the shift from fossil fuel-based heating to the use of more energy-efficient appliances and building renovations.** The feebate could take the form of a carbon tax on heating fuels, while subsidies can be provided for electric or clean-fuel heating systems and energy-efficiency improving renovation. Domestic appliances (refrigerators, AC) could incur a fee depending on their efficiency level. Croatia could intensify the implementation of (i) programs for energy renovation of multi-apartment buildings, family houses, public sector buildings, and buildings of cultural importance to promote the deployment of RES; (ii) systematic energy management in the public sector to achieve energy savings (e.g., remote metering); and (iii) public lighting energy renovation programs to reduce electricity consumption and light pollution.

[17] Feebates are modeled through shadow prices, which affect the efficiency channel of the energy use but not the usage channel. While average prices are not affected, the stock shifts toward more energy efficient vehicles, buildings, power generators, etc.

[18] Finalize and swiftly implement REPowerEU will also further facilitate Croatia's green transition.

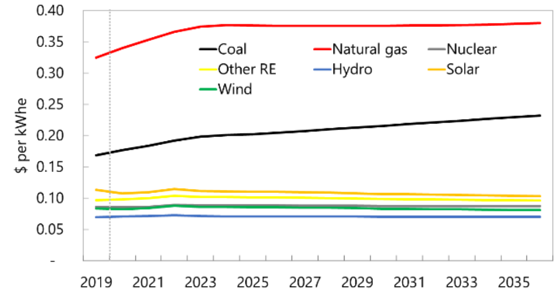
Figure 9. Power Sector

Gross Production of Electricity and Derived Heat from Combustible Fuels, 2021–Croatia
(Percent)



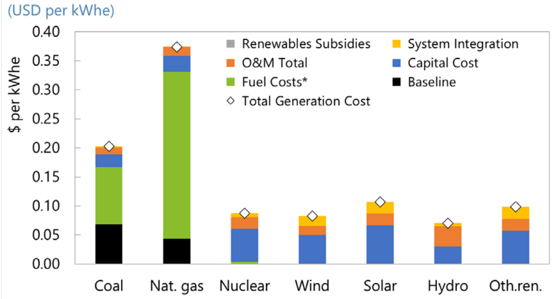
Source: Eurostat.

Total Power Systems Costs by Fuel (Engineer model)
(USD per kWhe)



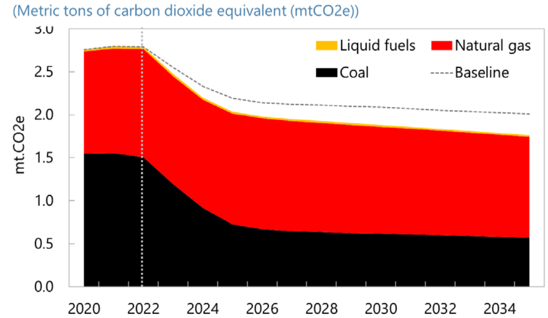
Source: CPAT.
Note: Includes storage for RE. Assumes current capacity factors. Biomass and oil generation excluded due to

Generation Costs in 2030 (Engineer model)
(USD per kWhe)



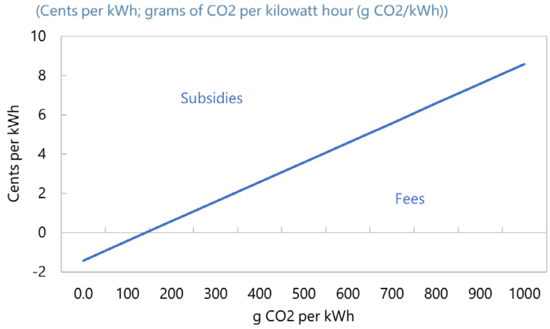
Source: CPAT.
Note: Assumes current capacity factors. Biomass and oil generation excluded due to high costs at these capacity factors. Nuclear capex includes decomissioning and waste costs (2*capex, but discounted as at

Power Sector CO2 Emissions (Average of elasticity- and engineering-based model)
(Metric tons of carbon dioxide equivalent (mtCO2e))



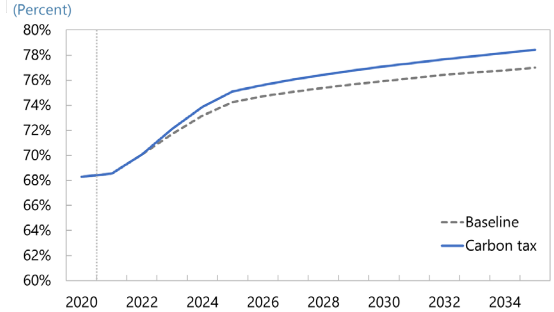
Source: CPAT.

Illustrative Feebate for Power Sector–Croatia
(Cents per kWh; grams of CO2 per kilowatt hour (g CO2/kWh))



Source: IMF staff estimates.
Note: Average CO2 emissions intensity (g CO2/kwh): 142 (electricity generation), 352 (natural gas), 986 (coal), 0 (renewables).

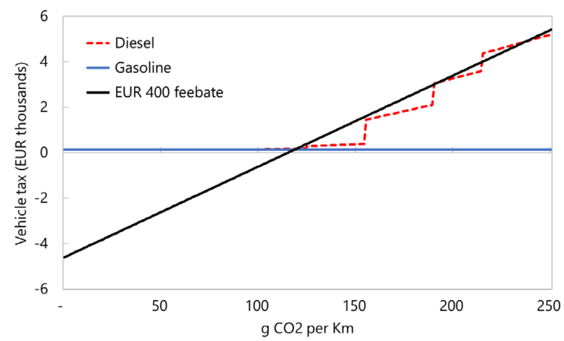
Proportion of Renewables in Total Power
(Percent)



Source: CPAT.

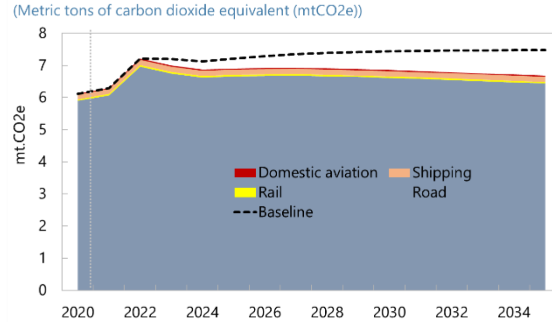
- **Road transportation emissions in Croatia mainly come from passenger vehicles and continue to grow.** A feebate provides a sliding scale of fees on vehicles with above average emission rates and a sliding scale of rebates for vehicles with below average emission rates. Car acquisitions in Croatia are taxed the standard VAT rate (25 percent) and a special tax on motor vehicles based on the vehicle sale price, its CO_2 emissions and the type of fuel used (diesel or gasoline). The Fund for Environmental Protection and Energy Efficiency periodically awards grants for co-financing the purchase of energy-efficient vehicles, for individuals and legal entities, and for the public sector. For illustration, a feebate with price of €400/tCO2e would provide a subsidy for electric or smaller gasoline vehicles, and apply an equivalent tax of €3,400 to a vehicle with 200 g CO2/km, which is €130 above the current tax for diesel-powered vehicles but considerably higher than the tax applied to gasoline-powered vehicles.[19] Given that traffic emissions are still growing, the introduction of electric cars into the economy, as well as the use of biofuels, could be intensified. The decision to cancel the penalties for fuels suppliers not meeting the RES mandates[20] should be reversed. Furthermore, the lower price measure for "blue diesel" in agriculture and fisheries could be replaced by a subsidy for the use of biodiesel and its production in these sectors, instead of blue diesel. Other sectoral measures to decarbonize the transportation sector that would benefit from faster implementation could include the development of (i) energy-efficient rail transport, maritime, and inland navigation traffic; (ii) a market for advanced biofuels to be used for direct energy consumption in traffic; and (iii) urban transport systems through the optimization of freight transport logistics, smart management of

CO2-Based Components of Vehicle Taxes–Croatia
(EUR thousands; grams of CO2 per kilometer (g CO2/Km))



Sources: European Automobile Manufacturers' Association (ACEA); and IMF staff calculations.

Transport CO2 Emissions
(Metric tons of carbon dioxide equivalent (mtCO2e))



Source: CPAT.

[19] With many thanks to Nate Vernon (FAD) for sharing the feebates calculations.

[20] Biofuels in Croatia are mainly used blended in motor gasoline or diesel fuel in a share of up to 5 and 7 percent (Croatia NPF, 2017).

public parking areas and traffic management, platforms for integrated passenger transport, and low-emission urban zones.

Sectoral Emissions Outcomes, 2030 (Percent relative to 2005 levels)						
Scope	2030 Target	2019	BAU	Feebates (€ per tonne of CO_2e)		
				100	200	400
Non-ETS	-7%	-2%	2%	-3%	-6%	-9%
Transport		21%	36%	31%	27%	23%
Buildings		-29%	-33%	-37%	-40%	-42%
Agriculture		-18%	-19%	-23%	-25%	-27%
Waste	-43%	31%	22%	17%	13%	10%
ETS		-38%	-43%	-46%	-47%	-49%
Power		-56%	-67%	-67%	-67%	-68%
Industry		-20%	-17%	-23%	-25%	-28%
Economy-wide	[-34%,37%]	-20%	-21%	-25%	-27%	-29%

Source: IMF staff estimates using CPAT.

- **Measures to reduce GHG emissions, in particular methane (CH_4), in other non-ETS sectors** (especially, waste management and agriculture) could include (i) preventing the creation and reducing the amount of disposed biodegradable waste; (ii) using biogas to produce biomethane, electricity and heat when feasible, or flaring methane in a landfill (waste management), as well as changes in livestock nutrition and quality of fodder, (iii) introducing biogas plants, and (iv) improving livestock facilities and manure management systems (agriculture).

- **Finally, although industry is not included in the sectoral analysis, it is a significant source of emissions and could be looked at in future work.**

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