



Supplement of

European primary emissions of criteria pollutants and greenhouse gases in 2020 modulated by the COVID-19 pandemic disruptions

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Supplementary material

GNFR_A 30: Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, Netherlands, Norway, Poland, Portugal, Romania, Russia, Switzerland, Stovakia, Slovenia, Turkey, Ukraine GNFR_B Manufacturing industry 32: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Slovakia, Slovenia, Turkey, Ukraine GNFR_C Manufacturing industry 35: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Slovenia, Turkey GNFR_C Other stationary combustion activities 35: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Czech Republic, Switzerland, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Iteland, Italy, Lithuania, Latvia, Luxembourg, Malta, Moldova, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Russia, Sweden, Slovakia, Slovenia, Turkey, Walta, Moldova, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Slovenia, Turkey Walta, Moldova, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Slovenia, Turkey Walta, Belgium, Bulgaria, Czech Republic, Cyrus, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Hungary, Italy, Lithuania, Latvia, Methar, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Slovenia, Turkey 23: Austria, Bosnia and Herzegovina, Belgium, Belgium, Belgium, Bulgaria, Czech Republic, Switzerland, Ciernany, Demmark, Estonia, Spain, France, Finland, United Kingdom, Groreet, Aungary, Italy, Lithuania, Latvia, Luxembourg, Malta, Mol	Sector	Description	Countries included		
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GNFR_IOff-road transportSea, North Sea, Norwegian SeaGNFR_IOff-road transport39: Albania, Armenia, Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic, Denmark, Germany, Estonia, Spain, Finland, France, United Kingdom, Greece, Croatia, Hungary, Ireland, Italy, Latvia, Luxembourg, Lithuania, Malta, Morocco, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Turkey, UkraineGNFR_IOff-road transport32: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Czech Republic, Cyprus, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal, Austria, Bosnia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal,	GNFR_G	Shipping			
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GNFR_H Aviation Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic, Denmark, Germany, Estonia, Spain, Finland, France, United Kingdom, Greece, Croatia, Hungary, Ireland, Italy, Latvia, Luxembourg, Lithuania, Malta, Morocco, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Turkey, Ukraine 32: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Czech Republic, Cyprus, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal,					
GNFR_HAviationDenmark, Germany, Estonia, Spain, Finland, France, United Kingdom, Greece, Croatia, Hungary, Ireland, Italy, Latvia, Luxembourg, Lithuania, Malta, Morocco, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Turkey, UkraineGNFR_IOff-road transport32: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Czech Republic, Cyprus, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal,	GNFR_H	Aviation			
GNFR_HAviationKingdom, Greece, Croatia, Hungary, Ireland, Italy, Latvia, Luxembourg, Lithuania, Malta, Morocco, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Turkey, UkraineGNFR_IOff-road transport32: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Czech Republic, Cyprus, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, 					
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GNFR_I Off-road transport 32: Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Czech Republic, Cyprus, Germany, Denmark, Estonia, Spain, France, Finland, United Kingdom, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal,					
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Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Luxembourg, Netherlands, Norway, Poland, Portugal,					
Luxembourg, Netherlands, Norway, Poland, Portugal,					
Romania, Serbia, Sweden, Slovakia, Slovenia, Turkey			Romania, Serbia, Sweden, Slovakia, Slovenia, Turkey		

Table S1: List of countries (sea regions) included in the COVID-19 emission adjustment factors per GNFR sector

	Fossil fuel + biomass consumption (ktep)	Fossil fuel + biomass consumption (%)	Change due to COVID-19 restrictions	Change in consumption (%)
Workplaces	977	26.5%	-80%	-21.2%
Hospitals	428	11.6%	50%	5.8%
Commercia l buildings	1509	40.9%	-80%	-32.8%
Restaurants and hotels	160	4.3%	-90%	-3.9%
Schools and universities	287	7.8%	-100%	-7.8%
Other buildings	325	8.8%	-80%	-7.0%
	-66.9%			

Table S2: Energy consumption by subsectors of the Spanish commercial/institutional sector (IDAE, 2018) and estimated changes in the energy demand due to the COVID-19 restrictions.

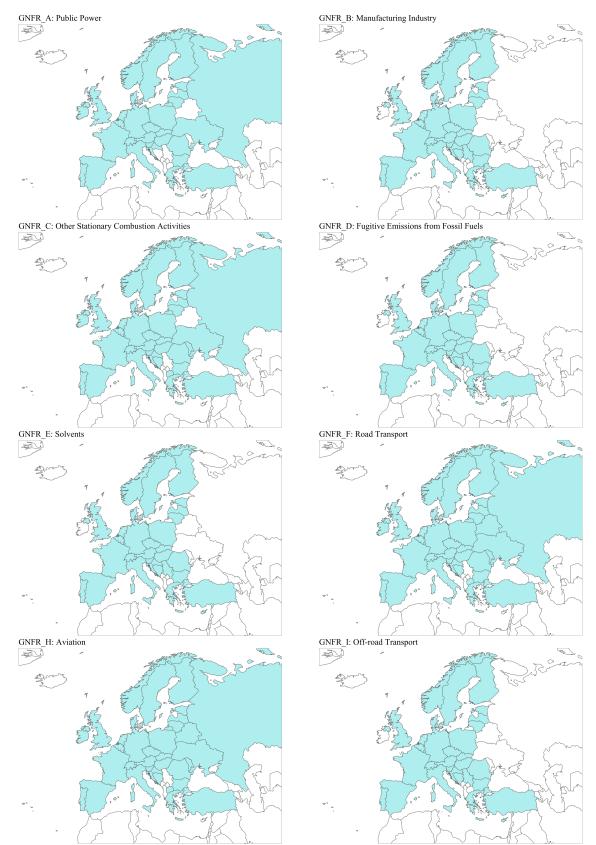


Figure S1: Spatial coverage of the COVID-19 emission adjustment factors constructed for each GNFR sector. Countries included in the database are highlighted in light turquoise

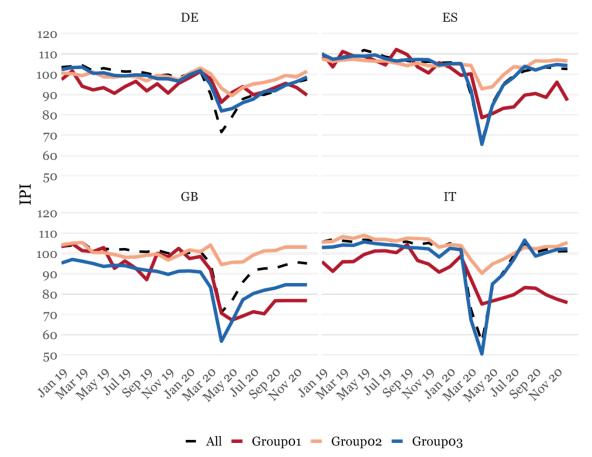


Figure S2 Evolution of the average monthly Industrial Production Index (IPI) values (January 2019 to December 2020) for four manufacturing categories: Group01 (petroleum refining products), Group02 (pharmaceutical, chemistry, food and beverages products), Group03 (non-metallic mineral products, basic metals, paper and machinery and equipment) and All (general index for all the manufacturing industry). Results are presented for Germany (DE), Spain (ES), Italy (IT) and the United Kingdom (GB). The IPI values are seasonally and calendar adjusted data (Eurostat, 2021a)

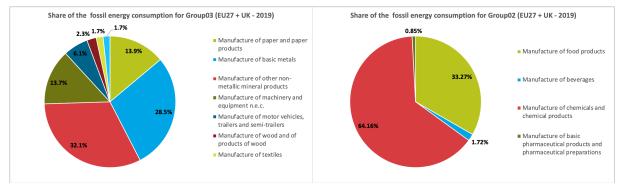


Figure S3: Relative fossil energy consumption in the GNFR_B3 - Manufacture of other products (left) and GNFR_B2 - Manufacture of pharmaceutical, chemistry, food and beverages products – (right) manufacturing industry subcategories per industrial branch in the EU27 + UK during 2019 (Eurostat, 2021b).

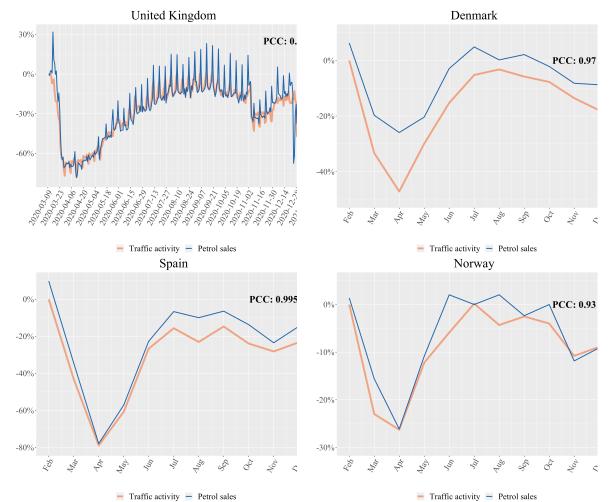


Figure S4: Weekly (UK) and monthly (Denmark, Spain, Norway) changes in traffic activity (orange line) and petrol sales (blue line) due to COVID-19 restrictions during 2020. Correlation between the two parameters is represented with the Pearson correlation coefficient (PCC).

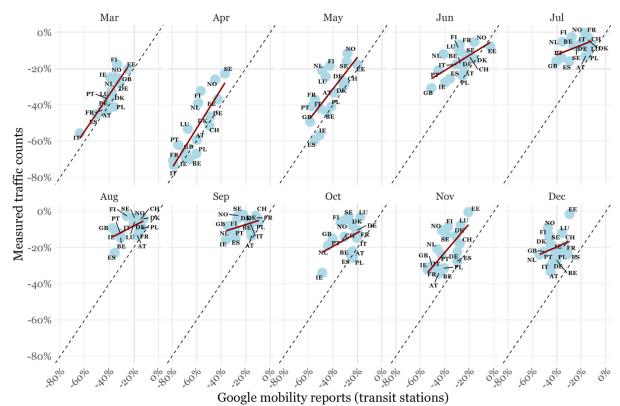


Figure S5: Comparison between averaged monthly adjustment factors for road traffic reported by Google COVID-19 Community Mobility Reports (Google LLC, 2021) and light duty vehicles and cars (LDV) measured-based trends per country (see Table A1 of the paper for references).

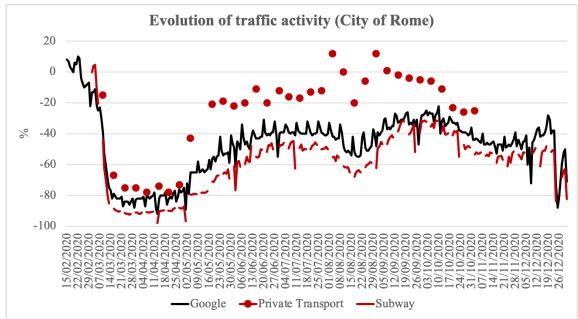
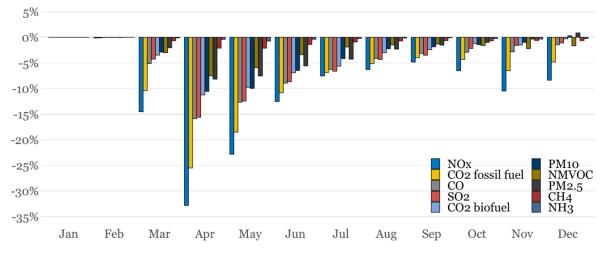


Figure S6: Comparison of Google LCC (2021) traffic movement trends with the evolution of the private transport and access to subway reported by Roma Mobilita (2021) for the city of Rome and the period 21 February to 31 December 2020.



Relative Emission Changes by Pollutant and Month EU-27 + UK

Figure S7: Relative decline in monthly emissions [%] by pollutant between January and December 2020 for EU27 + UK.

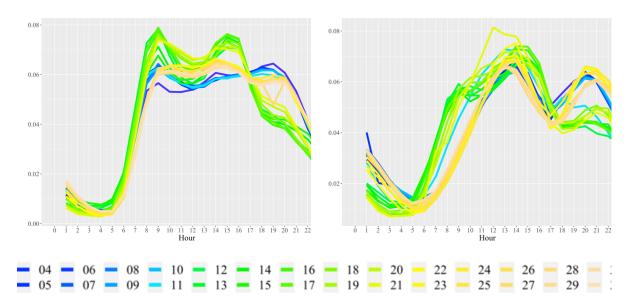


Figure S8. Hourly temporal profiles derived from measured-traffic counts in Madrid city for the year 2020 (AM, 2021) for weekdays (left) and Saturdays (right) discriminated by week of the year (week 4 to week 29)

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AM: Madrid city council. Permanent traffic counts. Available at: https://datos.madrid.es/portal/site/egob/menuitem.c05c1f754a33a9fbe4b2e4b284f1a5a0/?vgnextoid=fabbf 3e1de124610VgnVCM2000001f4a900aRCRD&vgnextchannel=374512b9ace9f310VgnVCM100000171f 5a0aRCRD&vgnextfmt=default (last accessed, May 2021) 2021.

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