

*Supplementary Information***Saving the Planet's Climate or Water Resources?
The Trade-Off between Carbon and Water Footprints of
European Biofuels. Title. *Sustainability* 2015, 7, 6665-6683****Markus Berger ^{1,*}, Stephan Pfister ², Vanessa Bach ¹ and Matthias Finkbeiner ¹**

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ETH Mean Estimates

Table S1. Total (blue) water consumption of crops underlying the European bioethanol consumption (10^6 m^3) based on ETH mean estimates [1].

Irrigation (blue) water consumption [10^6 m^3]	Wheat	Maize	Barley	Rye	Sugar beet	Sugar cane	Total	Share
European Union								
Austria	-	1.5	-	-	4.5	-	6.0	0%
Belgium	-	-	-	-	6.2	-	6.2	0%
Bulgaria	17.9	26.6	-	-	-	-	44.6	3%
Croatia	-	1.3	-	-	-	-	1.3	0%
Czech Republic	4.7	-	0.4	-	3.1	-	8.2	1%
Denmark	14.2	-	3.7	0.8	-	-	18.7	1%
Finland	-	-	0.9	-	-	-	0.9	0%
France	113.4	57.2	6.6	-	51.8	-	229.1	18%
Germany	46.8	4.9	4.7	5.5	35.7	-	97.6	8%
Greece	13.7	20.7	-	-	-	-	34.4	3%
Hungary	10.7	22.6	-	-	-	-	33.3	3%
Ireland	-	-	0.0	-	-	-	0.0	0%
Italy	35.0	30.4	-	-	-	-	65.4	5%
The Netherlands	-	-	-	-	16.4	-	16.4	1%
Poland	10.1	2.5	0.8	1.7	6.6	-	21.8	2%
Portugal	-	12.0	-	-	-	-	12.0	1%
Romania	43.0	143.8	2.0	-	-	-	188.9	15%
Spain	51.8	32.6	13.6	###	18.3	-	133.1	10%
Sweden	-	-	1.3	-	-	-	1.3	0%
United Kingdom	-	-	1.9	-	9.2	-	11.1	1%
Brazil	-	1.6	-	-	-	105.8	107.4	8%
USA	4.0	111.2	-	-	-	-	115.2	9%
Peru	-	-	-	-	-	21.9	21.9	2%
Switzerland	3.9	-	-	-	-	-	3.9	0%
Bolivia	-	-	-	-	-	10.3	10.3	1%
Ukraine	4.4	9.7	-	-	1.0	-	15.1	1%
Egypt	-	-	-	-	-	53.5	53.5	4%
Guatemala	-	-	-	-	-	4.6	4.6	0%
Argentina	-	0.8	-	-	-	6.3	7.0	1%
Cuba	-	-	-	-	-	8.7	8.7	1%
Total	374	479	36	25	153	211	1'278	100%
	29%	38%	3%	2%	12%	17%		

Table S2. Total (blue) water consumption of crops underlying the European biodiesel consumption [10^6 m^3] based on ETH mean estimates [1].

Irrigation (blue) water consumption [10^6 m^3]	Rapeseed	Soybean	Oil palm	Sunflower	Total	Share
European Union						
Austria	-	7.5	0.0	-	7.5	0%
Bulgaria	-	-	-	346.6	346.6	7%
Croatia	-	3.1	-	0.9	4.0	0%
Czech Republic	17.9	-	-	-	17.9	0%
Denmark	68.1	-	-	-	68.1	1%
France	585.0	24.5	-	47.7	657.2	12%
Germany	312.5	-	0.0	-	312.5	6%
Greece	-	-	-	100.4	100.4	2%
Hungary	1.2	16.1	-	90.6	107.8	2%
Italy	-	110.8	-	5.7	116.5	2%
Lithuania	0.0	-	-	-	0.0	0%
Poland	60.7	-	-	-	60.7	1%
Romania	0.6	95.6	-	527.2	623.4	12%
Slovakia	-	12.0	-	-	12.0	0%
Spain	75.5	-	-	18.6	94.0	2%
United Kingdom	80.2	-	-	-	80.2	2%
Argentina	-	1164.2	-	-	1164.2	22%
Indonesia	-	-	55.4	-	55.4	1%
Brazil	-	341.1	-	-	341.1	6%
Canada	7.8	30.0	-	-	37.8	1%
Ukraine	1.4	89.1	-	-	90.5	2%
US	0.6	722.0	-	-	722.7	14%
Malaysia	-	-	5.1	-	5.1	0%
Paraguay	3.0	39.2	-	-	42.2	1%
Russia	0.3	194.0	-	-	194.4	4%
China	-	4	-	-	3.6	0%
Total	1214.9	2842.3	60.6	790.2	5266.0	100%
	23%	54%	1%	15%		

ETH Low Estimates

Table S3. Total (blue) water consumption of crops underlying the European bioethanol consumption [10^6 m^3] based on ETH low estimates [2].

Irrigation (blue) water consumption [10^6 m^3]	Wheat	Maize	Barley	Rye	Sugar beet	Sugar cane	Total	Share
European Union								
Austria	-	0.4	-	-	1.3	-	1.7	0%
Belgium	-	-	-	-	1.0	-	1.0	0%
Bulgaria	5.7	9.6	-	-	-	-	15.3	3%
Croatia	-	0.1	-	-	-	-	0.1	0%
Czech Republic	0.4	-	0.0	-	0.4	-	0.8	0%
Denmark	5.1	-	1.3	0.2	-	-	6.6	1%
Finland	-	-	0.2	-	-	-	0.2	0%
France	33.0	21.4	1.8	-	13.3	-	69.5	14%
Germany	8.7	0.9	0.9	0.8	8.7	-	20.1	4%
Greece	7.5	13.5	-	-	-	-	21.0	4%
Hungary	2.3	5.2	-	-	-	-	7.5	1%
Ireland	-	-	0.0	-	-	-	0.0	0%
Italy	17.4	16.4	-	-	-	-	33.8	7%
The Netherlands	-	-	-	-	7.8	-	7.8	2%
Poland	0.9	0.2	0.1	0.2	0.6	-	1.8	0%
Portugal	-	5.9	-	-	-	-	5.9	1%
Romania	18.9	66.7	0.9	-	-	-	86.4	17%
Spain	19.0	13.0	4.9	5.9	7.7	-	50.6	10%
Sweden	-	-	0.3	-	-	-	0.3	0%
United Kingdom	-	-	0.3	-	1.7	-	2.0	0%
Brazil	-	0.2	-	-	-	29.6	29.9	6%
USA	1.7	60.6	-	-	-	-	62.3	12%
Peru	-	-	-	-	-	13.1	13.1	3%
Switzerland	0.6	-	-	-	-	-	0.6	0%
Bolivia	-	-	-	-	-	1.2	1.2	0%
Ukraine	1.6	2.7	-	-	0.2	-	4.5	1%
Egypt	-	-	-	-	-	52.3	52.3	10%
Guatemala	-	-	-	-	-	1.7	1.7	0%
Argentina	-	0.2	-	-	-	2.5	2.7	1%
Cuba	-	-	-	-	-	3.2	3.2	1%
Total	123	217	11	7	43	104	504	100%
	24%	43%	2%	1%	8%	21%		

Table S4. Total (blue) water consumption of crops underlying the European biodiesel consumption [10^6 m^3] based on ETH low estimates [2].

Irrigation (blue) water consumption [10^6 m^3]	Rapeseed	Soybean	Oil palm	Sunflower	Total	Share
European Union						
Austria	-	2.0	0.0	-	2.0	0%
Bulgaria	-	-	-	125.6	125.6	8%
Croatia	-	0.1	-	0.0	0.2	0%
Czech Republic	0.8	-	-	-	0.8	0%
Denmark	21.2	-	-	-	21.2	1%
France	172.2	9.1	-	18.8	200.2	12%
Germany	48.9	-	0.0	-	48.9	3%
Greece	-	-	-	69.5	69.5	4%
Hungary	0.0	4.0	-	21.4	25.4	2%
Italy	-	71.9	-	2.8	74.6	4%
Lithuania	0.0	-	-	-	0.0	0%
Poland	5.3	-	-	-	5.3	0%
Romania	0.0	50.4	-	287.3	337.7	20%
Slovakia	-	4.0	-	-	4.0	0%
Spain	30.3	-	-	4.4	34.7	2%
United Kingdom	11.0	-	-	-	11.0	1%
Argentina	-	221.4	-	-	221.4	13%
Indonesia	-	-	25.9	-	25.9	2%
Brazil	-	65.2	-	-	65.2	4%
Canada	0.5	3.2	-	-	3.7	0%
Ukraine	0.0	32.9	-	-	32.9	2%
US	0.1	311.5	-	-	311.6	19%
Malaysia	-	-	1.2	-	1.2	0%
Paraguay	3.0	4.0	-	-	7.1	0%
Russia	0.0	37.5	-	-	37.6	2%
China	-	2	-	-	1.9	0%
Total	293.5	817.2	27.1	404.3	1'669.8	100%

Global Average Blue Water Consumption of Biofuel Feedstock

Table S5. ETH mean and low estimates of blue water consumption of first generation biofuels for global average crop production [m^3/GJ]; based on [2].

Ethanol							
	Wheat	Maize	Barley	Rye	Sugar beet	Sugar cane	Average
Mean estimates	51.4	21.5	26.1	7.1	18.6	30.5	25.9
Low Estimates	25.2	8.8	7.9	2.4	8.3	16.5	11.5
Biodiesel							
	Rapeseed	Soy bean	Palm oil	Sunflower		Average	
Mean estimates	35.7	54.0	3.1	57.3		37.5	
Low Estimates	17.5	17.3	0.5	17.6		13.2	

Comparison of Blue Water Consumption Distribution

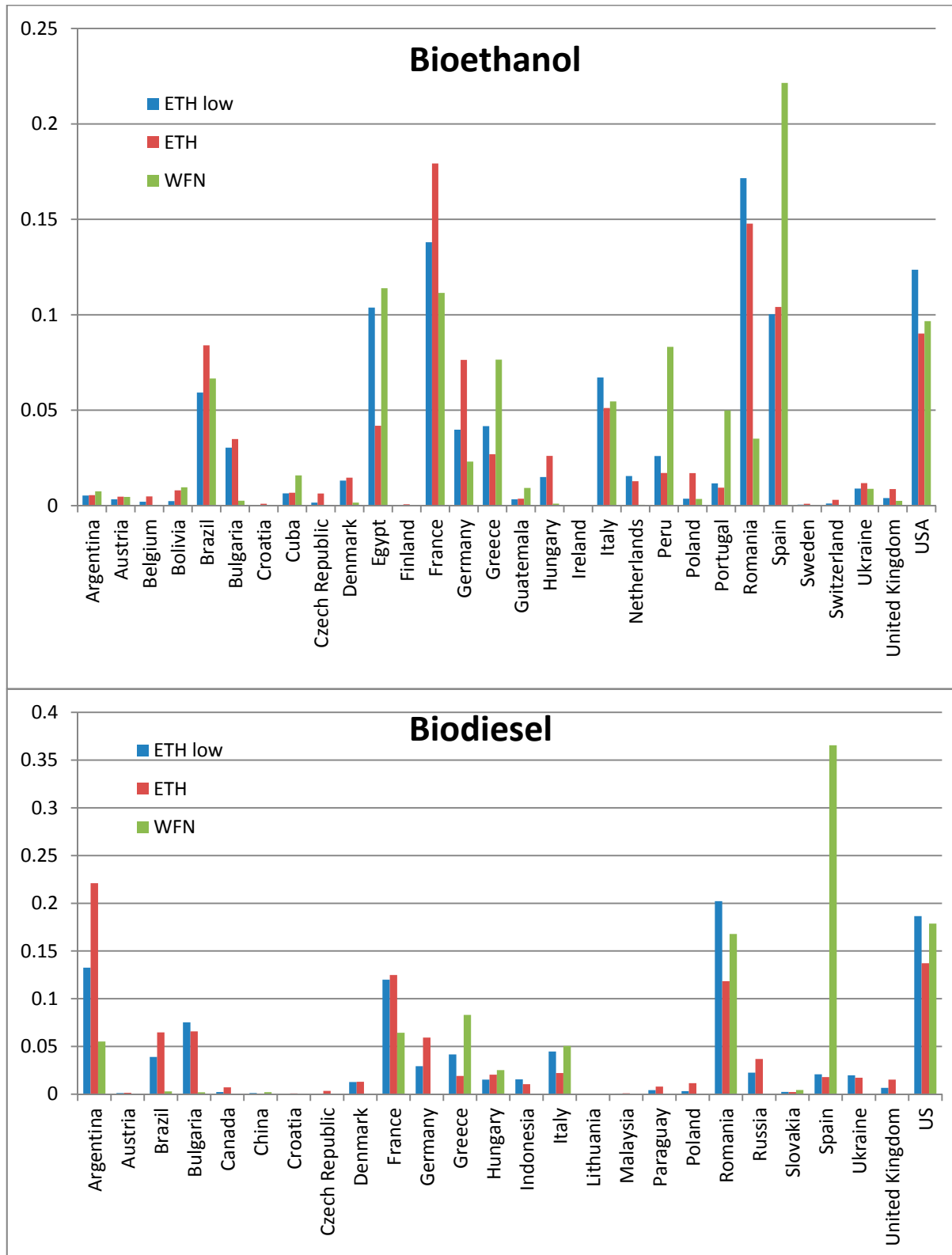


Figure S1. Distribution of water consumption for EU bioethanol (**top**) and biodiesel (**bottom**), based on the different dataset (shares total water consumption).

References

1. Pfister, S.; Bayer, P. Monthly water stress: Spatially and temporally explicit consumptive water footprint of global crop production. *J.Clean. Prod.* **2014**, *73*, 52–62.
2. Pfister, S.; Bayer, P.; Koehler, A.; Hellweg, S. Environmental impacts of water use in global crop production: Hotspots and trade-offs with land use. *Environ. Sci. Technol.* **2011**, *45*, 5761–5768.

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