Supplementary Information: North-South polarization of European electricity consumption under future warming

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This document contains supplementary information to Wenz, Levermann and Auffhammer (2017). Section 1 provides additional figures that complement the figures shown in the main manuscript by displaying the results for all remaining variants of daily peak load/daily electricity consumption and daily maximum/daily average temperature. Section 2 comprises four tables with detailed information on the data used in and obtained by the analysis. Specifically, Tables S2+S3 complement the two tables shown in the main manuscript by documenting computation results for daily average temperatures instead of daily maximum temperatures. Section 3 examines the robustness of the results to specific modeling assumptions.

1. Supplemental figures

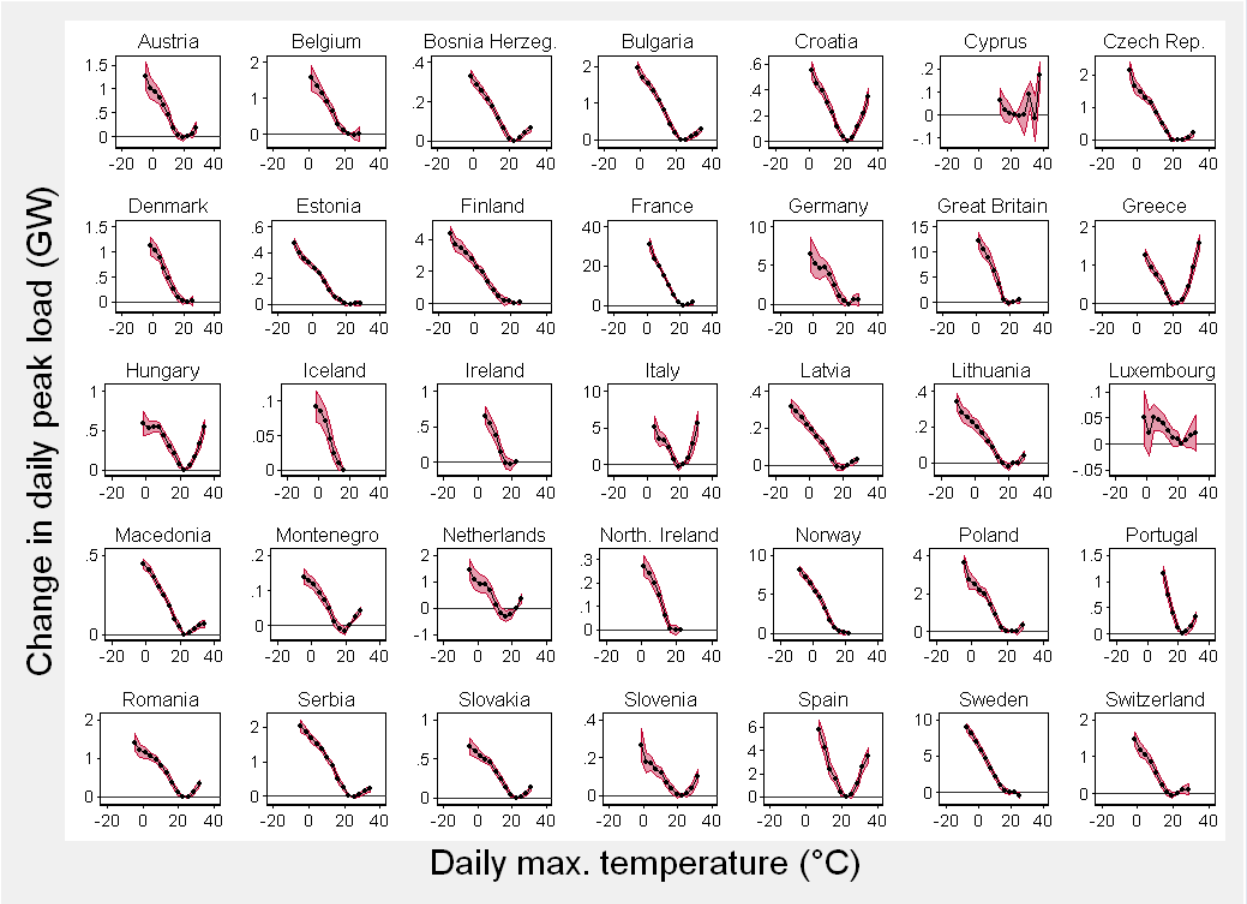

Figure S1: Response of daily peak load to daily maximum temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily maximum temperature in the omitted bin category (21°C-24°C) with a day of the relevant maximum temperature. First and last bin are chosen such that each comprises at least 2% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up to degree six). Pink shaded areas denote 95%-confidence band based on Newey-West standard error. Regression functions of all countries display similar characteristics with minimal peak load values at ~22°C (71.6°F) that increase monotonically in lower and higher temperature, where data coverage is sufficient.

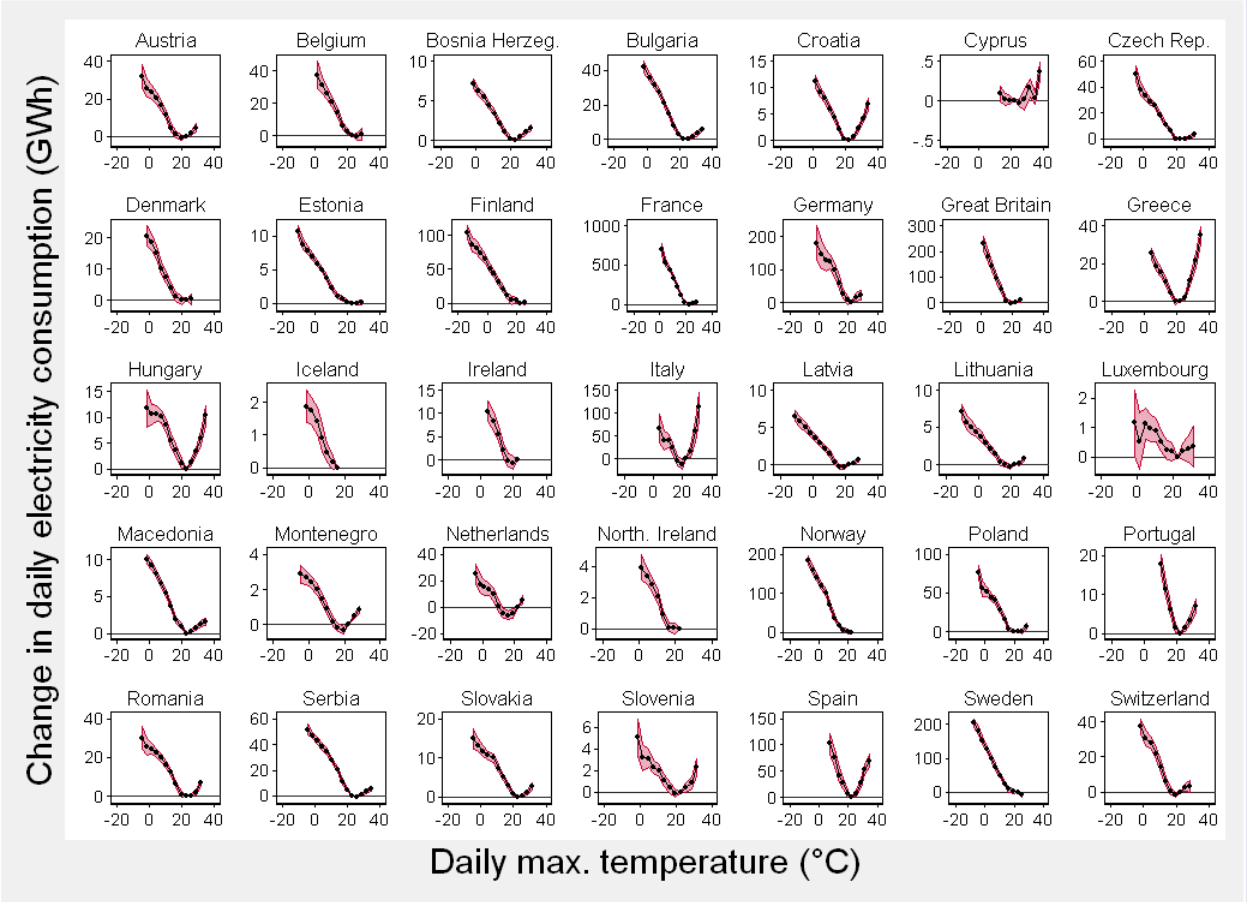

Figure S2: Response of daily electricity consumption to daily maximum temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily maximum temperature in the omitted bin category (21°C-24°C) with a day of the relevant maximum temperature. First and last bin are chosen such that each comprises at least 2% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up to degree six). Pink shaded areas denote 95%-confidence band based on Newey-West standard error. Regression functions of all countries display similar characteristics with minimal electricity consumption values at ~22°C (71.6°F) that increase monotonically in lower and higher temperature, where data coverage is sufficient.

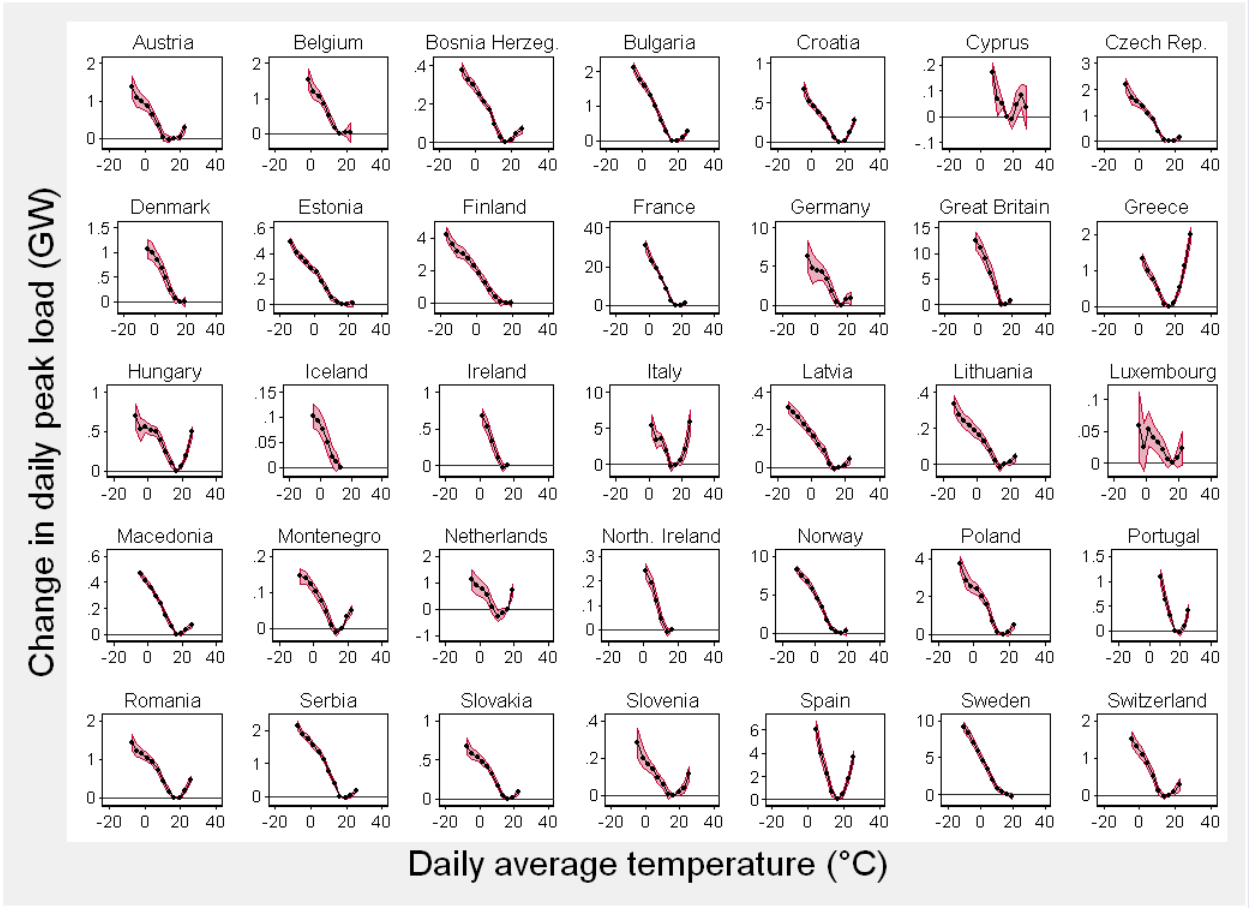

Figure S3: Response of daily peak load to daily average temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily average temperature in the omitted bin category (15°C-18°C) with a day of the relevant average temperature. First and last bin are chosen such that each comprises at least 2% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up to degree six). Pink shaded areas denote 95%-confidence band based on Newey-West standard error. Regression functions of all countries display similar characteristics with minimal peak load values at ~16°C (60.8°F) that increase monotonically in lower and higher temperature, where data coverage is sufficient.

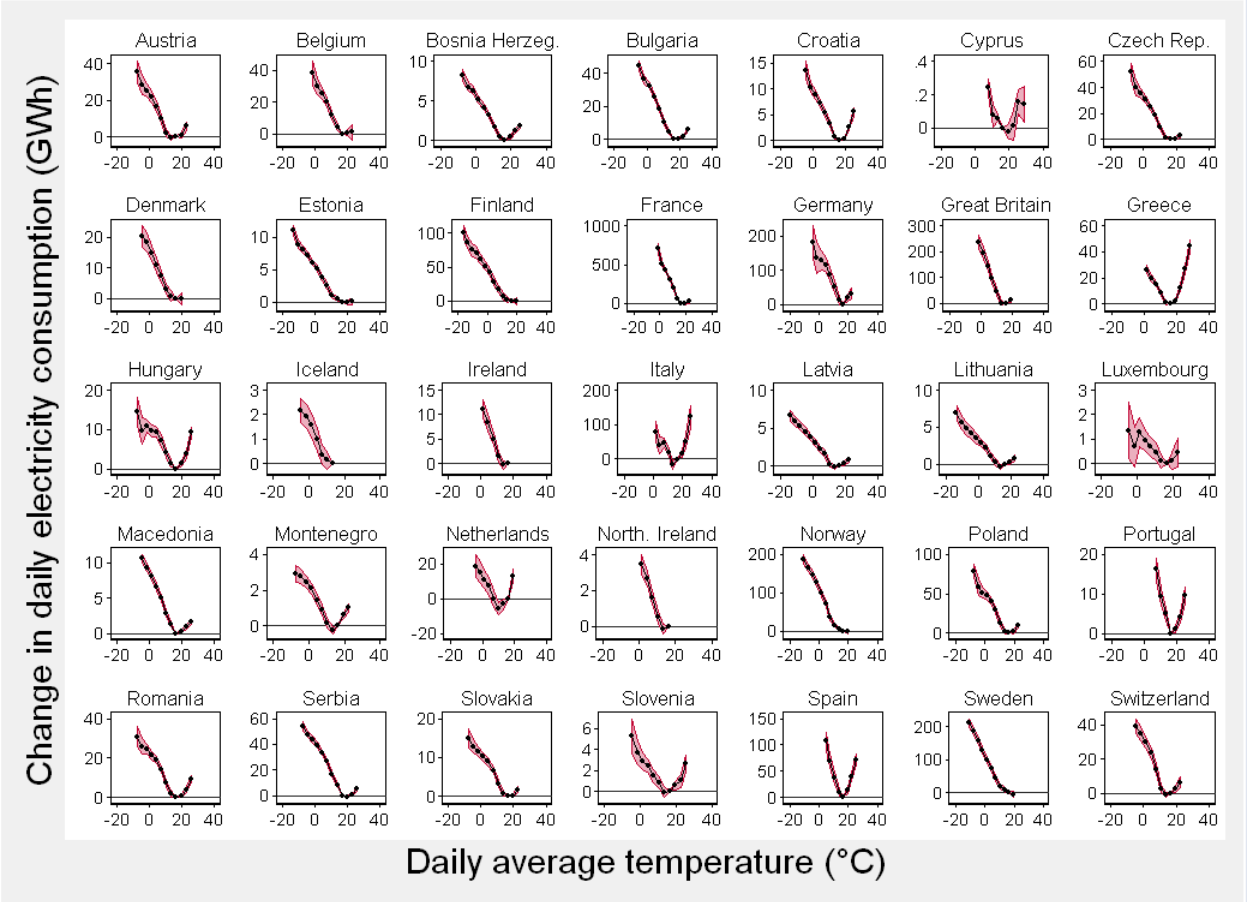

Figure S4: Response of daily electricity consumption to daily average temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily average temperature in the omitted bin category (15°C-18°C) with a day of the relevant average temperature. First and last bin are chosen such that each comprises at least 2% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up degree six). Pink shaded areas denote 95%-confidence band based on Newey-West standard error. Regression functions of all countries display similar characteristics with minimal electricity consumption values at ~16°C (60.8°F) that increase monotonically in lower and higher temperature, where data coverage is sufficient.

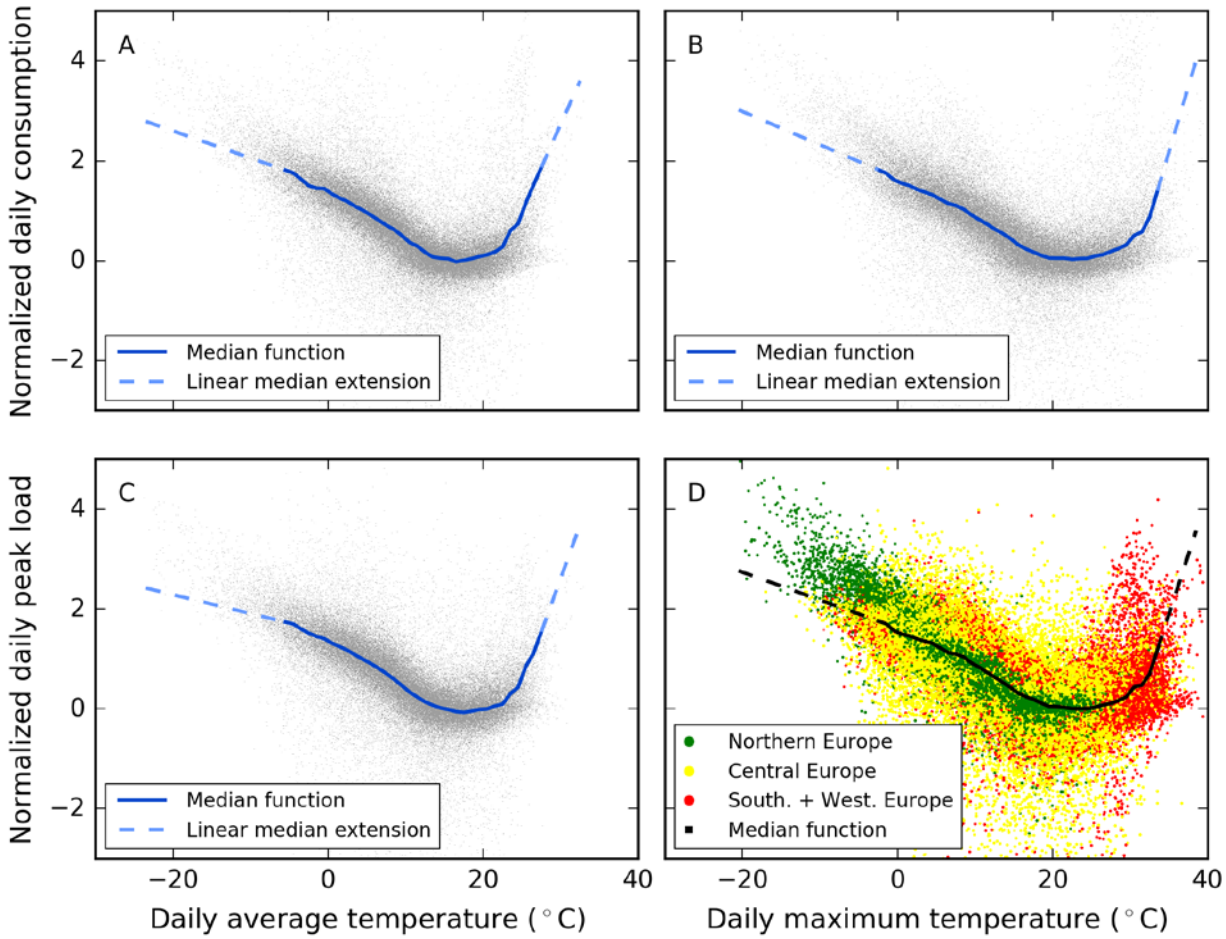

Figure S5: Common response function. ***(A)*** **Daily electricity consumption and daily average temperature.** Observational daily electricity consumption and daily average temperature data (2006-2012) of all countries are combined taking national population size into account (gray dots). Load values have been adjusted based on the country-level regression coefficients to remove the influence of non-temperature confounders and the resulting residual load data have been normalized to allow for comparison across countries ($\hat{L}_{c,d}^{norm}$, see *Methods* for detail). We obtain the response function by linking the medians of 1°C-bins (thick blue line). The first and last bin each comprises at least 20,000 data points; we linearly extend the median function for temperatures beyond these bins (dashed blue lines). ***(B)*** **Daily electricity consumption and daily maximum temperature.** As in *A* but with observational daily maximum instead of daily average temperature. ***(C)*** **Daily peak load and daily average temperature.** As in *A* but with daily peak load instead of daily electricity consumption. ***(D)*** **Daily maximum temperature and normalized load data for different European regions.** As in *B* but with daily peak load instead of daily electricity consumption (see also Fig. 2). Data points are colored according to the geographical region a country belongs to (the assignment of countries to geographical regions can be found in Table S1).

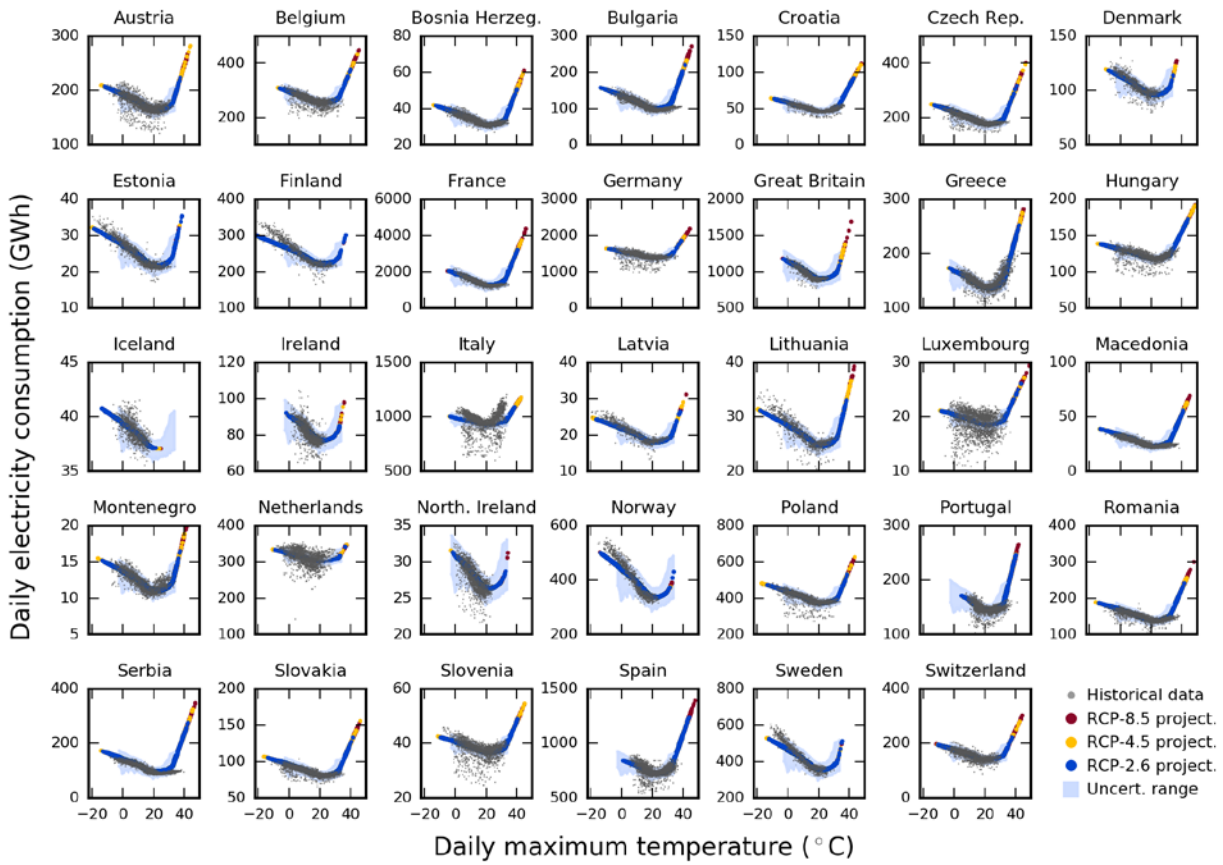

Figure S6: Estimated daily electricity demand for projected daily maximum temperatures in 2013-2099 under three different warming scenarios. Estimated daily electricity demand values for the years 2013-2099 under three different Representative Concentration Pathways (RCPs; blue, yellow, and red dots) lie well within the range of observational data ($\hat{L}_{c,d}$, gray dots). Blue shaded areas denote the uncertainty range (see *Methods* for detail).

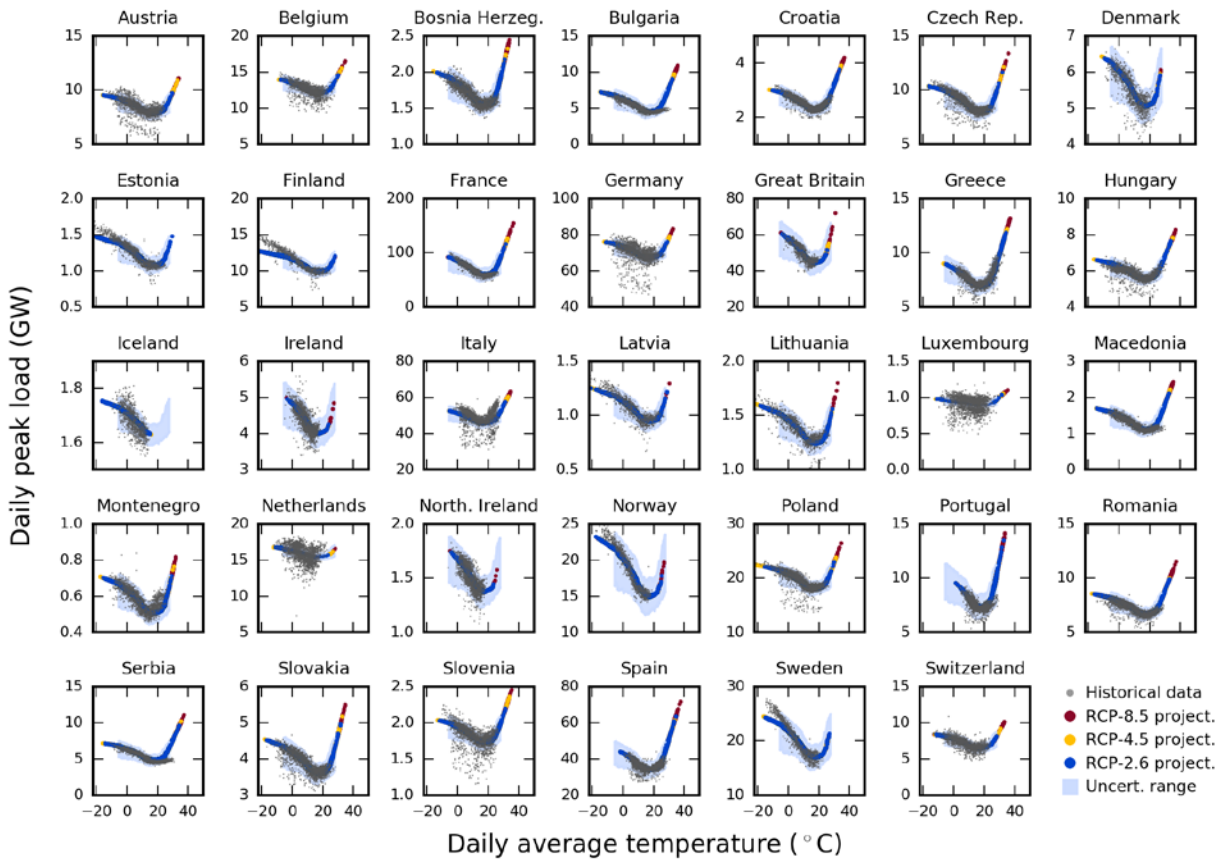

Figure S7: Estimated daily peak load values for projected daily average temperatures in 2013-2099 under three different warming scenarios. Estimated daily peak load values for the years 2013-2099 under three different RCPs (blue, yellow, and red dots) lie well within the range of observational data ($\hat{L}_{c,d}$, gray dots). Blue shaded areas denote the uncertainty range (see *Methods* for detail).

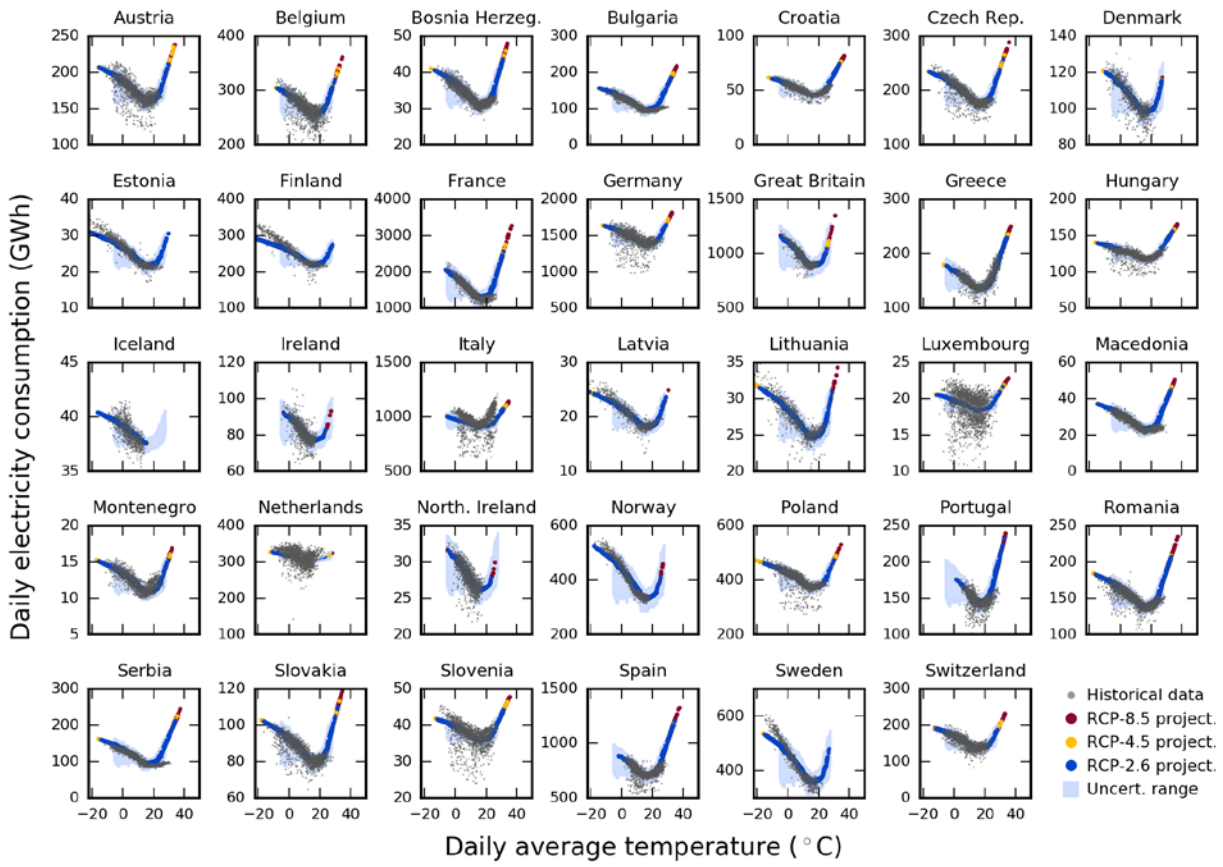

Figure S8: Estimated daily electricity demand for projected daily average temperatures in 2013-2099 under three different warming scenarios. Estimated daily electricity demand values for the years 2013-2099 under three different RCPs (blue, yellow, and red dots) lie well within the range of observational data ($\hat{L}_{c,d}$, gray dots). Blue shaded areas denote the uncertainty range (see *Methods* for detail).

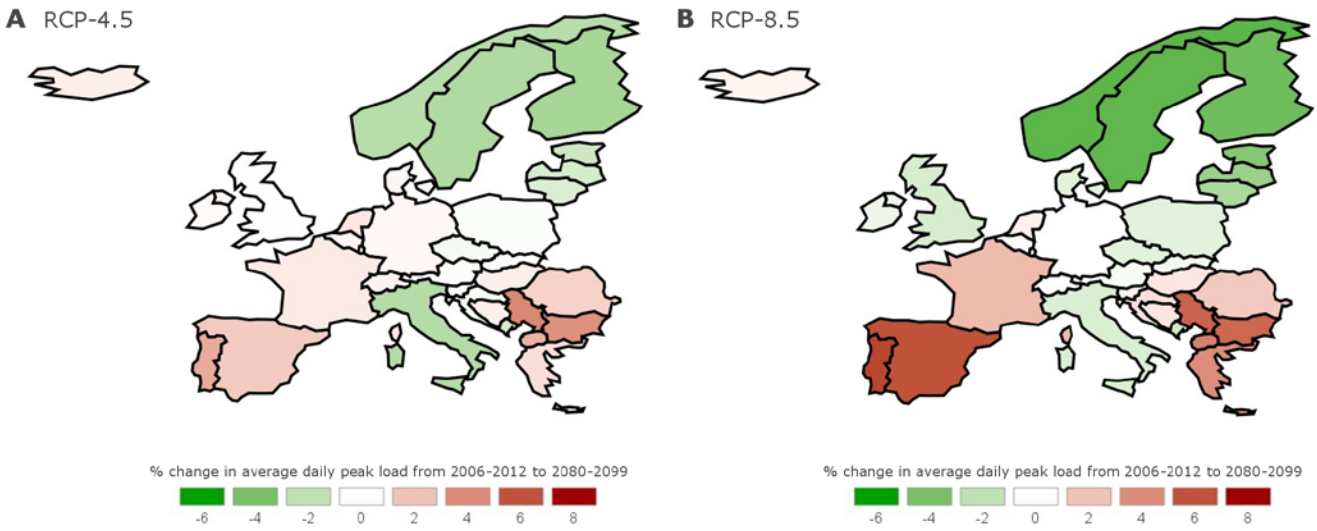

Figure S9: Percentage change in average daily peak load from 2006-2012 to 2080-2099 for projected daily average temperatures under mitigated *(A)* and unmitigated *(B)* climate change. While daily peak load decreases in Northern European countries, it increases in Southern and Western Europe countries. This trend is most pronounced for a scenario of unabated climate change (RCP-8.5, *B*) but still holds for a scenario of mitigated climate change (RCP-4.5, *A*). Table S2 provides data on all countries and the three RCPs, as well as on different planning horizons until 2100.

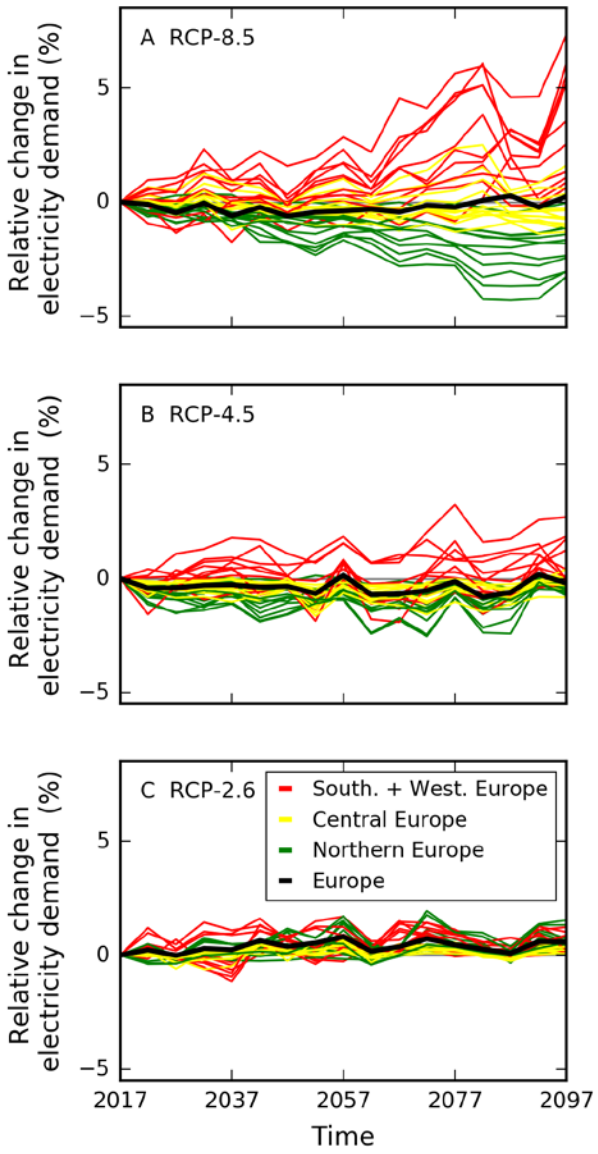

Figure S10: Percentage change in daily electricity demand (5-y average) compared with 2015-2019 average for projected daily average temperatures under different scenarios of climate change mitigation. Five-year average electricity demand values are denoted by the year in the middle of the respective time interval on the *x* axis. ***(A)*** Under a scenario of unabated climate change (RCP-8.5), daily electricity demand decreases in Northern European countries and increases in countries in Southern and Western Europe. Total European electricity demand increases in the last two decades of the century relative to 2015-2019. ***(B)*** For a scenario of mitigated climate change (RCP-4.5) the trend observed in *A* is present but less pronounced. ***(C)*** For a scenario of very ambitious climate change mitigation that keeps global temperature increase below 2°C (RCP-2.6), there is no clear trend. Table S3 provides data on all countries, RCPs and 5-y periods until 2100.

Supplemental tables

Table S1 contains an alphabetical list of all 35 European countries analyzed in this study (columns 1-2). Column 3 denotes the geographical region a country is assigned to in Figures 5, S5d and S10. Column 4 documents whether hourly load data are provided by the Entso-e database (1) for the entire 2006-2012-period or for smaller sub-periods only. The percentage of missing data points within both the 2006-2012-period and the potentially smaller country-specific coverage period is given in columns 5-6. Cyprus is excluded from the second part of the analysis because of load data scarcity.

Table S2 displays the percentage change in average daily peak load by country relative to 2006-2012 for projections of average temperature under three different scenarios of climate change mitigation.

Table S3 shows the percentage change in average daily electricity consumption by country relative to 2015-2019 for projections of daily average temperature under three different scenarios of climate change mitigation.

Table S4 documents for each country in which season annual peak load is found to occur most often at present time (2006-2012) and by the end of the century (2080-2099) under a scenario of unabated climate change (RCP-8.5). In the Netherlands and in Poland annual peak load occurs equally often in two different seasons. The last two columns indicate whether annual peak load is shifted from one season to another in general and specifically from winter to summer under future climate change. The total number of countries with a change in seasonal peak load is given in the last row.

Table S1: List of countries and temporal load data coverage

Country Name	ISO code	Geographical region	Entso-e data coverage	Missing data (hours, %) in	
				coverage period	2006-2012 period
Austria	AUT	Central	2006-2012	0	0
Belgium	BEL	Central	2006-2012	0	0
Bosnia Herzeg.	BIH	Southern	2006-2012	0	0
Bulgaria	BGR	Southern	2006-2012	0	0
Croatia	HRV	Southern	2006-2012	0.001	0.001
Cyprus	CYP	*excluded*	2010-2012	99.72	99.88
Czech Republic	CZE	Central	2006-2012	0	0
Denmark	DNK	Northern	2010-2012	0	57.14
Estonia	EST	Northern	2009-2012	0	42.87
Finland	FIN	Northern	2010-2012	0	57.14
France	FRA	Southern	2006-2012	0	0
Germany	DEU	Central	2006-2012	0	0
Great Britain	GBR	Northern	2010-2012	2.62	58.26
Greece	GRC	Southern	2006-2012	0	0
Hungary	HUN	Central	2006-2012	0	0
Iceland	ISL	Northern	2008-2012	39.9	57.06
Ireland	IRL	Northern	2008-2012	0	28.55
Italy	ITA	Southern	2006-2012	0.04	0.04
Latvia	LVA	Northern	2010-2012	0.02	57.15
Lithuania	LTH	Northern	2010-2012	0	57.14
Luxembourg	LUX	Central	2006-2012	0	0
Macedonia	MKD	Southern	2006-2012	0.002	0.002
Montenegro	MNE	Southern	2007-2012	5.61	19.56
Netherlands	NLD	Central	2006-2012	0.004	0.004
North. Ireland	NIR	Northern	2008-2012	0	28.55
Norway	NOR	Northern	2010-2012	0.03	57.15
Poland	POL	Central	2006-2012	0	0
Portugal	PRT	Southern	2006-2012	0	0
Romania	ROU	Central	2006-2012	0	0
Serbia	SRB	Southern	2007-2012	0	14.78
Slovakia	SVK	Central	2006-2012	0	0
Slovenia	SVN	Central	2006-2012	0	0
Spain	ESP	Southern	2006-2012	0	0
Sweden	SWE	Northern	2010-2012	0	57.14
Switzerland	CHE	Central	2006-2012	1.09	1.09

Table S2: Percentage change in average daily peak load by country relative to 2006-2012 for daily average temperatures under RCP-2.6, RCP-4.5 and RCP-8.5

	2020-2039			2040-2059			2060-2079			2080-2099		
	RCP-2.6	RCP-4.5	RCP-8.5	RCP-2.6	RCP-4.5	RCP-8.5	RCP-2.6	RCP-4.5	RCP-8.5	RCP-2.6	RCP-4.5	RCP-8.5
Austria	0.001	0.165	0.104	0.293	0.032	-0.085	0.179	-0.138	-0.196	0.127	0.027	-0.340
Belgium	0.236	0.331	0.414	0.464	0.253	0.256	0.355	0.127	0.105	0.375	0.205	0.027
Bosnia Herzeg.	0.135	0.541	0.428	0.491	0.441	0.210	0.451	0.136	0.552	0.254	0.509	0.813
Bulgaria	1.768	3.145	2.696	2.338	2.935	2.561	2.914	2.691	4.297	2.584	3.780	5.303
Croatia	-1.213	-0.448	-0.568	-0.581	-0.512	-0.518	-0.550	-0.769	0.257	-0.701	-0.299	0.960
Czech Rep.	-0.492	-0.291	-0.232	-0.063	-0.492	-0.558	-0.265	-0.629	-0.744	-0.304	-0.387	-0.964
Denmark	0.202	0.234	0.699	0.738	0.187	0.107	0.481	-0.146	-0.330	0.623	0.250	-0.967
Estonia	-1.571	-1.720	-1.230	-1.158	-1.995	-2.072	-1.322	-2.090	-2.544	-1.410	-1.605	-3.644
Finland	-2.593	-2.733	-2.419	-2.442	-2.889	-2.995	-2.394	-2.989	-3.352	-2.436	-2.716	-4.244
France	0.505	0.899	1.175	1.245	1.048	1.075	0.828	0.612	1.138	0.765	0.624	2.310
Germany	0.173	0.253	0.305	0.366	0.195	0.142	0.268	0.095	0.016	0.274	0.184	-0.087
Great Britain	-0.011	0.251	0.412	0.611	-0.096	-0.114	0.335	-0.409	-0.695	0.523	-0.159	-1.270
Greece	-0.974	-0.076	-0.672	-0.732	0.141	0.356	-0.144	0.459	2.393	-0.605	1.023	3.959
Hungary	0.032	0.517	0.487	0.370	0.291	0.354	0.372	0.276	0.571	0.247	0.493	0.757
Iceland	0.518	0.533	0.797	0.515	0.621	0.411	0.706	0.462	0.415	0.777	0.510	0.259
Ireland	0.251	0.534	0.515	0.610	0.205	0.135	0.485	0.007	-0.203	0.550	0.123	-0.653
Italy	-2.706	-2.438	-2.405	-2.358	-2.306	-2.394	-2.537	-2.409	-1.872	-2.578	-2.313	-1.226
Latvia	-1.371	-1.446	-1.012	-0.881	-1.684	-1.707	-1.132	-1.774	-2.131	-1.176	-1.342	-3.010
Lithuania	-1.272	-1.299	-0.905	-0.804	-1.516	-1.509	-1.070	-1.587	-1.883	-1.092	-1.207	-2.558
Luxembourg	0.613	0.695	0.715	0.753	0.634	0.618	0.689	0.562	0.536	0.679	0.613	0.528
Macedonia	1.006	1.971	1.433	1.535	1.943	1.721	1.891	1.814	3.208	1.488	2.625	4.387
Montenegro	-1.550	-1.288	-1.416	-1.187	-1.351	-1.774	-1.233	-1.685	-1.569	-1.452	-1.306	-1.534
Netherlands	0.762	0.795	0.856	0.911	0.729	0.698	0.843	0.637	0.556	0.870	0.743	0.373
North. Ireland	0.362	0.609	0.698	0.723	0.301	0.238	0.623	0.083	-0.187	0.769	0.221	-0.662
Norway	-1.956	-1.954	-1.156	-1.383	-2.096	-2.430	-1.477	-2.686	-3.228	-1.233	-2.236	-4.695
Poland	-0.406	-0.298	-0.078	-0.006	-0.445	-0.476	-0.207	-0.542	-0.682	-0.260	-0.255	-0.944
Portugal	2.494	2.798	2.580	2.731	3.086	3.662	2.143	3.099	4.389	2.160	2.864	6.408
Romania	0.711	1.392	1.430	1.159	1.244	1.115	1.193	1.123	1.681	0.989	1.480	1.755
Serbia	2.579	3.901	3.510	3.342	3.668	3.426	3.490	3.350	4.608	3.145	4.145	5.412
Slovakia	-0.277	0.019	0.039	0.117	-0.262	-0.283	-0.029	-0.342	-0.345	-0.127	-0.068	-0.465
Slovenia	-0.150	0.122	0.057	0.155	0.068	-0.005	0.113	-0.117	0.203	0.088	0.086	0.360
Spain	1.313	1.213	1.435	1.499	1.994	2.306	0.918	1.880	3.671	0.880	1.740	6.021
Sweden	-2.440	-2.485	-1.806	-1.844	-2.600	-2.775	-2.012	-3.065	-3.422	-1.956	-2.451	-4.605
Switzerland	0.518	0.645	0.633	0.901	0.541	0.275	0.718	0.263	0.039	0.630	0.364	-0.126

Table S3: Percentage change in average daily electricity consumption by country relative to 2015-2019 for daily average temperatures under RCP-2.6, RCP-4.5 and RCP-8.5

	RCP-2.6				RCP-4.5				RCP-8.5			
	2035 - 39	2055 - 59	2075 - 79	2095 - 99	2035 - 39	2055 - 59	2075 - 79	2095 - 99	2035 - 39	2055 - 59	2075 - 79	2095 - 99
Austria	0.030	0.779	0.343	0.418	-0.479	-0.321	-0.612	-0.330	-0.639	-0.436	-0.477	-0.965
Belgium	0.139	0.469	0.279	0.428	-0.429	-0.200	-0.292	-0.342	-0.605	-0.556	-0.940	-0.667
Bosnia Herzeg.	-0.312	0.550	0.173	0.209	-0.290	0.119	-0.435	-0.071	0.020	0.311	0.986	1.075
Bulgaria	-0.954	0.070	0.948	0.402	0.437	0.069	1.266	1.733	0.888	1.740	4.772	5.540
Croatia	-0.291	0.646	0.520	0.571	0.405	0.765	0.032	0.397	0.756	1.167	2.448	2.540
Czech Rep.	-0.018	0.878	0.378	0.516	-0.756	-0.426	-0.624	-0.503	-0.613	-0.540	-0.694	-1.198
Denmark	0.072	0.840	0.393	0.628	-0.803	-0.704	-0.530	-0.611	-0.451	-0.598	-1.197	-1.418
Estonia	0.477	1.477	0.697	0.729	-0.626	-0.628	-0.611	-0.499	-0.816	-1.507	-2.440	-3.048
Finland	0.480	0.884	0.547	0.583	-0.218	-0.182	-0.323	-0.186	-0.679	-1.357	-1.942	-2.453
France	0.940	1.691	0.946	1.225	-0.404	0.830	-0.254	-0.550	-1.753	-1.102	-0.845	0.855
Germany	0.027	0.479	0.183	0.327	-0.478	-0.297	-0.337	-0.381	-0.544	-0.451	-0.742	-0.761
Great Britain	0.070	0.495	0.354	0.548	-0.648	-0.854	-0.563	-0.530	-1.060	-1.062	-1.906	-1.667
Greece	-0.640	-0.279	0.531	0.089	1.783	1.549	3.235	2.699	1.431	2.849	5.638	7.324
Hungary	-0.196	0.192	0.251	0.169	0.050	0.001	-0.160	0.070	0.514	0.590	0.996	0.593
Iceland	-0.231	-0.171	-0.013	0.199	-0.020	0.006	-0.022	0.072	0.316	-0.215	-0.045	-0.047
Ireland	0.044	0.065	0.220	0.174	-0.109	-0.538	-0.248	-0.195	-0.663	-0.740	-1.206	-1.140
Italy	-0.028	0.343	-0.059	0.110	0.134	0.406	0.282	0.083	0.197	0.296	1.059	1.323
Latvia	0.302	1.379	0.533	0.649	-0.637	-0.571	-0.573	-0.456	-0.652	-1.013	-1.814	-2.352
Lithuania	0.102	1.100	0.334	0.427	-0.606	-0.468	-0.530	-0.362	-0.466	-0.697	-1.299	-1.813
Luxembourg	0.084	0.264	0.156	0.208	-0.256	-0.110	-0.200	-0.193	-0.344	-0.258	-0.450	-0.291
Macedonia	-1.152	0.362	0.758	0.349	0.720	0.789	1.641	1.844	0.455	1.685	4.645	6.068
Montenegro	-0.446	0.737	0.130	0.187	-0.673	-0.062	-0.620	-0.225	-0.136	0.028	0.658	0.624
Netherlands	-0.025	0.114	0.070	0.080	-0.182	-0.175	-0.181	-0.144	-0.175	-0.205	-0.371	-0.368
North. Ireland	0.064	0.100	0.264	0.271	-0.158	-0.533	-0.242	-0.154	-0.494	-0.663	-1.183	-1.077
Norway	0.480	1.527	1.051	1.533	-1.051	-0.940	-0.842	-0.741	-0.685	-1.665	-2.786	-3.280
Poland	-0.150	0.689	0.202	0.241	-0.583	-0.285	-0.427	-0.289	-0.295	-0.363	-0.665	-1.108
Portugal	1.087	1.234	0.882	0.873	0.929	1.553	0.796	-0.055	-0.170	1.062	1.720	3.554
Romania	-0.492	0.177	0.555	0.033	-0.056	-0.299	-0.021	0.411	0.873	1.019	2.352	1.610
Serbia	-0.789	0.905	1.122	1.011	0.478	0.662	0.532	1.248	0.961	2.304	4.456	5.212
Slovakia	-0.176	0.594	0.266	0.232	-0.404	-0.280	-0.565	-0.282	-0.042	-0.004	-0.020	-0.755
Slovenia	-0.025	0.436	0.218	0.306	-0.019	0.141	-0.198	0.014	-0.002	0.142	0.502	0.363
Spain	0.882	0.849	0.427	0.248	0.800	1.839	0.842	-0.040	0.061	0.543	2.288	5.216
Sweden	0.491	1.712	1.003	1.325	-1.116	-0.865	-0.836	-0.709	-0.804	-1.388	-2.632	-3.047
Switzerland	0.041	0.845	0.335	0.365	-1.019	-0.624	-1.025	-0.821	-1.227	-0.995	-1.310	-1.308

Table S4: Seasonal peak load at present time (2006-2012) and under future climate change (2080-2099; RCP-8.5)

Country	Season in which annual peak load occurs most often		Current winter peak	Future winter peak	Current summer peak	Future summer peak	Change in season	Winter to summer
	2006-2012	2080-2099 (RCP-8.5)	0=False, 1=True					
Greece	summer	summer	0	0	1	1	0	0
Italy	summer	summer	0	0	1	1	0	0
Denmark	winter	winter	1	1	0	0	0	0
Estonia	winter	winter	1	1	0	0	0	0
Finland	winter	winter	1	1	0	0	0	0
Great Britain	winter	winter	1	1	0	0	0	0
Ireland	winter	winter	1	1	0	0	0	0
Latvia	winter	winter	1	1	0	0	0	0
Lithuania	winter	winter	1	1	0	0	0	0
North. Ireland	winter	winter	1	1	0	0	0	0
Norway	winter	winter	1	1	0	0	0	0
Sweden	winter	winter	1	1	0	0	0	0
Iceland	autumn	winter	0	1	0	0	1	0
Netherlands	autumn/winter	winter	0	1	0	0	1	0
Poland	winter	summer/winter	1	0	0	0	1	0
Austria	winter	summer	1	0	0	1	1	1
Belgium	winter	summer	1	0	0	1	1	1
Bosnia Herzeg.	winter	summer	1	0	0	1	1	1
Bulgaria	winter	summer	1	0	0	1	1	1
Croatia	winter	summer	1	0	0	1	1	1
Czech Rep.	winter	summer	1	0	0	1	1	1
France	winter	summer	1	0	0	1	1	1
Germany	winter	summer	1	0	0	1	1	1
Hungary	winter	summer	1	0	0	1	1	1
Luxembourg	winter	summer	1	0	0	1	1	1
Macedonia	winter	summer	1	0	0	1	1	1
Montenegro	winter	summer	1	0	0	1	1	1
Portugal	winter	summer	1	0	0	1	1	1
Romania	winter	summer	1	0	0	1	1	1
Serbia	winter	summer	1	0	0	1	1	1
Slovakia	winter	summer	1	0	0	1	1	1
Slovenia	winter	summer	1	0	0	1	1	1
Spain	winter	summer	1	0	0	1	1	1
Switzerland	winter	summer	1	0	0	1	1	1
Number of countries			**30**	**12**	**2**	**21**	**22**	**19**

2. Robustness of results to specific modeling assumptions

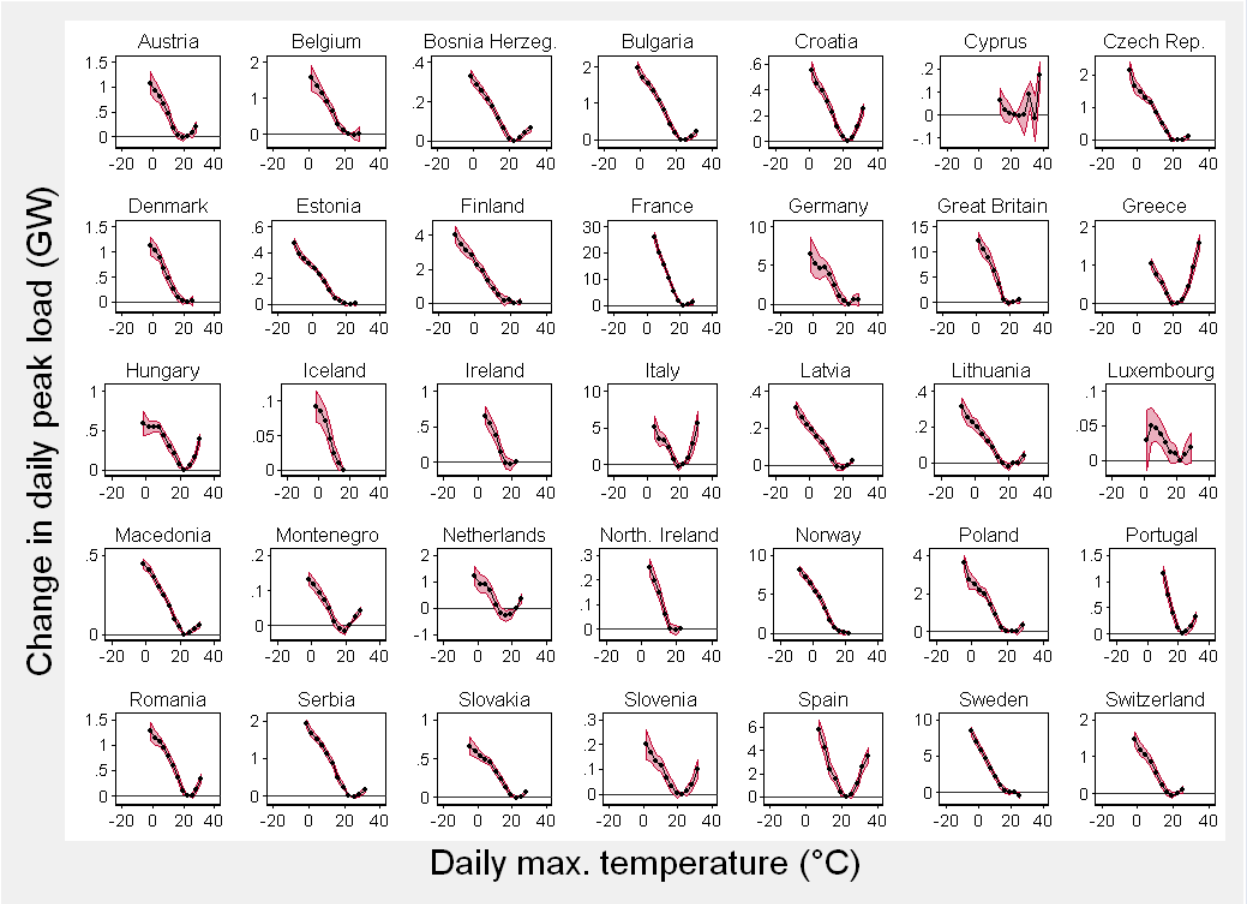

Figure S11: Robustness of results to different specification of first and last bin (3% of all data): Response of daily peak load to daily maximum temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily maximum temperature in the omitted bin category (21°C-24°C) with a day of the relevant maximum temperature. First and last bin are chosen such that each comprises at least 3% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up to degree six). Pink shaded areas denote 95%-confidence band based on Newey-West standard error.

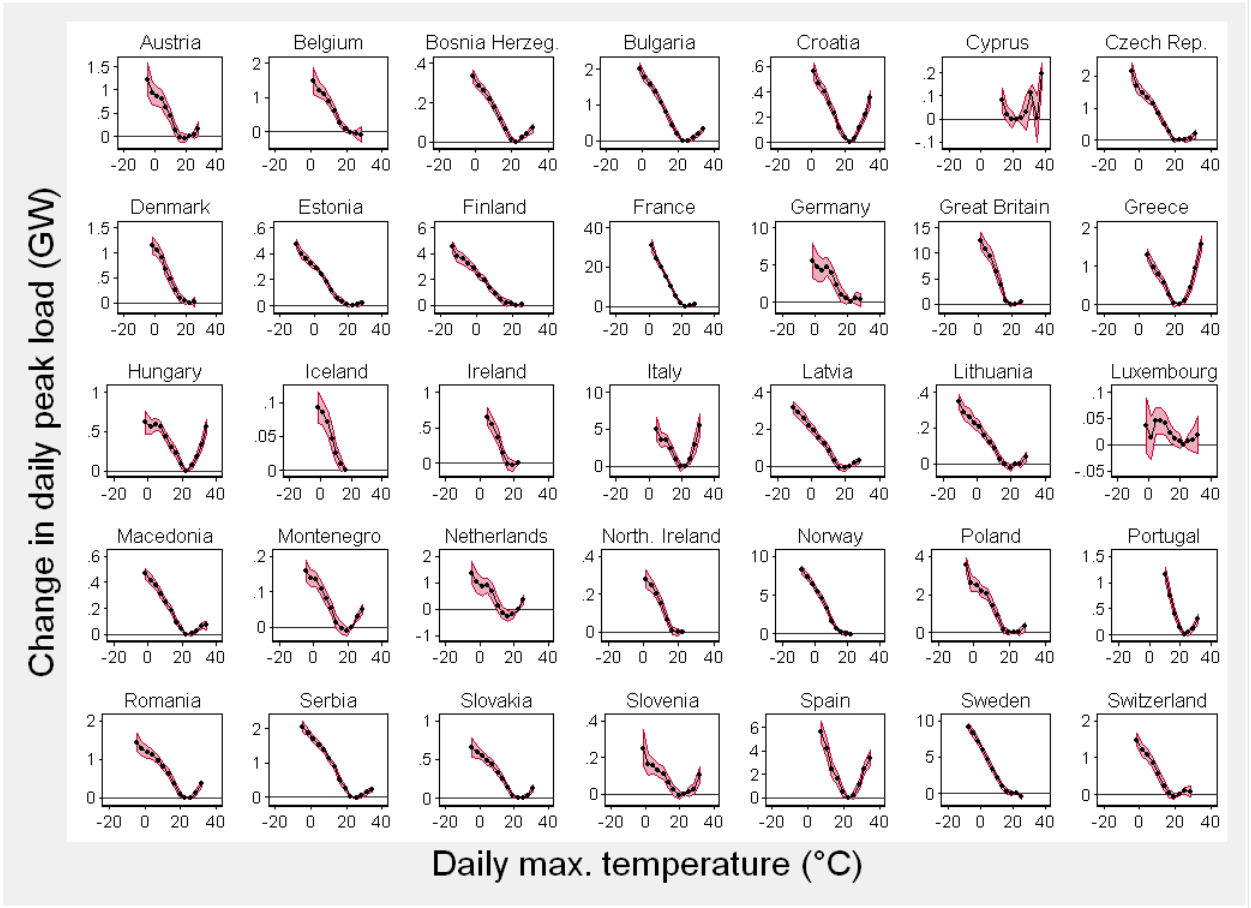

Figure S12: Robustness of results to degree of Chebyshev polynomials (up to third degree): Response of daily peak load to daily maximum temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily maximum temperature in the omitted bin category (21°C-24°C) with a day of the relevant maximum temperature. First and last bin are chosen such that each comprises at least 2% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up to degree three). Pink shaded areas denote 95%-confidence band based on Newey-West standard error.

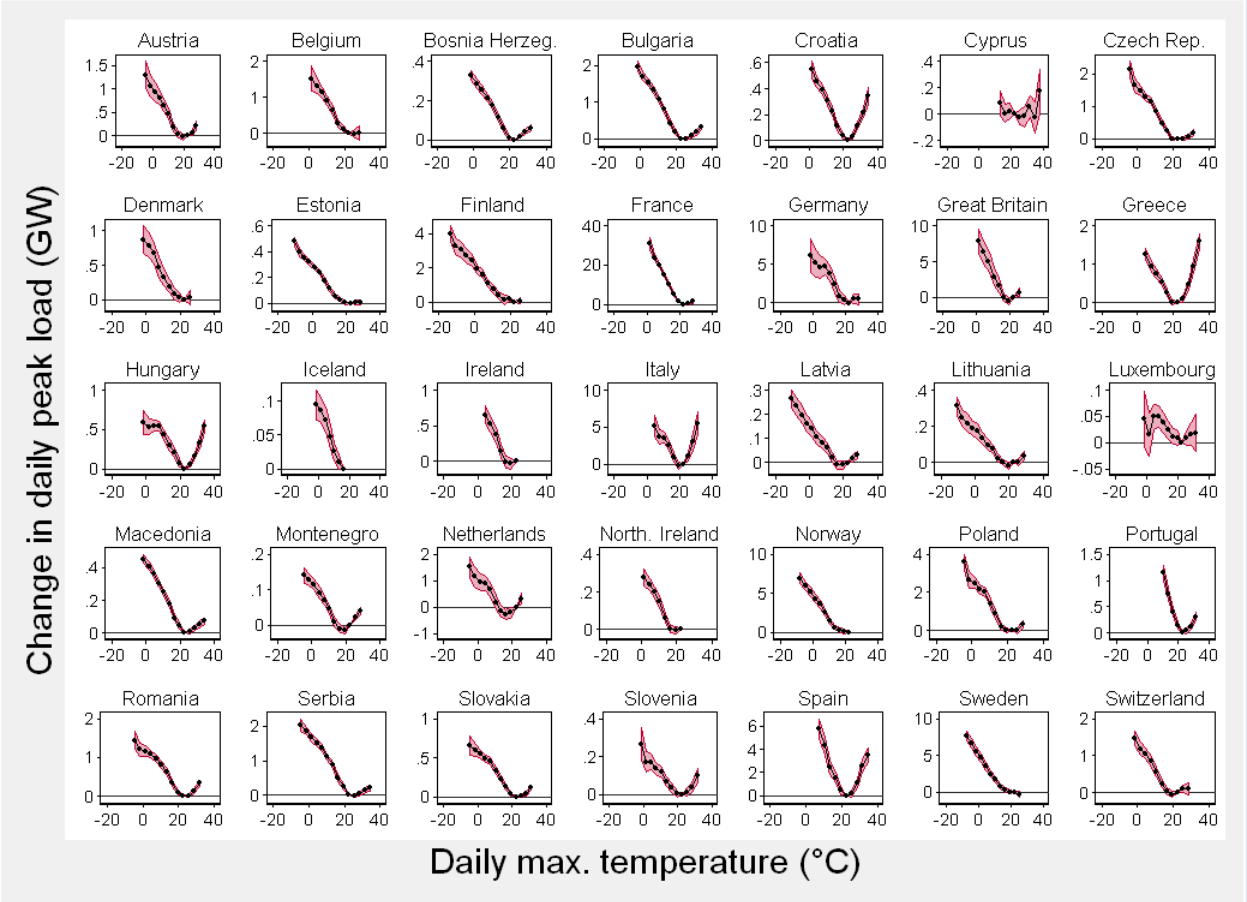

Figure S13: Robustness of results to degree of Chebyshev polynomials (up to tenth degree): Response of daily peak load to daily maximum temperature based on observational data for the years 2006-2012. Black dots represent the effect of replacing a day of daily maximum temperature in the omitted bin category (21°C-24°C) with a day of the relevant maximum temperature. First and last bin are chosen such that each comprises at least 2% of all data. The regression model controls for seasonality, day-of-the-week effects and large-scale economic events (Chebyshev polynomials up to degree ten). Pink shaded areas denote 95%-confidence band based on Newey-West standard error.

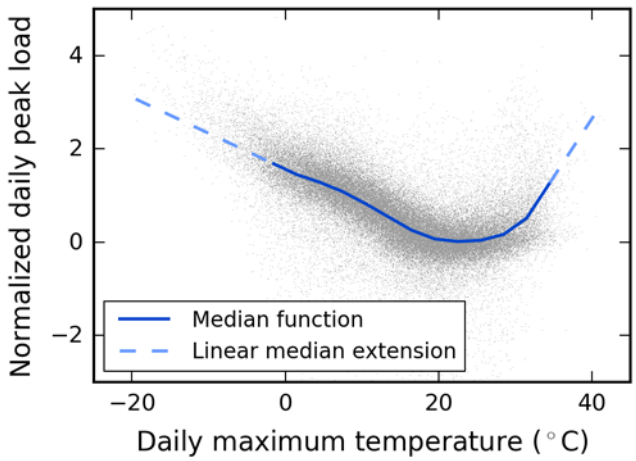

Figure S14: Robustness of result to bin-width (3°C-width): Common response function. Observational daily peak load and daily maximum temperature data (2006-2012) of all countries are combined taking national population size into account (gray dots). Load values have been adjusted based on the country-level regression coefficients to remove the influence of non-temperature confounders and the resulting residual load data have been normalized to allow for comparison across countries ($\hat{L}_{c,d}^{norm}$, see *Methods* for detail). We obtain the response function by linking the medians of 3°C-bins (thick blue line). The first and last bin each comprises at least 20,000 data points; we linearly extend the median function for temperatures beyond these bins (dashed blue lines).

References

1. European Network of Transmission System Operators for Electricity. Consumption Data. Available at: https://www.entsoe.eu/data/data-portal/consumption/Pages/default.aspx [Accessed April, 2015].