Online Appendix

Appendix A. Empirical results of hourly autoregressive model for day-ahead and intraday electricity prices

In the following, we present our autroregressive models estimated for each single hour of the day. The results are reported for the day-ahead (Tables A.1 to A.3), as well as intraday electricity prices (Tables A.4 to A.6).

Dependent variable: hourly day-ahead electricity price $\hat{P}_t^{A}$

	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12
$Wind_{t-1}$	**−0.11**	**−0.14**	**−0.17**	**−0.19**	**−0.19**	**−0.15**	**−0.13**	**−0.11**	**−0.10**	**−0.09**	**−0.09**	**−0.08**
t-value	(−9.50)	(−10.05)	(−9.79)	(−12.03)	(−11.75)	(−9.12)	(−8.16)	(−9.41)	(−9.93)	(−9.95)	(−9.11)	(−8.18)
PV_{t-1}						−0.03	**−0.04**	**−0.05**	**−0.05**	**−0.06**	**−0.07**	**−0.08**
t-value						(−1.81)	(−3.00)	(−4.28)	(−6.25)	(−6.35)	(−6.35)	(−6.33)
$Load_{t-1}$	**0.36**	**0.41**	**0.46**	**0.47**	**0.51**	**0.56**	**0.67**	**0.72**	**0.66**	**0.60**	**0.57**	**0.56**
t-value	(10.23)	(10.55)	(10.61)	(12.90)	(10.65)	(7.53)	(10.84)	(12.39)	(15.41)	(13.97)	(12.93)	(11.79)
ΔEUA_{t-1}	0.01	0.00	0.00	0.00	0.00	0.00	0.00	−0.01	−0.00	−0.00	−0.00	−0.00
t-value	(1.00)	(0.82)	(0.38)	(0.50)	(0.06)	(0.35)	(0.10)	(−0.86)	(−0.73)	(−0.32)	(−0.44)	(−0.39)
P_{t-1}^{A}	**0.43**	**0.44**	**0.44**	**0.44**	**0.40**	**0.36**	**0.25**	**0.21**	**0.26**	**0.28**	**0.29**	**0.30**
t-value	(14.33)	(14.20)	(15.15)	(17.07)	(8.44)	(5.09)	(10.79)	(10.48)	(12.59)	(12.31)	(11.02)	(10.21)
P_{t-2}^{A}	**0.16**	**0.14**	**0.12**	**0.12**	**0.14**	**0.17**	**0.20**	**0.20**	**0.22**	**0.21**	**0.20**	**0.19**
t-value	(7.57)	(5.97)	(5.49)	(5.84)	(5.98)	(8.57)	(7.31)	(8.13)	(10.30)	(10.88)	(10.18)	(9.32)
P_{t-7}^{A}	**0.17**	**0.18**	**0.18**	**0.19**	**0.19**	**0.19**	**0.20**	**0.21**	**0.19**	**0.20**	**0.21**	**0.21**
t-value	(6.21)	(7.74)	(7.97)	(8.81)	(6.80)	(4.64)	(5.19)	(5.57)	(6.35)	(7.17)	(7.97)	(7.69)
Observations	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00
Adjusted R^2	0.97	0.96	0.96	0.95	0.93	0.94	0.95	0.96	0.97	0.98	0.98	0.98
F-statistic	7148.73	6065.85	4808.09	3911.56	3008.38	3321.42	3846.37	4669.10	7367.43	8631.44	9351.06	9342.73

	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24
$Wind_{t-1}$	**−0.08**	**−0.09**	**−0.10**	**−0.10**	**−0.10**	**−0.09**	**−0.08**	**−0.07**	**−0.07**	**−0.07**	**−0.06**	**−0.08**
t-value	(−8.17)	(−8.19)	(−8.63)	(−9.60)	(−10.66)	(−10.99)	(−9.91)	(−8.59)	(−9.58)	(−8.97)	(−8.11)	(−7.55)
PV_{t-1}	**−0.09**	**−0.09**	**−0.09**	**−0.07**	**−0.05**	**−0.04**	**−0.03**	**−0.02**	**−0.02**	−0.01	−0.00	
t-value	(−6.47)	(−6.52)	(−6.21)	(−5.93)	(−5.28)	(−5.42)	(−4.52)	(−4.40)	(−4.27)	(−2.62)	(−0.34)	
$Load_{t-1}$	**0.55**	**0.62**	**0.66**	**0.63**	**0.55**	**0.47**	**0.43**	**0.36**	**0.32**	**0.28**	**0.25**	**0.30**
t-value	(11.41)	(13.29)	(14.00)	(14.97)	(15.10)	(15.02)	(11.61)	(10.82)	(10.74)	(10.21)	(8.65)	(8.85)
ΔEUA_{t-1}	−0.00	−0.00	−0.01	−0.01	−0.00	0.00	0.00	−0.00	0.00	0.00	0.00	0.00
t-value	(−0.18)	(−0.70)	(−1.22)	(−1.42)	(−0.53)	(0.10)	(0.15)	(−0.49)	(0.46)	(1.24)	(0.65)	(0.71)
P_{t-1}^{A}	**0.29**	**0.27**	**0.25**	**0.27**	**0.30**	**0.36**	**0.38**	**0.37**	**0.38**	**0.42**	**0.45**	**0.42**
t-value	(11.04)	(11.77)	(11.23)	(12.14)	(14.53)	(14.61)	(11.17)	(14.72)	(14.39)	(13.30)	(14.80)	(13.86)
P_{t-2}^{A}	**0.19**	**0.19**	**0.18**	**0.19**	**0.20**	**0.21**	**0.21**	**0.24**	**0.22**	**0.19**	**0.19**	**0.23**
t-value	(9.90)	(10.12)	(9.28)	(10.31)	(11.51)	(8.27)	(5.98)	(9.02)	(10.34)	(8.57)	(8.27)	(10.74)
P_{t-7}^{A}	**0.20**	**0.19**	**0.18**	**0.19**	**0.20**	**0.18**	**0.17**	**0.18**	**0.21**	**0.22**	**0.20**	**0.15**
t-value	(7.62)	(7.43)	(7.42)	(7.38)	(7.05)	(5.94)	(4.39)	(6.03)	(6.33)	(7.53)	(6.97)	(5.75)
Observations	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00
Adjusted R^2	0.98	0.98	0.97	0.97	0.98	0.98	0.97	0.98	0.98	0.98	0.99	0.98
F-statistic	9519.36	8797.70	6714.56	7051.32	9038.01	9145.08	7473.92	8935.80	10,923.58	12,262.67	13,339.62	11,148.95

Dummies: weekday, month

Stated: standardized coefficients (because of different units); robust t-statistics in parenthesis

Bold highlighting: coefficients with a p-value of below 0.05

Table A.1: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases II and III (2010–2014) of the EU ETS. Dependent variables are the hourly day-ahead electricity prices.

Dependent variable: hourly day-ahead electricity price $\hat{P}_t^{\mathrm{A}}$ – EU ETS Phase II

	h 1	h 2	h 3	h 4	h 5	h 6	h 7	h 8	h 9	h 10	h 11	h 12
Infeed: $Wind_{t-1}$	**−0.16**	**−0.20**	**−0.23**	**−0.23**	**−0.22**	**−0.16**	**−0.15**	**−0.13**	**−0.11**	**−0.11**	**−0.10**	**−0.10**
t-value	(−15.44)	(−15.43)	(−13.05)	(−13.64)	(−11.65)	(−13.10)	(−7.90)	(−11.07)	(−11.18)	(−10.87)	(−11.35)	(−11.71)
Infeed: PV_{t-1}						**−0.01**	−0.01	−0.01	**−0.02**	**−0.03**	**−0.04**	**−0.05**
t-value						(−2.30)	(−1.61)	(−1.86)	(−2.17)	(−3.11)	(−4.11)	(−4.59)
$Load_{t-1}$	**0.50**	**0.59**	**0.66**	**0.63**	**0.62**	**0.59**	**0.78**	**0.85**	**0.82**	**0.76**	**0.71**	**0.69**
t-value	(8.48)	(8.74)	(8.70)	(9.08)	(8.79)	(10.01)	(11.03)	(13.77)	(16.07)	(15.55)	(15.36)	(13.49)
EUA_{t-1}	0.00	−0.02	−0.06	−0.08	−0.06	−0.03	−0.01	−0.05	−0.04	−0.01	0.01	0.04
t-value	(0.06)	(−0.56)	(−1.28)	(−1.78)	(−1.56)	(−0.99)	(−0.41)	(−1.68)	(−1.54)	(−0.55)	(0.44)	(1.67)
P_{t-1}^{A}	**0.30**	**0.31**	**0.33**	**0.37**	**0.37**	**0.35**	**0.18**	**0.16**	**0.19**	**0.20**	**0.20**	**0.20**
t-value	(8.44)	(9.17)	(10.34)	(11.04)	(8.18)	(12.36)	(7.92)	(7.45)	(7.88)	(6.89)	(6.39)	(6.62)
P_{t-2}^{A}	**0.14**	**0.10**	**0.08**	**0.09**	**0.10**	**0.11**	**0.16**	**0.17**	**0.18**	**0.15**	**0.15**	**0.15**
t-value	(6.03)	(3.92)	(3.11)	(3.41)	(4.02)	(4.30)	(7.26)	(6.18)	(5.09)	(5.95)	(5.71)	(6.12)
P_{t-7}^{A}	**0.16**	**0.16**	**0.16**	**0.18**	**0.19**	**0.21**	**0.17**	**0.15**	**0.11**	**0.11**	**0.11**	**0.11**
t-value	(5.21)	(5.13)	(4.99)	(5.96)	(5.14)	(6.55)	(3.54)	(4.11)	(3.42)	(3.44)	(3.34)	(3.37)
Observations	1089.00	1089.00	1088.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00
Adjusted R^2	0.98	0.97	0.96	0.96	0.96	0.97	0.97	0.98	0.98	0.98	0.99	0.99
F-statistic	6644.97	4624.47	3269.58	2889.14	2993.70	4285.11	3820.31	4661.56	5649.89	7534.46	7765.85	7759.66

	h 13	h 14	h 15	h 16	h 17	h 18	h 19	h 20	h 21	h 22	h 23	h 24
Infeed: $Wind_{t-1}$	**−0.11**	**−0.11**	**−0.12**	**−0.11**	**−0.11**	**−0.10**	**−0.09**	**−0.08**	**−0.08**	**−0.08**	**−0.08**	**−0.12**
t-value	(−12.55)	(−12.76)	(−12.82)	(−12.97)	(−13.41)	(−11.94)	(−10.48)	(−11.28)	(−13.17)	(−12.20)	(−11.17)	(−8.97)
Infeed: PV_{t-1}	**−0.05**	**−0.05**	**−0.04**	**−0.02**	−0.01	**−0.02**	**−0.01**	−0.01	−0.00	0.00	**0.01**	
t-value	(−4.71)	(−4.37)	(−3.48)	(−2.21)	(−1.61)	(−2.42)	(−2.08)	(−1.24)	(−0.29)	(0.55)	(7.17)	
$Load_{t-1}$	**0.66**	**0.72**	**0.71**	**0.67**	**0.62**	**0.54**	**0.49**	**0.43**	**0.36**	**0.31**	**0.28**	**0.40**
t-value	(13.13)	(14.70)	(14.58)	(15.20)	(14.05)	(13.07)	(9.42)	(9.63)	(8.39)	(7.58)	(6.87)	(6.92)
EUA_{t-1}	**0.05**	**0.07**	**0.07**	**0.05**	0.03	−0.01	−0.03	−0.02	−0.01	0.00	0.01	0.02
t-value	(2.31)	(2.77)	(3.21)	(2.56)	(1.75)	(−0.47)	(−1.45)	(−1.37)	(−0.42)	(0.01)	(0.68)	(1.02)
P_{t-1}^{A}	**0.20**	**0.19**	**0.19**	**0.22**	**0.24**	**0.33**	**0.38**	**0.31**	**0.29**	**0.30**	**0.32**	**0.29**
t-value	(6.62)	(7.66)	(8.18)	(8.32)	(8.79)	(8.34)	(7.29)	(9.75)	(9.14)	(8.55)	(9.10)	(8.42)
P_{t-2}^{A}	**0.14**	**0.13**	**0.13**	**0.15**	**0.18**	**0.19**	**0.21**	**0.26**	**0.26**	**0.24**	**0.25**	**0.22**
t-value	(5.94)	(5.67)	(6.25)	(6.61)	(6.48)	(4.83)	(4.28)	(5.87)	(8.20)	(8.34)	(9.31)	(10.49)
P_{t-7}^{A}	**0.11**	**0.10**	**0.11**	**0.12**	**0.13**	**0.12**	**0.11**	**0.14**	**0.19**	**0.22**	**0.19**	**0.14**
t-value	(3.67)	(3.35)	(3.54)	(3.98)	(3.61)	(2.92)	(2.41)	(2.78)	(3.87)	(6.40)	(5.45)	(3.39)
Observations	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00
Adjusted R^2	0.98	0.98	0.98	0.98	0.99	0.98	0.98	0.99	0.99	0.99	0.99	0.99
F-statistic	7670.48	7437.21	7277.67	7564.34	7919.15	6997.51	6006.78	7782.36	10,344.62	12,681.41	13,517.31	8883.99

Dummies: weekday, month

Stated: standardized coefficients (because of different units); robust t-statistics in parenthesis

Bold highlighting: coefficients with a p-value of below 0.05

Table A.2: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases II (2010–2012) of the EU ETS. Dependent variables are the hourly day-ahead electricity prices.

	h 1	h 2	h 3	h 4	h 5	h 6	h 7	h 8	h 9	h 10	h 11	h 12	h 13	h 14	h 15	h 16	h 17	h 18	h 19	h 20	h 21	h 22	h 23	h 24
	Dependent variable: hourly day-ahead electricity price $\hat{P}_t^{\mathrm{A}}$ – EU ETS Phase III																							
Infeed: $Wind_{t-1}$	**−0.07**	**−0.09**	**−0.11**	**−0.16**	**−0.19**	**−0.15**	**−0.09**	**−0.09**	**−0.08**	**−0.07**	**−0.07**	**−0.06**	**−0.05**	**−0.05**	**−0.06**	**−0.08**	**−0.08**	**−0.09**	**−0.07**	**−0.06**	**−0.06**	**−0.06**	**−0.05**	**−0.04**
t-value	(−4.07)	(−5.67)	(−6.60)	(−8.25)	(−7.16)	(−4.48)	(−4.48)	(−4.74)	(−5.42)	(−5.96)	(−5.07)	(−4.11)	(−3.33)	(−3.24)	(−3.36)	(−4.11)	(−5.19)	(−5.89)	(−5.29)	(−3.84)	(−4.86)	(−4.38)	(−3.55)	(−3.22)
Infeed: PV_{t-1}						−0.07	−0.06	**−0.08**	**−0.06**	**−0.08**	**−0.09**	**−0.10**	**−0.10**	**−0.10**	**−0.12**	**−0.11**	**−0.07**	**−0.06**	**−0.06**	**−0.03**	**−0.03**	**−0.02**	−0.01	
t-value						(−1.40)	(−1.95)	(−3.11)	(−5.46)	(−5.24)	(−4.89)	(−4.53)	(−4.24)	(−4.31)	(−3.94)	(−3.99)	(−3.86)	(−4.06)	(−4.46)	(−3.16)	(−3.64)	(−3.03)	(−1.57)	
$Load_{t-1}$	**0.52**	**0.53**	**0.55**	**0.65**	**0.82**	**0.97**	**0.88**	**1.00**	**0.82**	**0.77**	**0.73**	**0.72**	**0.65**	**0.73**	**0.89**	**0.92**	**0.79**	**0.73**	**0.69**	**0.53**	**0.51**	**0.49**	**0.44**	**0.40**
t-value	(7.41)	(7.96)	(7.81)	(7.51)	(4.91)	(3.68)	(5.26)	(6.67)	(11.99)	(10.73)	(9.67)	(8.45)	(7.59)	(9.10)	(8.76)	(9.20)	(9.47)	(9.74)	(9.50)	(6.85)	(7.06)	(6.99)	(6.42)	(7.06)
EUA_{t-1}	**−0.22**	**−0.22**	**−0.22**	**−0.25**	**−0.31**	**−0.37**	**−0.27**	**−0.32**	**−0.23**	**−0.20**	**−0.19**	**−0.19**	**−0.17**	**−0.18**	**−0.24**	**−0.26**	**−0.22**	**−0.22**	**−0.21**	**−0.15**	**−0.15**	**−0.14**	**−0.14**	**−0.13**
t-value	(−3.93)	(−3.78)	(−3.37)	(−3.16)	(−2.74)	(−2.37)	(−2.64)	(−3.45)	(−4.38)	(−4.04)	(−3.91)	(−3.75)	(−3.33)	(−3.75)	(−4.20)	(−4.54)	(−4.13)	(−4.27)	(−4.03)	(−2.79)	(−3.01)	(−2.78)	(−3.03)	(−3.00)
P_{t-1}^{A}	**0.50**	**0.52**	**0.55**	**0.47**	**0.37**	**0.30**	**0.28**	**0.19**	**0.28**	**0.30**	**0.31**	**0.34**	**0.33**	**0.30**	**0.26**	**0.27**	**0.32**	**0.33**	**0.31**	**0.37**	**0.39**	**0.47**	**0.50**	**0.50**
t-value	(10.65)	(10.39)	(12.18)	(11.40)	(4.27)	(2.49)	(4.84)	(4.41)	(9.86)	(11.33)	(9.66)	(9.35)	(9.69)	(10.41)	(7.45)	(7.52)	(11.61)	(11.20)	(9.06)	(10.82)	(10.54)	(9.96)	(12.89)	(16.22)
P_{t-2}^{A}	**0.15**	**0.17**	**0.14**	**0.15**	**0.17**	**0.19**	**0.19**	**0.18**	**0.22**	**0.23**	**0.22**	**0.20**	**0.22**	**0.23**	**0.20**	**0.20**	**0.20**	**0.21**	**0.21**	**0.25**	**0.21**	**0.16**	**0.17**	**0.22**
t-value	(3.85)	(3.88)	(3.58)	(5.16)	(7.65)	(7.58)	(3.84)	(4.06)	(9.20)	(5.72)	(6.41)	(6.40)	(8.47)	(8.49)	(5.86)	(5.45)	(6.77)	(7.76)	(6.13)	(7.68)	(7.13)	(4.73)	(5.14)	(5.95)
P_{t-7}^{A}	**0.14**	**0.14**	**0.14**	**0.17**	**0.16**	**0.12**	**0.18**	**0.21**	**0.21**	**0.20**	**0.23**	**0.22**	**0.22**	**0.20**	**0.18**	**0.17**	**0.19**	**0.19**	**0.20**	**0.18**	**0.18**	**0.16**	**0.14**	**0.12**
t-value	(3.20)	(3.95)	(4.10)	(5.16)	(3.21)	(2.08)	(2.75)	(3.12)	(5.43)	(4.86)	(5.94)	(5.26)	(5.75)	(6.06)	(4.67)	(4.28)	(5.05)	(5.13)	(4.58)	(5.21)	(4.57)	(4.77)	(4.21)	(3.80)
Observations	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00
Adjusted R^2	0.96	0.96	0.96	0.93	0.87	0.88	0.92	0.94	0.97	0.97	0.97	0.97	0.98	0.97	0.95	0.95	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98
F-statistic	1989.54	2177.92	2072.65	1270.84	618.47	606.20	915.83	1148.79	2512.64	2612.68	2945.56	2931.88	3095.03	2739.01	1607.68	1659.21	2588.19	2950.64	2226.31	2528.57	2813.22	2946.91	3545.37	3809.93

Dummies: weekday, month

Stated: standardized coefficients (because of different units); robust t-statistics in parenthesis

Bold highlighting: coefficients with a p-value of below 0.05

Table A.3: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases III (2013–2014) of the EU ETS. Dependent variables are the hourly day-ahead electricity prices.

	Dependent variable: hourly intraday electricity price $\hat{P}_t^{\mathrm{I}}$																							
	h 1	h 2	h 3	h 4	h 5	h 6	h 7	h 8	h 9	h 10	h 11	h 12	h 13	h 14	h 15	h 16	h 17	h 18	h 19	h 20	h 21	h 22	h 23	h 24
Infeed: $Wind_t$	**−0.22**	**−0.26**	**−0.28**	**−0.29**	**−0.27**	**−0.21**	**−0.17**	**−0.17**	**−0.16**	**−0.16**	**−0.15**	**−0.16**	**−0.16**	**−0.18**	**−0.19**	**−0.18**	**−0.16**	**−0.15**	**−0.15**	**−0.14**	**−0.14**	**−0.13**	**−0.13**	**−0.16**
t-value	(−10.69)	(−10.04)	(−10.61)	(−11.74)	(−12.49)	(−12.35)	(−10.82)	(−13.02)	(−12.82)	(−13.01)	(−14.85)	(−15.50)	(−15.42)	(−16.74)	(−15.98)	(−16.51)	(−16.08)	(−14.88)	(−14.11)	(−13.08)	(−15.24)	(−13.99)	(−12.59)	(−11.07)
Infeed: PV_t						**−0.02**	**−0.02**	**−0.04**	**−0.07**	**−0.10**	**−0.13**	**−0.17**	**−0.18**	**−0.20**	**−0.19**	**−0.14**	**−0.10**	**−0.08**	**−0.07**	**−0.04**	**−0.02**	**−0.01**	−0.01	
t-value						(−3.41)	(−3.27)	(−5.24)	(−6.69)	(−8.64)	(−10.06)	(−10.55)	(−10.49)	(−10.74)	(−10.25)	(−9.07)	(−7.76)	(−7.26)	(−7.36)	(−5.16)	(−3.97)	(−2.71)	(−1.76)	
$Load_t$	**0.59**	**0.71**	**0.76**	**0.75**	**0.73**	**0.70**	**0.83**	**0.87**	**0.86**	**0.81**	**0.80**	**0.84**	**0.87**	**0.93**	**0.94**	**0.88**	**0.77**	**0.69**	**0.66**	**0.58**	**0.50**	**0.44**	**0.41**	**0.43**
t-value	(10.04)	(9.65)	(11.27)	(13.13)	(15.00)	(13.86)	(14.16)	(20.38)	(19.92)	(15.99)	(16.96)	(17.44)	(17.54)	(20.04)	(20.41)	(20.84)	(19.14)	(18.15)	(17.98)	(13.47)	(14.73)	(13.80)	(11.69)	(9.55)
ΔEUA_t	0.01	0.01	0.01	0.01	0.01	0.00	0.00	−0.00	−0.00	−0.01	−0.00	−0.00	0.00	0.00	0.00	0.00	−0.00	−0.00	−0.00	−0.01	−0.00	−0.00	0.00	0.00
t-value	(1.39)	(1.53)	(1.06)	(0.97)	(0.69)	(0.58)	(0.14)	(−0.48)	(−0.42)	(−0.99)	(−0.51)	(−0.18)	(0.30)	(0.43)	(0.20)	(−0.07)	(−0.20)	(−0.56)	(−0.40)	(−1.26)	(−0.73)	(−0.47)	(0.09)	(0.66)
P_{t-1}^{I}	**0.23**	**0.30**	**0.32**	**0.31**	**0.30**	**0.32**	**0.21**	**0.17**	**0.19**	**0.23**	**0.23**	**0.23**	**0.24**	**0.23**	**0.23**	**0.23**	**0.25**	**0.28**	**0.29**	**0.27**	**0.29**	**0.31**	**0.31**	**0.30**
t-value	(6.58)	(5.93)	(6.63)	(5.93)	(5.98)	(8.66)	(9.01)	(8.07)	(8.18)	(6.46)	(9.37)	(9.57)	(10.96)	(10.85)	(12.17)	(12.77)	(13.46)	(11.29)	(7.62)	(9.33)	(12.99)	(14.64)	(14.51)	(11.11)
P_{t-2}^{I}	**0.15**	0.05	0.04	0.05	**0.09**	**0.09**	**0.12**	**0.12**	**0.14**	**0.13**	**0.13**	**0.12**	**0.10**	**0.09**	**0.07**	**0.09**	**0.10**	**0.10**	**0.08**	**0.11**	**0.14**	**0.16**	**0.19**	**0.20**
t-value	(6.81)	(0.90)	(0.80)	(1.20)	(2.20)	(2.51)	(4.54)	(6.45)	(6.90)	(4.39)	(7.63)	(6.84)	(4.93)	(4.34)	(3.62)	(4.88)	(5.55)	(5.66)	(4.08)	(5.17)	(6.38)	(7.70)	(8.44)	(6.51)
P_{t-7}^{I}	**0.18**	**0.13**	**0.11**	**0.13**	**0.14**	**0.16**	**0.14**	**0.15**	**0.13**	**0.13**	**0.14**	**0.13**	**0.12**	**0.11**	**0.11**	**0.14**	**0.15**	**0.15**	**0.17**	**0.19**	**0.22**	**0.23**	**0.20**	**0.19**
t-value	(5.02)	(2.31)	(2.54)	(3.03)	(3.78)	(4.21)	(3.33)	(6.04)	(5.43)	(5.00)	(5.31)	(5.22)	(4.86)	(4.80)	(5.26)	(6.57)	(6.70)	(5.60)	(5.44)	(6.61)	(8.71)	(10.27)	(9.10)	(6.66)
Observations	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00	1819.00
Adjusted R^2	0.94	0.90	0.89	0.89	0.91	0.93	0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.95	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.96
F-statistic	3535.63	2026.08	1843.41	1926.39	2310.88	2719.65	3176.37	3959.73	3817.61	3898.20	4887.60	4535.71	4418.77	4379.83	3890.26	4505.73	5212.67	5095.63	4652.69	5206.85	6902.64	7663.69	7448.30	6164.12

Dummies: weekday, month

Stated: standardized coefficients (because of different units); robust t-statistics in parenthesis

Bold highlighting: coefficients with a p-value of below 0.05

Table A.4: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases II and III (2010–2014) of the EU ETS. Dependent variables are the hourly intraday electricity prices.

	Dependent variable: hourly intraday electricity price $\hat{P}_t^{\mathrm{I}}$ – EU ETS Phase II																							
	h 1	h 2	h 3	h 4	h 5	h 6	h 7	h 8	h 9	h 10	h 11	h 12	h 13	h 14	h 15	h 16	h 17	h 18	h 19	h 20	h 21	h 22	h 23	h 24
Infeed: $Wind_t$	**−0.21**	**−0.25**	**−0.27**	**−0.26**	**−0.25**	**−0.19**	**−0.16**	**−0.16**	**−0.14**	**−0.13**	**−0.12**	**−0.12**	**−0.12**	**−0.13**	**−0.14**	**−0.14**	**−0.13**	**−0.13**	**−0.14**	**−0.12**	**−0.12**	**−0.11**	**−0.11**	**−0.14**
t-value	(−6.74)	(−6.22)	(−6.91)	(−7.78)	(−8.60)	(−8.03)	(−7.62)	(−8.94)	(−7.76)	(−7.87)	(−8.93)	(−9.77)	(−9.93)	(−11.28)	(−11.72)	(−11.79)	(−10.73)	(−10.14)	(−8.72)	(−8.17)	(−10.83)	(−9.66)	(−8.77)	(−7.08)
Infeed: PV_t						**−0.01**	−0.01	**−0.02**	**−0.03**	**−0.04**	**−0.06**	**−0.07**	**−0.08**	**−0.08**	**−0.07**	**−0.05**	**−0.04**	**−0.04**	**−0.04**	**−0.02**	−0.01	−0.00	−0.00	
t-value						(−2.20)	(−1.15)	(−2.68)	(−2.56)	(−3.40)	(−4.32)	(−5.37)	(−5.51)	(−5.92)	(−5.12)	(−4.00)	(−3.68)	(−4.39)	(−4.78)	(−3.23)	(−1.36)	(−0.54)	(−0.29)	
$Load_t$	**0.63**	**0.70**	**0.79**	**0.77**	**0.77**	**0.76**	**0.93**	**1.04**	**1.01**	**0.94**	**0.88**	**0.87**	**0.85**	**0.89**	**0.90**	**0.86**	**0.79**	**0.76**	**0.76**	**0.67**	**0.54**	**0.46**	**0.45**	**0.49**
t-value	(9.01)	(9.24)	(9.68)	(10.19)	(10.80)	(11.33)	(13.89)	(18.20)	(16.60)	(14.40)	(14.29)	(14.32)	(13.29)	(15.82)	(15.18)	(16.10)	(15.17)	(13.95)	(12.91)	(9.48)	(11.04)	(9.25)	(8.44)	(8.12)
EUA_t	0.02	−0.04	−0.06	−0.07	−0.06	−0.04	−0.03	−0.07	−0.06	−0.04	0.01	0.02	0.04	0.04	0.04	0.05	0.02	−0.04	**−0.07**	−0.05	0.00	0.02	0.03	0.05
t-value	(0.44)	(−0.84)	(−1.19)	(−1.33)	(−1.39)	(−1.00)	(−1.08)	(−1.85)	(−1.64)	(−1.00)	(0.31)	(0.44)	(1.10)	(1.31)	(1.37)	(1.74)	(0.84)	(−1.38)	(−2.19)	(−1.65)	(0.11)	(0.93)	(1.62)	(1.88)
P_{t-1}^{I}	**0.19**	**0.29**	**0.32**	**0.32**	**0.29**	**0.31**	**0.19**	**0.13**	**0.15**	**0.19**	**0.18**	**0.19**	**0.21**	**0.21**	**0.21**	**0.21**	**0.23**	**0.27**	**0.26**	**0.23**	**0.24**	**0.27**	**0.28**	**0.27**
t-value	(4.90)	(5.36)	(5.97)	(4.67)	(4.63)	(6.40)	(5.65)	(4.44)	(4.27)	(3.01)	(4.19)	(4.28)	(5.80)	(6.17)	(7.29)	(7.66)	(8.33)	(7.21)	(4.55)	(5.13)	(7.13)	(9.51)	(9.95)	(8.25)
P_{t-2}^{I}	**0.11**	0.01	0.00	0.03	0.06	0.06	**0.07**	**0.07**	**0.08**	**0.06**	**0.08**	**0.09**	**0.09**	**0.08**	**0.06**	**0.07**	**0.08**	**0.09**	**0.09**	**0.12**	**0.14**	**0.15**	**0.16**	**0.14**
t-value	(4.16)	(0.19)	(0.07)	(0.48)	(1.35)	(1.38)	(2.41)	(3.03)	(3.45)	(2.09)	(3.61)	(3.88)	(4.00)	(3.54)	(2.40)	(3.11)	(3.54)	(3.71)	(3.28)	(4.33)	(5.26)	(5.04)	(5.46)	(4.01)
P_{t-7}^{I}	**0.16**	**0.18**	**0.13**	**0.14**	**0.15**	**0.13**	**0.09**	0.05	0.05	0.05	0.05	0.04	0.02	0.01	0.02	0.04	**0.07**	**0.08**	**0.11**	**0.13**	**0.16**	**0.18**	**0.14**	**0.13**
t-value	(4.21)	(3.92)	(4.49)	(4.76)	(4.41)	(4.03)	(2.30)	(1.74)	(1.93)	(1.71)	(1.77)	(1.31)	(0.76)	(0.48)	(0.74)	(1.43)	(2.49)	(2.45)	(2.26)	(3.26)	(5.34)	(6.28)	(4.84)	(3.63)
Observations	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00	1089.00
Adjusted R^2	0.94	0.89	0.88	0.89	0.90	0.93	0.94	0.95	0.95	0.95	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.97	0.98	0.98	0.98	0.97
F-statistic	2060.90	1103.92	1004.64	1077.13	1281.39	1563.60	1819.89	2359.96	2346.90	2444.46	3574.11	3714.94	3751.53	3742.55	3325.31	3526.41	3833.20	3358.30	2772.23	3342.09	5061.40	5317.76	5333.20	3940.32

Dummies: weekday, month

Stated: standardized coefficients (because of different units); robust t-statistics in parenthesis

Bold highlighting: coefficients with a p-value of below 0.05

Table A.5: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases II (2010–2012) of the EU ETS. Dependent variables are the hourly intraday electricity prices.

Dependent variable: hourly intraday electricity price $\hat{P}_t^{\mathrm{I}}$ – EU ETS Phase III

	h 1	h 2	h 3	h 4	h 5	h 6	h 7	h 8	h 9	h 10	h 11	h 12
Infeed: $Wind_t$	**−0.29**	**−0.34**	**−0.37**	**−0.38**	**−0.34**	**−0.28**	**−0.19**	**−0.18**	**−0.19**	**−0.20**	**−0.21**	**−0.23**
t-value	(−12.13)	(−11.31)	(−11.37)	(−10.83)	(−10.69)	(−11.91)	(−11.38)	(−14.26)	(−12.89)	(−13.49)	(−14.10)	(−15.03)
Infeed: PV_t						**−0.02**	**−0.02**	**−0.05**	**−0.10**	**−0.16**	**−0.24**	**−0.30**
t-value						(−2.15)	(−3.10)	(−5.44)	(−8.17)	(−9.69)	(−11.04)	(−11.23)
$Load_t$	**1.13**	**1.23**	**1.23**	**1.22**	**1.19**	**1.10**	**1.14**	**1.16**	**1.27**	**1.32**	**1.43**	**1.48**
t-value	(14.34)	(13.66)	(12.91)	(11.05)	(11.21)	(14.15)	(23.00)	(20.42)	(19.74)	(17.56)	(16.60)	(16.41)
EUA_t	**−0.27**	**−0.29**	**−0.30**	**−0.30**	**−0.30**	**−0.30**	**−0.34**	**−0.36**	**−0.42**	**−0.43**	**−0.46**	**−0.43**
t-value	(−4.48)	(−3.98)	(−3.68)	(−3.36)	(−3.53)	(−4.33)	(−6.44)	(−6.25)	(−7.16)	(−6.27)	(−5.96)	(−5.81)
P_{t-1}^{I}	**0.10**	**0.11**	**0.13**	**0.17**	**0.19**	**0.21**	**0.13**	**0.11**	**0.13**	**0.16**	**0.16**	**0.17**
t-value	(2.10)	(2.14)	(2.76)	(4.54)	(5.46)	(6.49)	(4.50)	(4.00)	(5.24)	(5.38)	(5.21)	(4.94)
P_{t-2}^{I}	**0.08**	0.06	**0.09**	**0.09**	**0.10**	**0.09**	**0.15**	**0.13**	**0.17**	**0.14**	**0.09**	**0.06**
t-value	(2.63)	(1.65)	(2.19)	(2.99)	(3.50)	(3.47)	(6.96)	(4.97)	(4.66)	(5.03)	(4.00)	(3.01)
P_{t-7}^{I}	**0.13**	**0.10**	**0.11**	**0.11**	**0.12**	**0.16**	**0.18**	**0.20**	**0.13**	**0.10**	**0.08**	**0.08**
t-value	(4.52)	(3.29)	(3.79)	(4.18)	(4.39)	(5.26)	(5.64)	(6.04)	(3.89)	(2.76)	(2.34)	(2.51)
Observations	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00
Adjusted R^2	0.96	0.95	0.94	0.93	0.94	0.95	0.96	0.97	0.96	0.96	0.96	0.94
F-statistic	2253.77	1625.61	1412.45	1252.57	1498.32	1647.42	2071.85	2277.76	1841.05	1863.55	1711.57	1287.58

	h 13	h 14	h 15	h 16	h 17	h 18	h 19	h 20	h 21	h 22	h 23	h 24
Infeed: $Wind_t$	**−0.25**	**−0.27**	**−0.28**	**−0.25**	**−0.22**	**−0.20**	**−0.19**	**−0.17**	**−0.17**	**−0.18**	**−0.19**	**−0.24**
t-value	(−15.95)	(−16.28)	(−12.55)	(−13.94)	(−16.13)	(−14.60)	(−13.31)	(−12.92)	(−11.00)	(−12.79)	(−12.33)	(−14.40)
Infeed: PV_t	**−0.34**	**−0.37**	**−0.36**	**−0.28**	**−0.20**	**−0.15**	**−0.11**	**−0.06**	**−0.03**	−0.01	0.01	
t-value	(−11.94)	(−11.87)	(−11.32)	(−11.06)	(−9.89)	(−9.12)	(−7.71)	(−4.81)	(−2.66)	(−0.53)	(1.35)	
$Load_t$	**1.57**	**1.66**	**1.65**	**1.54**	**1.38**	**1.21**	**1.07**	**0.93**	**0.90**	**0.88**	**0.89**	**0.97**
t-value	(19.67)	(19.79)	(19.41)	(19.70)	(19.59)	(17.43)	(13.77)	(11.63)	(11.94)	(12.80)	(12.02)	(13.43)
EUA_t	**−0.44**	**−0.44**	**−0.44**	**−0.42**	**−0.39**	**−0.38**	**−0.30**	**−0.25**	**−0.26**	**−0.24**	**−0.26**	**−0.28**
t-value	(−6.16)	(−5.70)	(−5.30)	(−5.86)	(−6.02)	(−6.59)	(−4.91)	(−4.10)	(−4.35)	(−4.57)	(−4.45)	(−5.15)
P_{t-1}^{I}	**0.16**	**0.15**	**0.15**	**0.15**	**0.17**	**0.20**	**0.23**	**0.26**	**0.26**	**0.25**	**0.23**	**0.16**
t-value	(4.65)	(4.79)	(5.76)	(6.33)	(8.22)	(7.43)	(8.02)	(7.71)	(6.88)	(7.45)	(7.04)	(4.29)
P_{t-2}^{I}	0.02	0.00	−0.00	0.01	0.03	0.04	0.01	0.05	**0.08**	**0.09**	**0.10**	**0.14**
t-value	(0.84)	(0.09)	(−0.10)	(0.49)	(1.10)	(1.42)	(0.29)	(1.76)	(3.22)	(3.34)	(3.45)	(4.52)
P_{t-7}^{I}	**0.07**	**0.06**	**0.07**	**0.09**	**0.10**	**0.12**	**0.17**	**0.17**	**0.15**	**0.14**	**0.12**	**0.11**
t-value	(2.46)	(2.01)	(2.52)	(3.35)	(3.23)	(3.94)	(5.08)	(3.77)	(4.10)	(4.59)	(3.88)	(3.91)
Observations	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00	716.00
Adjusted R^2	0.94	0.94	0.93	0.95	0.96	0.96	0.97	0.96	0.97	0.97	0.97	0.97
F-statistic	1208.46	1234.77	1094.20	1485.25	1849.19	2025.28	2197.20	2031.04	2180.91	2677.92	2491.27	2852.08

Dummies: weekday, month

Stated: standardized coefficients (because of different units); robust t-statistics in parenthesis

Bold highlighting: coefficients with a p-value of below 0.05

Table A.6: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases III (2013–2014) of the EU ETS. Dependent variables are the hourly intraday electricity prices.

Appendix B. Robustness check with de-seasonalized global model

As part of our robustness checks, we follow an alternative approach based on a two-step procedure [1]. First, we de-seasonalize the electricity prices, as well as the covariates, and, subsequently, measure the influence of EUA on electricity prices in the different phases of the EU ETS.

Appendix B.1. Step 1: de-seasonalization of electricity prices

Accounting for seasonality is a crucial step when analyzing the the spot price of electricity [2]. Hence, we first de-seasonlize the time series by means of hourly, daily and monthly dummies, as well as a trend t. In addition, we add lags of 24, 48 and 168 hours in order to account for recurring patterns [2]. This yields the specification

$$P_t = \gamma_t t + \xi_1 P_{t-24} + \xi_2 P_{t-48} + \xi_1 P_{t-168} + h_t D_{hour} + w_t D_{weekday} + m_t D_{month} + \tilde{P}_t, \quad \text{(B.1)}$$

with electricity price P_t, residual $\tilde{P}_t$, dummy variables D_{hour}, D_{weekday}, D_{month}, and coefficients γ_t, ξ_1, ξ_2, ξ_3, h_t, w_t and m_t. We then utilize the residual $\tilde{P}_t$ in step 2, as it yields the de-seasonalized electricity prices.

Appendix B.1.1. Step 2: regression on de-seaonalized electricity prices

In a second step, we analyze the impact of the EUA price by running a regression on the de-seasonalized electricity price, i. e.

$$\tilde{P}_t = \beta_1 \mathit{Wind}_t + \beta_2 \mathit{PV}_t + \beta_3 \mathit{Load}_t + \beta_4 \mathit{EUA}_t + \varepsilon_t, \quad \text{(B.2)}$$

with the de-seasonlized spot price $\tilde{P}_t$, coefficients $\beta_1, \ldots, \beta_4$ and an error term ε_t. It is noteworthy that, in the case of phase II of the EU ETS, we apply the difference operator Δ to the EUA price in order to obtain a stationary time series. The reason is that the underlying time series is stationary only after first differences and we thus need to adapt

the above model specification. When estimating the day-ahead market, we utilize the lagged EUA price, since this price is set one day in advance. Table B.7 presents the final regression results.

	Dependent variable: hourly day-ahead electricity price $\hat{P}_t^{A}$				Dependent variable: hourly intraday electricity price $\hat{P}_t^{I}$		
	Phase II	Phase III	Phases II & III		Phase II	Phase III	Phases II & III
	2010–2012	2013–2014	2010–2014		2010–2012	2013–2014	2010–2014
Infeed: $Wind_t$	-0.458^{***}	-0.255^{***}	-0.457^{***}	Infeed: $Wind_t$	-0.408^{***}	-0.534^{***}	-0.457^{***}
	(−24.097)	(−11.477)	(−28.198)		(−17.198)	(−27.874)	(−28.198)
Infeed: PV_t	-0.126^{***}	-0.092^{***}	-0.231^{***}	Infeed: PV_t	-0.174^{***}	-0.317^{***}	-0.232^{***}
	(−10.516)	(−4.617)	(−20.452)		(−11.368)	(−16.460)	(−20.452)
$Load_t$	0.424^{***}	0.376^{***}	0.333^{***}	$Load_t$	0.326^{***}	0.350^{***}	0.333^{***}
	(21.685)	(12.979)	(20.779)		(14.334)	(17.584)	(20.779)
ΔEUA_{t-1}	0.014		−0.006	ΔEUA_t	−0.010		−0.006
	(0.830)		(−0.446)		(−0.623)		(−0.446)
EUA_{t-1}		−0.011		EUA_t		-0.043^{**}	
		(−0.561)				(−2.492)	
Observations	26135	17520	43655		26135	17520	43655
Adjusted R^2	0.408	0.205	0.304		0.301	0.471	0.359

Statistical significance levels: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Standardized coefficients (because of different units); robust t-statistics in parenthesis

Table B.7: Estimated coefficients of autoregressive model measuring the influence of the carbon price on electricity prices during phases II and III of the EU ETS. Dependent variables are the de-seasonalized variables of the hourly day-ahead and intraday electricity prices.

Appendix C. Policy review in the context of our findings

Evidently, not all policy adjustments to the Emissions Trading System implemented between phases II and III have resulted in the outcomes desired by policy-makers. Therefore, previous research discusses potential improvements for the future [e. g. 3, 4]. We now draw upon previous works from carbon-related research and embed our empirical evidence in the bigger picture. That is, we review policy implications from the literature regarding the current, as well as future, phases of the Emissions Trading System in order to achieve the climate goals of the European Union. More specifically, these policies (that are potentially under consideration) are likely to change the direction and magnitude of how emission allowances impact electricity prices with the aim of attaining a positive relationship between both price variables:

- **Reducing supply of emission allowances.** The current price of emission allowances is fairly low, especially when compared to previous phases of the Emissions Trading System. A low EUA price serves as a strong indicator of excess supply and, hence, policy-makers should re-evaluate the available volume of emission allowances. Such a reduction has recently been encouraged by economists; see e. g. [5] and [6]. Further cuts to the available volume are, in fact, indispensable in the quest to reach the stated climate objective by the year 2030. In particular, since the renewable policy might trigger price reductions [7]. In fact, the next development stage of the EU ETS, starting in 2020, is going to include additional measures to decrease emissions by yearly 2.2 %. Due to a strongly negative impact of the EUA price in our analysis, which is highly contrary to theory, it still remains unclear if this reduction yield appropriate results.

- **Evaluating side-effects among different regulatory tools.** Policy-makers should assess the interdependencies between different regulatory mechanisms such as the preferential treatment of renewable energies, the price-setting mechanism, and the Emissions Trading System. Support schemes for renewable energy sources encourage increased

electricity generation from these sources. This simultaneously replaces existing (carbon-intensive) power plants and frees up emission allowances for trading. The newly available allowances are not withdrawn from the market and, as a result, support schemes for renewable energies might not fulfill their original goal of reducing carbon emissions [8, 9, 10]. As a possible remedy, one could incorporate an automatism that reduces the number of EUA for each additional unit of electricity production that is carbon-free, such as those generated by renewables. Thereby, the volume of available emission allowances would shrink in proportion to the increase in the installed capacity of renewable energy sources. Additionally, in this context, a carbon tax system might overcome this drawbacks [11, 12]. However, carbon taxes and emission trading systems might cause different price effects depending on the market structure [13].

- **Introducing a lower bound to the carbon price.** Policy-makers might want to consider a minimum price for every emission allowance. This can help to create additional incentives to reduce greenhouse gases, especially as an ongoing lever during the transition from fossil fuels to renewable energy sources. For instance, to promote renewable energies, Gavard [14] calls for a minimum carbon price of at least 27 €/tCO2 if wind feed-ins are expected to compete with coal and an even higher figure in order to compete with more expensive power sources such as gas. Even with a lower bound, emission allowances can still be traded freely as part of the cap and trade system, leaving the eventual price to market dynamics. An extensive overview can be found in [11], which discussed hybrid cap-and-trade systems and their (dis)advantages.

Our results provide evidence that the current system of emissions trading lagging the original intentions of the policy-makers. Hence, the above review of policy options outlines potential levers that policy-makers can utilize in designing phase IV of the European Union Emissions Trading System. It is clear that such a design must be carefully chosen in order to successfully combine economic growth, penetration of renewable energy sources, and the total volume of emissions.

References

[1] Wooldridge J. Introductory econometrics: A modern approach. 5th. ed.; Mansion, USA: Cengage Learning; 2012.

[2] Weron R. Modeling and forecasting electricity loads and prices: A statistical approach; vol. 403. Chichester, England: John Wiley & Sons; 2007.

[3] Clò S, Cataldi A, Zoppoli P. The merit-order effect in the Italian power market: The impact of solar and wind generation on national wholesale electricity prices. Energy Policy 2015;77:79–88.

[4] Fan Y, Jia JJ, Wang X, Xu JH. What policy adjustments in the EU ETS truly affected the carbon prices? Energy Policy 2017;103:145 –64.

[5] Hintermann B. Pass-through of CO2 emission costs to hourly electricity prices in germany. Journal of the Association of Environmental and Resource Economists 2016;3(4).

[6] Sinn HW. The Green Paradox: A Supply-Side Approach to Global Warming. Cambridge, MA: MIT Press; 2011.

[7] Richstein JC, Émile J.L. Chappin , de Vries LJ. Adjusting the CO2 cap to subsidised RES generation: Can CO2 prices be decoupled from renewable policy? Applied Energy 2015;156:693 – 702.

[8] del Río González P. The interaction between emissions trading and renewable electricity support schemes. an overview of the literature. Mitigation and Adaptation Strategies for Global Change 2007;12(8):1363–90.

[9] Lehmann P, Gawel E. Why should support schemes for renewable electricity complement the EU emissions trading scheme? Energy Policy 2013;52:597 – 607.

[10] Thema J, Suerkemper F, Grave K, Amelung A. The impact of electricity demand reduction policies on the EU-ETS: Modelling electricity and carbon prices and the effect on industrial competitiveness. Energy Policy 2013;60:656 –66.

[11] Goulder LH, Schein AR. Carbon taxes versus cap and trade: A critical review. Climate Change Economics 2013;4(03):1350010.

[12] Taylor DD, Paiva S, Slocum AH. An alternative to carbon taxes to finance renewable energy systems and offset hydrocarbon based greenhouse gas emissions. Sustainable Energy Technologies and Assessments 2017;19:136 –45.

[13] Chiu FP, Kuo HI, Chen CC, Hsu CS. The energy price equivalence of carbon taxes and emissions trading — Theory and evidence. Applied Energy 2015;160:164 –71.

[14] Gavard C. Carbon price and wind power support in denmark. Energy Policy 2016;92:455 –67.