

Appendix to Exploring the System Security Veil: Uncovering Domestic Motivation to Establish Capacity Remuneration Mechanisms (CRMs)

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Table A1: Overview of theoretical expectations

Independent factor	Leading to the introduction of CRMs?	Effect on design
Techno-economic		
Intermittent energy (functional pressure has no implied design, but also a measure of interest group power that implies a targeted design)	Positive: Creates system security challenges through volatility	Not implied (technical), but targeted (when considering socio-technical actor dynamics)
Investment level	Positive when low: Indicates insufficient market signals	Market-wide: Addresses broader investment climate
Electricity intensity	Positive: Increases peak demand and security requirements	Not implied
Interconnection capacity	Negative: Provides alternative to domestic capacity	Not implied
Domestic resources	Negative: Reduces investment uncertainty and import dependence	Not implied
Socio-technical		
Share of gas	Positive: Gas utilities are new market players and might need additional support	Market-wide: According to consultation, market-wide aligns more with the political economy of gas utilities, due to their competitive advantage over coal but relying on additional funds to their high reliance on electricity peaks
Inefficient utilities/Utilities with high pollution (mostly coal generator)	Yes: Inefficient utilities need additional funds to compete against competition and get compensated for higher ETS costs	Ambivalent: A coal producer can profit from being in the reserve by steady payments but can also profit from market-wide approaches. Targeted solutions can potentially better accommodate specific preferences for lock-in
State ownership	Positive: Exacerbates missing money problem	Not implied
Political factors		
Price controls	Yes: Price controls can lead to problems for companies to remunerate their costs and attract investments	Market-wide: The problem is not volatility but rather a lack of investment
Blackout experience	Creates risk aversion and path dependence	Targeted: Targeted solutions are directly procuring capacity instead of relying on market mechanisms to ensure long-term security
Green growth orientation	Ambivalent: CRMs can impede the growth of renewables and increase fossil fuel subsidization - however it might be perceived as necessary	Targeted: Minimizes competition by conventional generators
State intervention stance	Positive: Aligns with interventionist approach	Market-wide: Enables deeper market restructuring

Source: Own illustration.

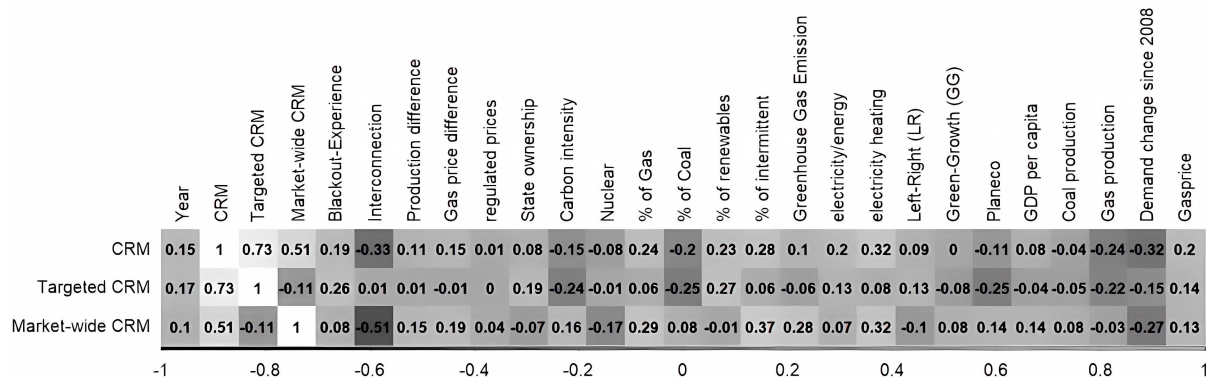
Table A2: Overview of operationalization

A. Dependent Variables	Measurement	Data sources	Notes
Existence of capacity mechanism	Binary indicator (1=adopted, 0=not adopted)	Own collection based on (ACER 2014; <i>European Commission</i> 2016; ACER/CEER 2019, 2022; <i>Hancher</i> 2022; <i>Roques/Verhaeghe</i> 2022; <i>Schittekatte/Meeus</i> 2022)	Counts from adoption not implementation. No data from Malta and Cyprus
Targeted capacity mechanism	Binary indicator for targeted design	Same as above	Categorization based on ACER/CEER (2019, 2022)
Market-wide capacity mechanism	Binary indicator for market-wide design	Same as above	Categorization based on ACER/CEER (2019, 2022)
B. Technical system	Measurement	Data sources	Notes
Carbon intensity	CO ₂ emissions per kWh from electricity production	Ritchie et al. (2023)	Proxy for fleet efficiency
Gas production	Per capita production	(BP, n.d.; Ritchie et al., 2023)	Imputed missing values using Amelia II
Coal production	Tonnes produced nationally	(BP, n.d.; Ritchie et al., 2023)	Imputed post-2018 values
C. Socio-technical system	Measurement	Data sources	Notes
Share of intermittent energy	Wind and solar percentage of total generation	Ritchie et al. (2023)	-
Share of gas	Percentage of gas in electricity production	Ritchie et al. (2023)	-
Share of coal	Percentage of coal in electricity production	Ritchie et al. (2023)	-
Change in demand	Δ electricity demand (demand in given year - demand in 2008)	Eurostat (nrg_cb_e)	Measures financial crisis impact in 2008 on investment
Gas price	Gas price on the whole-sale market	Eurostat (nrg_pc_202)	Measures investment incentives
Interconnection level	Export and Import/Production	Eurostat (nrg_cb_e)	-
Share of heating by electricity	Percentage of household heating from electricity	Eurostat (nrg_bal_c)	-
D. Political and regulatory factors	Measurement	Data sources	Notes
Regulated prices	Percentage of households under price regulation	Own collection based on (ACER, 2014; ACER/CEER, 2012, 2015, 2016, 2019, 2020; CEER, 2018b, 2018a, 2018a, 2019; CMS, 2015b, 2015a; ERGEG, 2007, 2010; European Commission, 2014a, 2014b; European Commission. Directorate General for Energy. et al., 2021)	2009, imputed from 2008/2010 average, same for 2013.
Blackout experience	Binary (1 = severe blackout experience)	Fotis et al. (2023)	-
Green growth orientation	Cabinet-weighted environmental policy index	PIP dataset (Jahn et al., 2022)	Data until 2018, excl. Malta
State intervention attitude	Cabinet-weighted intervention index	PIP dataset (Jahn et al., 2022)	Excl. Malta
State ownership	Ordinal (1=full state ownership, 0.5=partial, 0=none)	Own collection from European Commission reports, utility documents	-

Source: Own illustration.

Correlation analysis

Figure A1: Spearman correlation between the design of CRMs and main variables



Source: Own illustration.

The Spearman correlation in *Figure A1* shows considerable differences in the direction and magnitude of the factors between the CRMs in general and the different designs. The results must be interpreted cautiously because they do not consider that this data is clustered by years and countries (TSCS data). Nonetheless, the analysis is helpful because it can give a broader overview than the regression, which is limited to a small number of predictors because of the small number of cases and multicollinearity problems.

Countries that decided not to introduce CRMs, seem to have enabling alternatives at their hand, the interconnection and gas production level are decisive to reduce the need for CRMs. In contrast, countries with high levels of gas and renewables in their energy mix have introduced more CRMs. Countries with high peak demands because of high electrification also opt for more capacity through market-wide mechanisms. Interestingly, countries with high share of gas decide to introduce market-wide CRMs, and it is inverted for renewables, as hypothesized. Governments willing to intervene in the market negatively correlate with the more nuanced targeted model that keeps the market less distorted. The different choices of CRM design and the potential origin of the non-harmonization of the designs are mostly driven by the carbon intensity, greenhouse gas emissions, attitude towards the planned economy, and the level of coal variable in the mix, which seem to explain the missing harmonization results.

Robustness test

Table A3: Logistic regression with random intercepts

Variables	Reduced CRM Model with random intercept	Reduced Targeted CRM Model with random intercept	Reduced Market-Wide CRM Model with random intercept
(Intercept)	-4.32* (1.74)	-20.21** (7.06)	-20.20*** (4.25)
% of intermittent	3.51** (1.20)	8.38** (3.11)	5.33*** (1.31)
Demand change since 2008	-0.84 (0.71)	0.20 (1.92)	0.02 (0.43)
Gas production	-1.61 (1.01)	-4.30* (1.98)	-0.94 (1.15)
Electricity heating	3.29 (1.69)	-0.71 (5.46)	3.07*** (0.74)
% of gas	3.76** (1.27)	10.35** (3.32)	1.07 (0.75)
Planeco	-1.10 (0.61)	-4.86* (2.15)	0.27 (0.53)
Carbon intensity	-2.79* (1.41)	-18.05** (6.60)	1.82** (0.57)
State ownership	3.57 (2.06)		3.57*** (0.94)
Interconnection	-4.02** (1.38)	-6.77* (2.83)	-51.40*** (11.92)
sd__(Intercept)	3.86 (NA)	24.63 (NA)	0.00 (NA)
nobs	337	337	337
nobs.1	337.00	337.00	337.00
sigma	1.00	1.00	1.00
logLik	-95.39	-65.14	-52.93
AIC	212.77	150.29	127.86
BIC	254.79	188.49	169.89
deviance	127.33	48.77	105.86
df.residual	326.00	327.00	326.00

Source: Own illustration.

The random effect shown in *Table A3* entails only a selected set of variables to allow for convergence of the models due to the limited number of countries in the analysis. Several effects remain remarkably stable across model specifications, validating their role as key predictors. The strong negative impact of interconnection is even more pronounced in the random intercept models, especially for market-wide CRMs. Similarly, the share of intermittent energy and carbon intensity maintain their significance and even show more substantial effects in the new specifications. The share of gas and electric heating likewise retains their positive influence across models, supporting their role as robust predictors of CRM adoption. Some key variables lose their significance completely: The previously strong relationship between state ownership and CRMs vanishes completely in the new specifications, indicating that this effect might be driven by country-specific factors rather than a general effect of ownership structure. Similarly, the political factors seem less important than previously estimated, as the political willingness to intervene in the market is no longer a predictor of targeted solutions, and green-growth party orientation loses its explanatory power.

Demand change as a functional predictor loses significance and shows inconsistent directions across models, questioning its role in predicting CRM adoption. In contrast, gas production gains significance in the targeted model with a negative effect, while it previously showed no clear relationship.

Extended table Hypothesis

Table A4

Hypothesis	OLS Robust (General)	OLS Robust (Targeted)	OLS Robust (Market-wide)	Random Intercept (General)	Random Intercept (Targeted)	Random Intercept (Market-wide)	Assessment
H1: Higher share of intermittent energy increases CRM adoption	Moderate (Low)	Negative (None)	Moderate (High)	Strong (Medium)	Very Strong (Medium)	Strong (High)	Strongly supported for general and market-wide adoption; inconsistent for targeted
H2: Low investment levels increase CRM adoption	Weak (None)	Positive (None)	Moderate (Medium)	Negative (None)	Weak (None)	Weak (None)	Not supported: inconsistent direction, mostly non-significant
H3: Higher electricity intensity increases CRM adoption	Strong (High)	Moderate (Medium)	Very Strong (High)	Strong (None)	Negative (None)	Strong (High)	Strongly supported for market-wide; moderately supported for general/targeted
H4: Higher interconnection reduces CRM adoption	Very Strong (High)	Strong (High)	(not in final model)	Strong (Medium)	Strong (Low)	Very Strong (High)	Very strongly supported across all models
H5: Domestic gas resources reduce CRM adoption	Negative (None)	Weak (None)	Negative (None)	Moderate (None)	Strong (Low)	Negative (None)	Weakly supported: consistent negative direction, significant only for targeted random intercept
H6: Higher gas share leads to targeted CRMs	Strong (High)	Moderate (Low)	Strong (High)	Strong (Medium)	Very Strong (Medium)	Moderate (None)	Contradicted: strongest effect for targeted random intercept, not market-wide as hypothesized
H7: Inefficient generation fleet increases CRM adoption	Moderate (Low)	Strong (High)	Strong (Medium)	Strong (Low)	Very Strong (Medium)	Moderate (Medium)	Mixed: negative for general/targeted (contradicting hypothesis), positive for market-wide (supporting hypothesis)
H8: State-ownership increases CRM adoption	Strong (Medium)	Weak (None)	Strong (High)	Strong (None)	(not in final model)	Strong (High)	Supported for general and especially market-wide adoption, however varying significance
H9: Price controls increase market-wide CRM adoption	Moderate (Low)	Moderate (Medium)	Moderate (Low)	(not in final model)	(not in final model)	(not in final model)	Mixed: negative for general/targeted, positive for market-wide as hypothesized
H10: Blackout experience increases CRM adoption	Moderate (None)	Strong (High)	Negative (None)	(not in final model)	(not in final model)	(not in final model)	Partially supported: strong positive effect specifically for targeted CRMs
H11: Green growth orientation favors targeted design	Weak (None)	Negative (None)	Moderate (Low)	(not in final model)	(not in final model)	(not in final model)	Weakly supported: minor positive effect for market-wide adoption
H12: State intervention stance (Planeco) influences design choice	Negative (None)	Moderate (High)	Moderate (Medium)	Moderate (None)	Strong (Low)	Weak (None)	Supported: interventionist stance negative for targeted, positive for market-wide adoption

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