Assessment of renewable electricity generation in low and high income countries

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Introduction

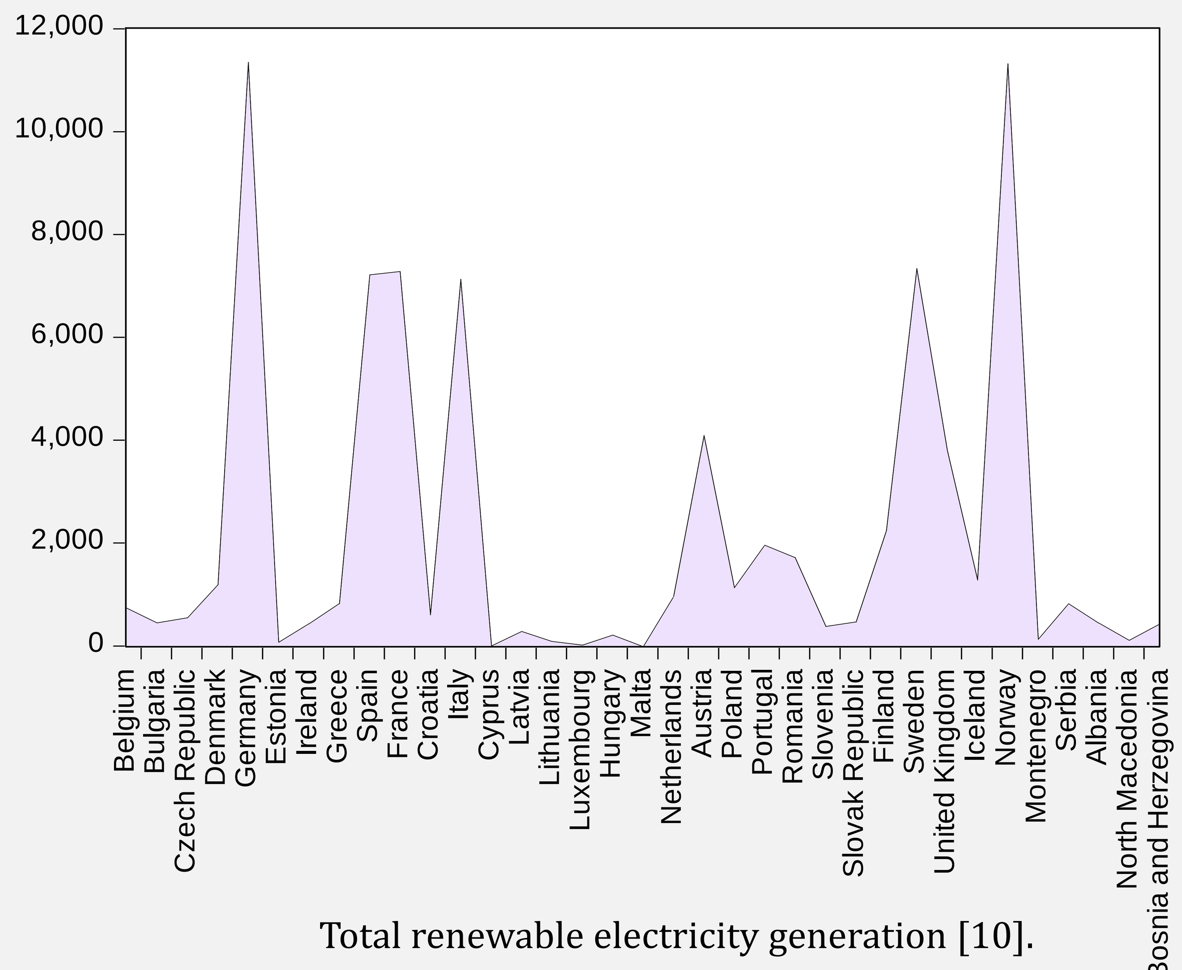
EU's regulation regarding energy and climate plan to 2030 is committed to reduce 40% of the greenhouse gas emissions, reach the share of 32% of renewables and increase energy efficiency for 32.5% [3]. However, the long-term strategy until 2050 predicts net-zero greenhouse gas emissions in the EU [4]. Therefore, **Germany's energy target** as a part of the EU long-term energy strategy is to reach 100% renewable electricity supply by 2050 [5]. Hence, the realization of this target is coordinated by adapting national energy plan and corresponding regulations. On the other side, **Finland's energy and climate plan** predicts 2035 as the target year for becoming carbon neutral society [6]. While **Denmark's government** has set ambiguous target of increasing the share of renewables in the total energy consumption for 55% until 2030 [7].

The **main goal** of this survey was to explain the nature of the short-run and long-run cointegration among REE and observed variables by means of electrical energy indicators and renewable energy data. The most fitting methodology for fulfilling this research objective was **Autoregressive Distributed Lag (ARDL) model**.

The expected **scientific contribution** of the study is to reveal the nature of the REE trend and acknowledge the most prominent variables that shape this trend. The research outcome could be valuable for considering the implementation effectiveness of European national energy plans.

Research data and methodology

Developing bound's testing for REE generation required employing several data sources. For constructing a coherent database, five different variables dating from **2004** to **2018** were gathered. The survey considered **35 European countries** that were divided according to their incomes into high-income and low-income countries.



Total renewable electricity generation [10].

Descriptive statistics

	TOTAL_REG	TOTAL_EG	EC	GROSS_REC	GDP
Mean	2215.509	8591.270	7.758705	2174.830	30329.27
Median	746.4679	3258.814	5.426667	718.1242	22799.28
Maximum	11359.04	51766.02	47.28667	11272.23	103941.2
Minimum	4.326465	197.2754	1.926667	4.326465	3984.193
Std. Dev.	3204.473	12650.79	8.170356	3154.527	23495.00
Skewness	1.728322	2.128092	3.623872	1.746325	1.147097
Kurtosis	4.814117	6.731775	17.16438	4.899211	4.223669
Observations	35	35	35	35	35

Heteroskedasticity test

A Breusch-Pagan-Godfrey test for discovering heteroscedasticity.

F-statistic	1.994818	Prob. F(11,19)	0.0898
Obs*R-squared	16.61415	Prob. Chi-Square(11)	**0.1198**
Scaled explained SS	12.59792	Prob. Chi-Square(11)	0.3204

Results and discussion

In order to define the short run effect of the regressor variables on the renewable electricity generation, **ARDL model** was employed. The selection of the optimal number of lags for each dependent and regressor variable was automatically determined and the number of lags equal to four. Method for model selection was **Hannan-Quinn criterion** and the total number of models that have been evaluated is 2500.

Short-run cointegration outcome

ARDL MODEL SUMMARY.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOTAL_REG(-1)	0.010977	0.004825	2.275022	0.0347
TOTAL_EG	-0.002200	0.001334	-1.648873	0.1156
TOTAL_EG(-1)	**-0.002196**	0.001067	-2.057623	0.0536
TOTAL_EG(-2)	0.000649	0.000466	1.391485	0.1802
TOTAL_EG(-3)	-0.000505	0.000461	-1.095974	0.2868
TOTAL_EG(-4)	**-0.001002**	0.000454	-2.205404	0.0399
EC	-1.183314	0.910782	-1.299228	0.2094
EC(-1)	**-7.056834**	1.779222	-3.966246	0.0008
GROSS_REC	**1.028221**	0.005776	178.0101	0.0000
GDP	0.000400	0.000327	1.223262	0.2362
GDP(-1)	**0.000986**	0.000350	2.815608	0.0110
C	20.96063	14.44593	1.450972	0.1631
R-squared	**0.999949**	Mean dependent var		2405.442
Adjusted R-squared	0.999919	S.D. dependent var		3361.683
S.E. of regression	30.25787	Akaike info criterion		9.942035
Sum squared resid	17395.23	Schwarz criterion		10.49713
Log likelihood	-142.1015	Hannan-Quinn criter.		**10.12298**
F-statistic	33662.25	Durbin-Watson stat		1.477565
Prob(F-statistic)	**0.000000**			

Long-run cointegration outcome

SUMMARIZED RESULTS OF THE BOUNDS TEST.

Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	43796.53	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

The outcome of the performed bounds testing presented is indicating that the F-statistics value is higher than the lower I(0) and upper I(1) bounds critical values at significance at 5% and is **confirming the long-run cointegrating** relationship among investigated variables.

SUMMARIZED RESULTS OF THE COINTEGRATION TEST.

Variable	Coef.	t-Stat.	Prob.
TOTAL_EG	-0.0053	-2.1288	0.0466
EC	-8.3316	-4.1391	0.0006
GROSS_REC	1.0396	104.0937	0.0000
GDP	0.0014	2.7030	0.0141
C	21.193	1.4486	0.1637

All examined regressor variables are statistically significant ($p<0.05$) meaning that **each particular regressor variable achieved the long-run relationship with the dependent variable**.

Conclusion

- ❑ Production of electrical energy obtained from renewable sources in Europe grows day by day.
- ❑ The governments of countries with low renewable electricity generation should **provide appropriate financial boost** to motivate producers to make clean electrical energy and on the other side should **intervene in high-energy consuming industries** to start using renewables.
- ❑ In order to increase the use of renewable energy sources it is necessary to work on improving energy policy and provide monetary incentives in industry and households.
- ❑ **Initiating energy projects** with the aim of increasing the production and consumption of electricity from renewable sources provides possibility to influence the structure of electricity consumption. This would increase awareness of the importance to use clean electricity in both private and public sectors.

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