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Energy Systems Integration Partnership Programme

Integrating European Electricity Markets – what impact for consumers and producers?

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Content

- Introduction: electricity market design and renewables
- Literature: main issues
- Ireland case study
- Estimation
- Results
- Conclusions and insights

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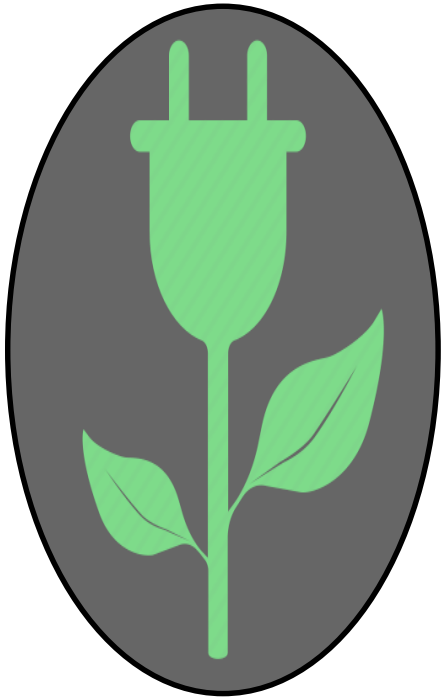
Electricity market design

- Increasing share of variable renewables due to EU and MS policy but the electricity market has been designed for fossil fuels
- Missing money problem
- Requirement for ancillary services and flexibility to facilitate high VRE
- Liberalisation of electricity markets
- Market integration:
  - To enhance economic efficiency
  - Reduce market concentration
  - Strengthen security of supply
  - Reduce reserve capacity

Electricity market design

Market design must satisfy the energy societal trilemma

Competitiveness



Sustainability

Security of supply

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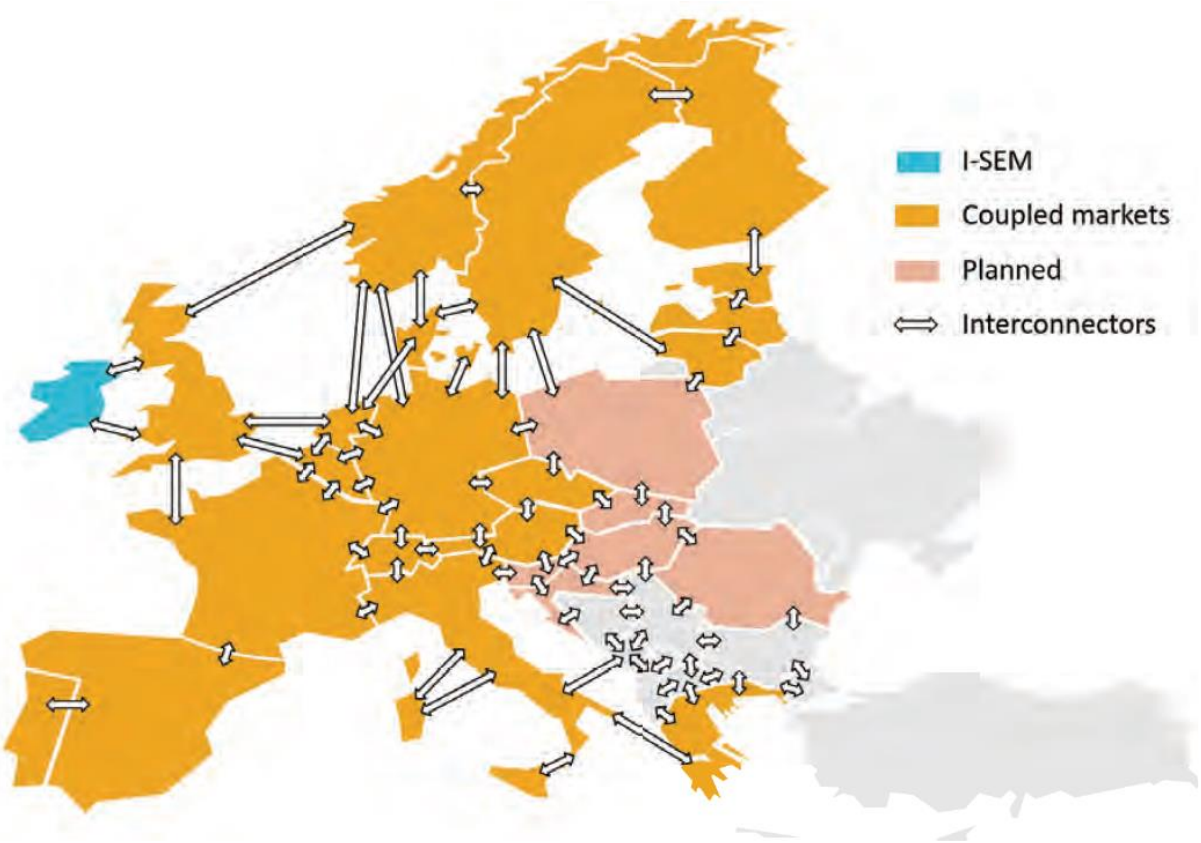
Market coupling across the EU



Inteconnection across the EU

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Literature on market integration

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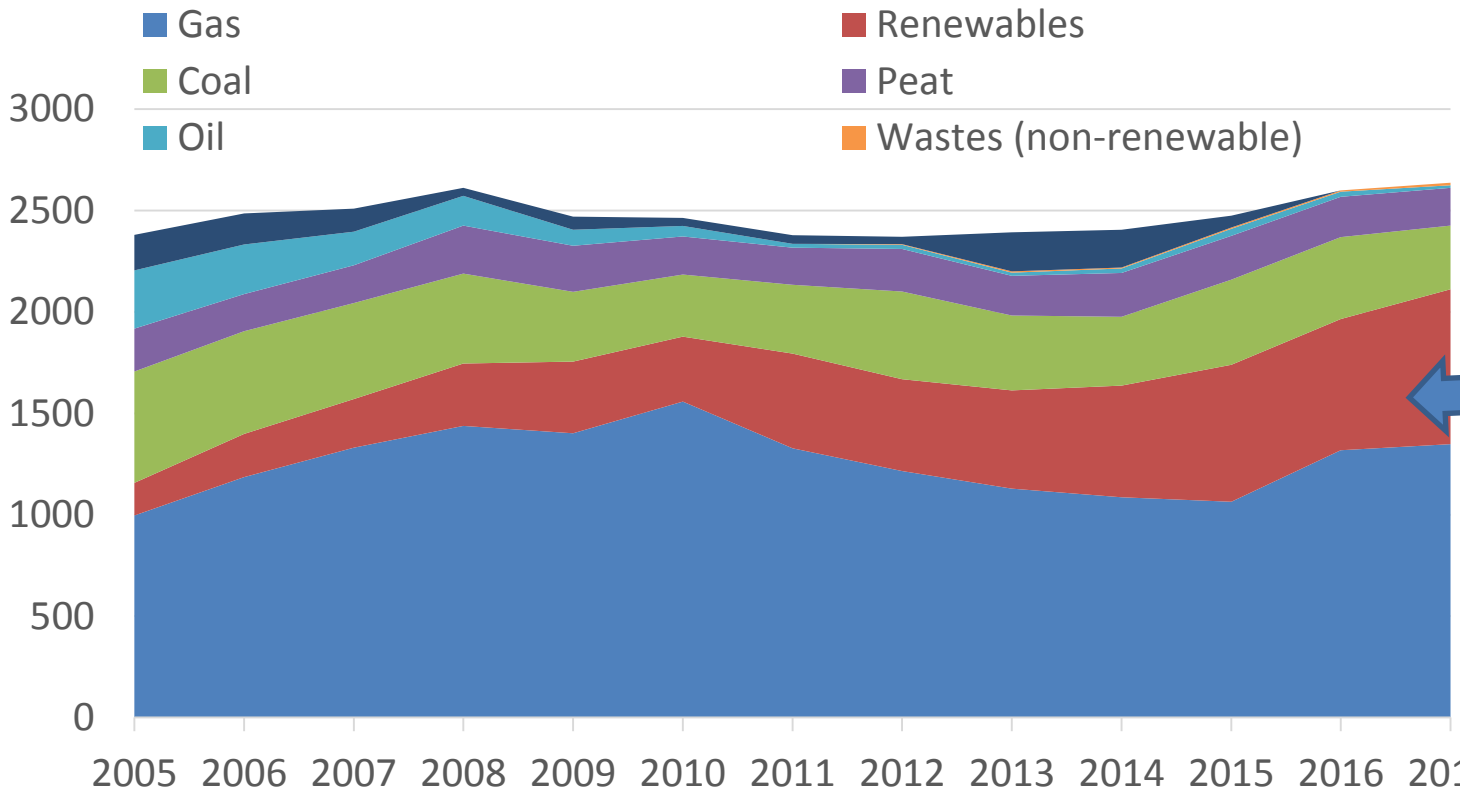
Case study: Ireland

- Move from Single Electricity Market to Integrated Single Electricity Market in 2018 in compliance with EU Internal Energy Markets
- Third energy package (2009) and Ireland
  - Towards a fully liberalised internal market for electricity - the formation of a number of regional markets across Europe, including the integration of the UK, Irish and French electricity markets.
  - Introduction of a 'target model' for the design of electricity markets across Europe.
  - Creates an integrated EU energy market with efficient wholesale prices for electricity.
  - To improve efficiencies by moving to an auction based capacity market.
  - To deliver a secure sustainable electricity system and meet renewables obligations of 40% by 2020.
- Derogation from one aspect of the legislation (Capacity Allocation and Congestion Management) until 2016, to allow for the SEM to be redesigned to meet the requirements of the Internal Energy Market
- Better operation of interconnectors should facilitate increased shares of renewable electricity.
- Increased coupling of markets => prices should drop and trading increase

Irish power system

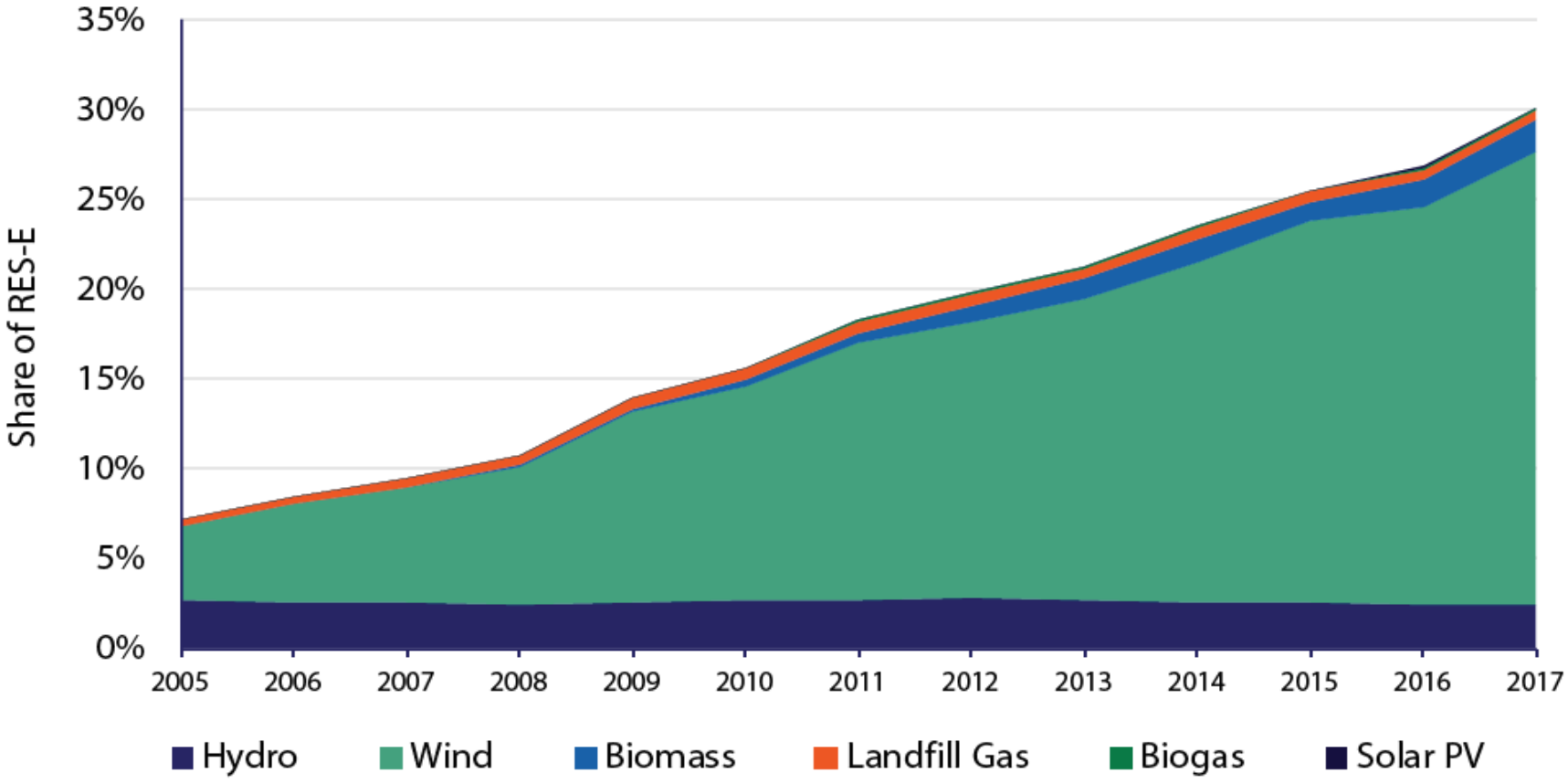
- Wind capacity 3700MW end 2017 (4976 all-Island)
- Total electricity demand: 25.9TWh



29.6% electricity generation from renewables

Source: SEAI 2018

Renewable energy contribution to Gross Electricity Consumption (RES-E normalised)



Source: SEAI 2018

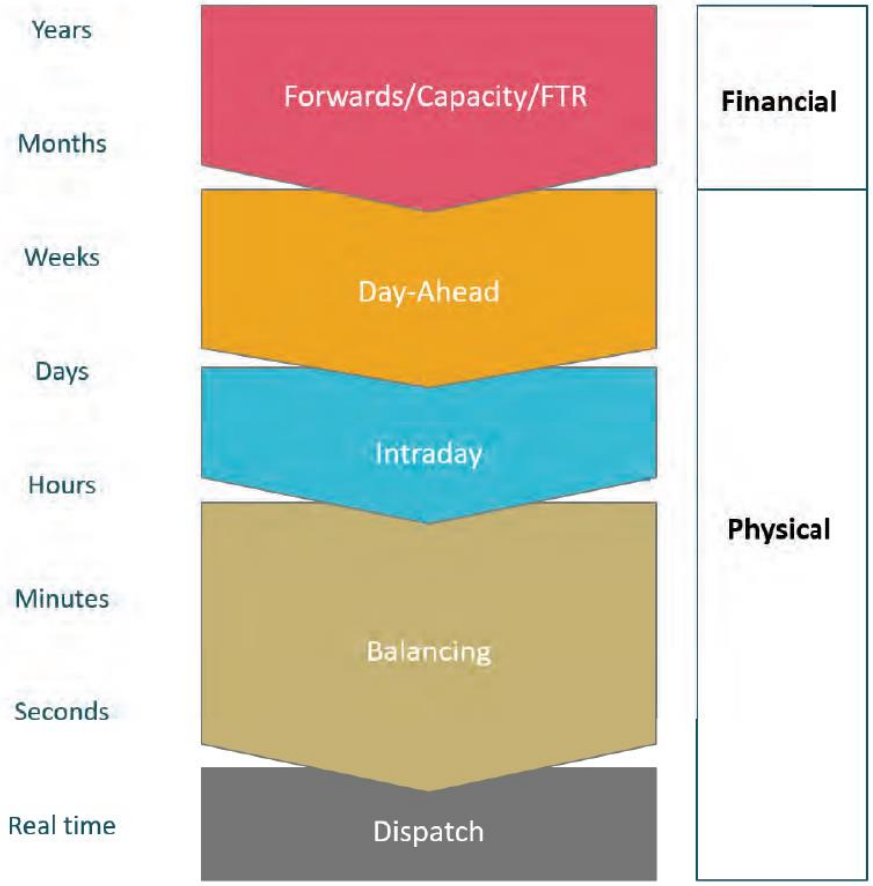
Irish Single Electricity Market (SEM)

1/11/2007-1/10/2018

- All-Island market: wholesale electricity markets from two separate jurisdictions, Northern Ireland and the Republic of Ireland.
- Three main components: the energy market (3-4 times other payments), capacity and constraint payments.
- Energy market:
  - Mandatory, centralised wholesale pool, through which generators and suppliers traded electricity.
  - Generators bid into the pool their short-run costs for each half hour trading period of the following day. The final SMP settled 4 days after the trading day
  - Capacity payments awarded to all based on availability
- Interconnectors reserved to flow power in line bilateral trades

Integrated Single electricity market Since 1/10/2018….

- New markets added:
  - Forward
  - Day-ahead
  - Intraday
  - Balancing
- Should facilitate increased trading



Data

	mean	sd	minimum	maximum	Number of obs
Irish price	57.98	24.34	-96.67	365.04	13848
Wind generation	1026.677	744.66	0	3019.50	13847

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Irish price	1.000						
(2) UK price	0.66	1.00					
(3) Peak period	0.33	0.39	1.00				
(4) ISEM	0.20	0.22	0.00	1.00			
(5) wind generation	-0.19	-0.20	0.01	0.24	1.00		
(6) System demand	0.33	0.37	0.35	0.16	0.21	1.00	
(7) imports	0.42	0.43	0.24	0.15	-0.37	0.46	1.00

interconnector flow. EN

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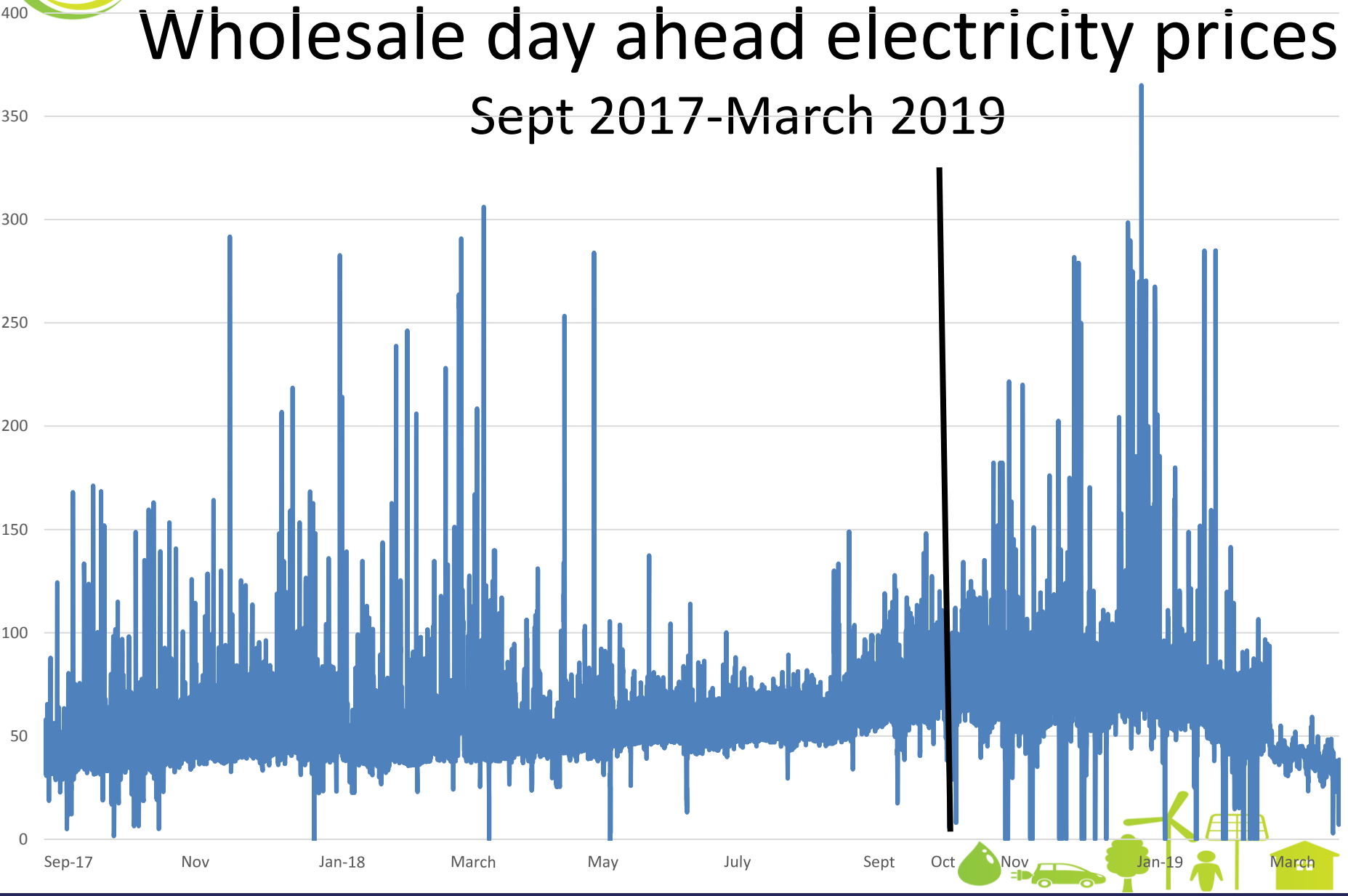
Wholesale day ahead electricity prices

Sept 2017-March 2019



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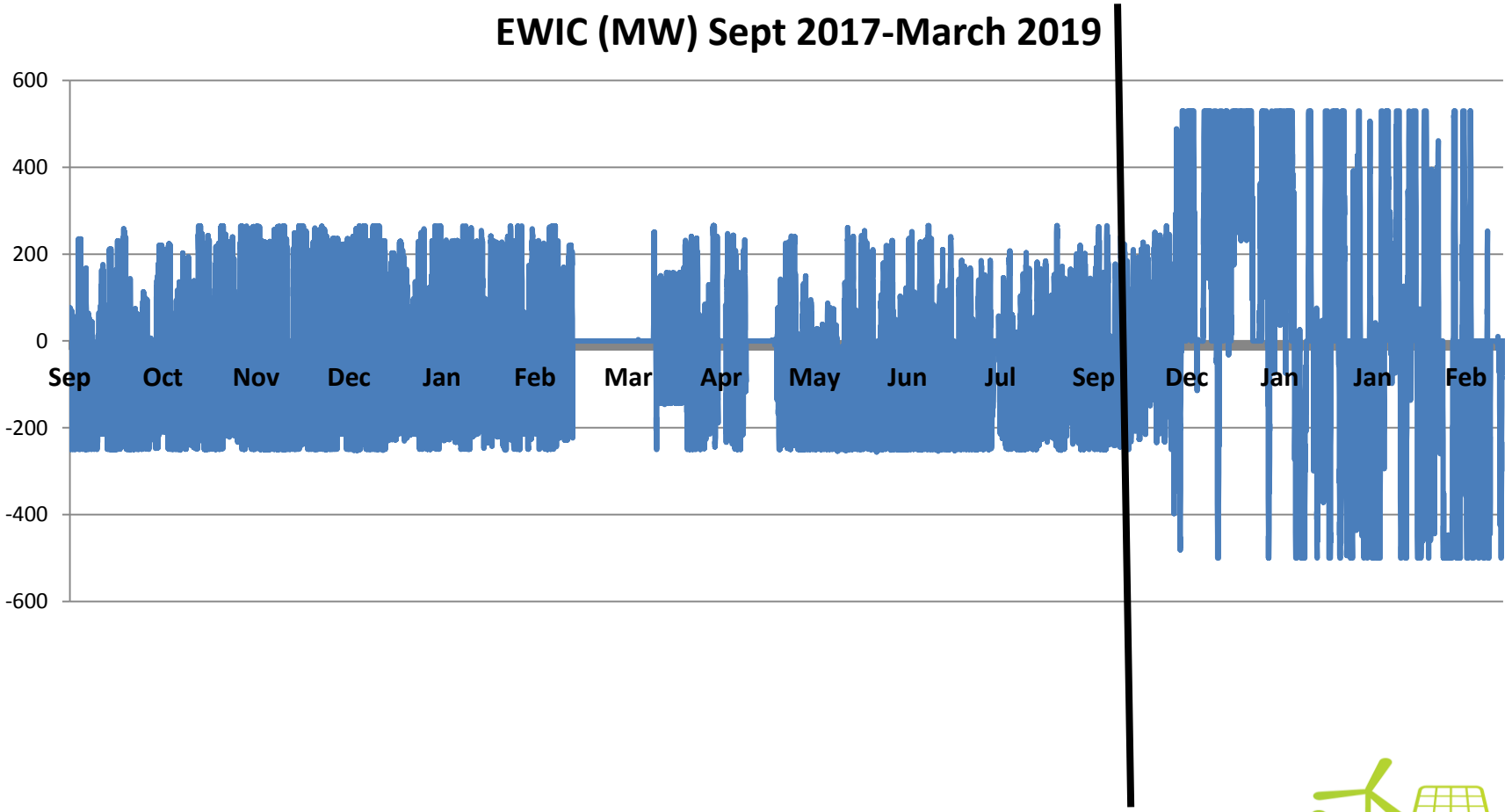
Interconnector flow



Price model

$$1)\quad P_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 Pk$$
$$2)\quad P_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 Pk + \beta_4 M$$
$$3)\quad P_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 Pk + \beta_4 M + \beta_5 (Pk * M)$$

Where:

P_t= day ahead electricity price

W_t = Wind generation

D_t = system demand (net wind)

Pk = peak (6pm-10pm) or off-peak

M = ISEM dummy

t = hour

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Import model

1) $I_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 P_{it} + \beta_4 Pk$
2) $I_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 P_{it} + \beta_4 M + \beta_5 Pk + \beta_6 (Pk * M)$
3) $I_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 P_{it} + \beta_4 M + \beta_5 Pk + \beta_6 (Pk * M)$
4) $I_t = \beta_0 + \beta_1 W_t + \beta_2 D_t + \beta_3 \frac{P_{1t}}{P_{2t}} + \beta_4 M + \beta_5 Pk + \beta_6 (Pk * M)$

Where:

I= Imports

i = UK or Ireland

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Results: 1. Wholesale prices

	Basic
Wind production	-0.064***
System demand	0.588***
Peak period	0.188***

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Results: 1. Wholesale prices

	Basic	With ISEM
Wind production	-0.064***	-0.077***
System demand	0.588***	0.523***
Peak period	0.188***	0.199***
ISEM		0.169***

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Results: 1. Wholesale prices

	Basic	With ISEM	ISEM interaction
Wind production	-0.064***	-0.077***	-0.077***
System demand	0.588***	0.523***	0.522***
Peak period	0.188***	0.199***	0.177***
ISEM		0.169***	0.158***
ISEM*peak			0.070***

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Summary: Price results

- Wholesale prices increase when:
  - System demand increases
  - During peak periods
  - Since the ISEM introduction
  - During peak periods of the ISEM (but less)
- Wholesale prices decrease when:
  - Wind production increases

Results: 2. Imports (A)

Variable	Irish price
Ire price	0.53***
UK price	
Peak period	0.03
Wind gen	-0.21***
System demand	2.18***
ISEM	
Peak*ISEM	
R^2	0.25

Results: 2. Imports (A)

Variable	Irish price	With ISEM
Ire price	0.53***	0.41***
UK price		
Peak period	0.03	0.16***
Wind gen	-0.21***	-0.23***
System demand	2.18***	2.21***
ISEM		0.37***
Peak*ISEM		-0.32***
R^2	0.25	0.27

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Results: 2. Imports (A)

Variable	Irish price	With ISEM	UK price & ISEM
Ire price	0.53***	0.41***	
UK price			0.52***
Peak period	0.03	0.16***	0.11***
Wind gen	-0.21***	-0.23***	-0.23***
System demand	2.18***	2.21***	2.20***
ISEM		0.37***	0.34***
Peak*ISEM		-0.32***	-0.34***
R^2	0.25	0.27	0.27

Results: 2. Imports (B)

Variable	Ire/UK price 1
Ire/UK price	0.043 (0.03)
Peak period	0.13*** (0.02)
Wind gen	-0.24*** (0.01)
System demand	2.49*** (0.05)
ISEM	
Peak*ISEM	
R^2	0.22

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Results: 2. Imports (B)

Variable	Ire/UK price 1	Ire/UK price 2
Ire/UK price	0.043 (0.03)	0.073* (0.03)
Peak period	0.13*** (0.02)	0.15*** (0.02)
Wind gen	-0.24*** (0.01)	-0.26*** (0.01)
System demand	2.49*** (0.05)	2.41*** (0.05)
ISEM		0.40*** (0.02)
Peak*ISEM		
R^2	0.22	0.25

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Results: 2. Imports (B)

Variable	Ire/UK price 1	Ire/UK price 2	Ire/UK price 3
Ire/UK price	0.043 (0.03)	0.073* (0.03)	0.069* (0.03)
Peak period	0.13*** (0.02)	0.15*** (0.02)	0.24*** (0.03)
Wind gen	-0.24*** (0.01)	-0.26*** (0.01)	-0.26*** (0.01)
System demand	2.49*** (0.05)	2.41*** (0.05)	2.43 *** (0.05)
ISEM		0.40*** (0.02)	0.46*** (0.02)
Peak*ISEM			-0.30*** (0.05)
R^2	0.22	0.25	0.25

Summary: Imports results

- Electricity is imported when:
  - Higher Irish price
  - Higher UK price
  - Higher system demand
  - Since ISEM introduction
  - At peak periods
  - Increased Irish to UK price ratio
- Electricity imports decrease when
  - Higher wind production
  - During peak periods of ISEM

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Conclusions and Future work

- Wholesale prices have not yet shown a decrease
- Imports appear to have increased
- Longer dataset with time => more robust estimation
- Further estimation: convergence of UK and Irish prices over time, volatility, peak variable, more investigation of interconnector flows.

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Thank You!

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