How much could domestic demand response technologies reduce CO_2 emissions?

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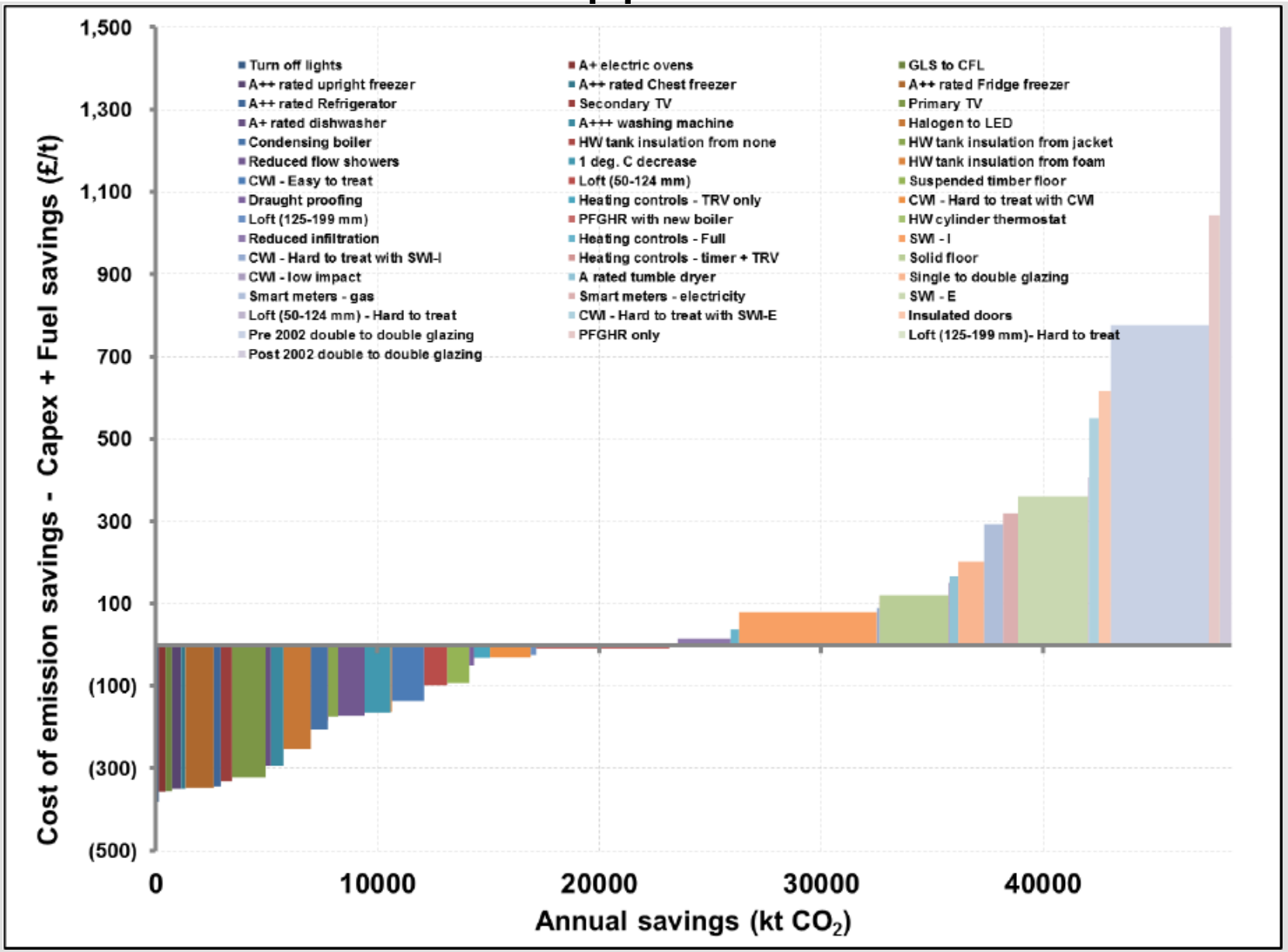
Presentation for eceee 2017 Summer Study on energy efficiency
Panel 2. Policy: governance, design, implementation and evaluation challenges
Paper 2-107-17

Marginal abatement cost curves: where are the smart appliances?



Source: Element Energy. "Review of potential for carbon savings from residential energy efficiency." *Final report for The Committee on Climate Change., Cambridge* (2013).

How much could domestic demand response technologies reduce CO_2 emissions?

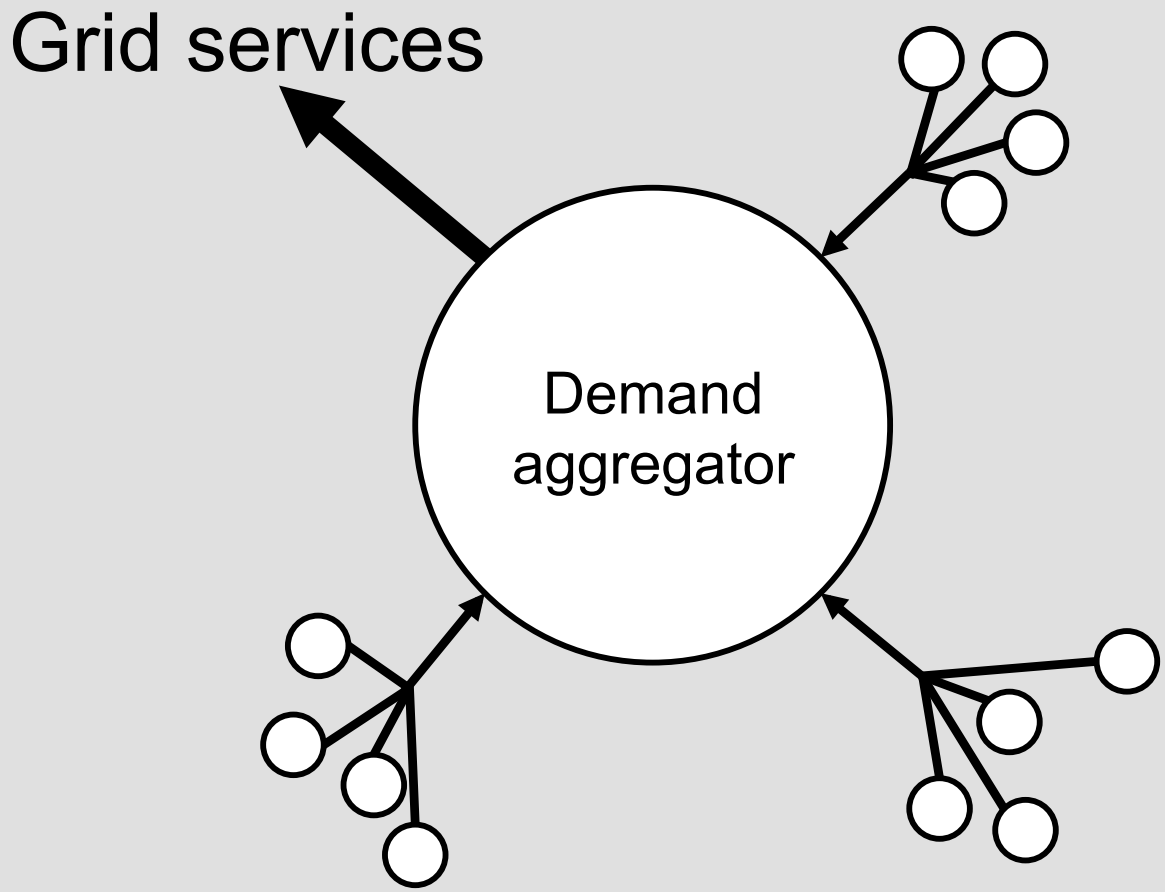
- Literature review: state-of-the-art in attributing CO_2 saving to smart technologies?
- CO_2 savings due to demand reduction, energy efficiency, demand response often not considered.
- Demand response impact:
  - Range of impacts depending on the method and assumptions.
  - Demand response can have a negligible effect, or may even increase emissions e.g. due to efficiency losses in domestic battery systems.
- CO_2 saved when DR assumed to have structural impact:
  - Flexibility e.g. reduction of renewables curtailment
  - Capacity e.g. removes peaking plant

Results

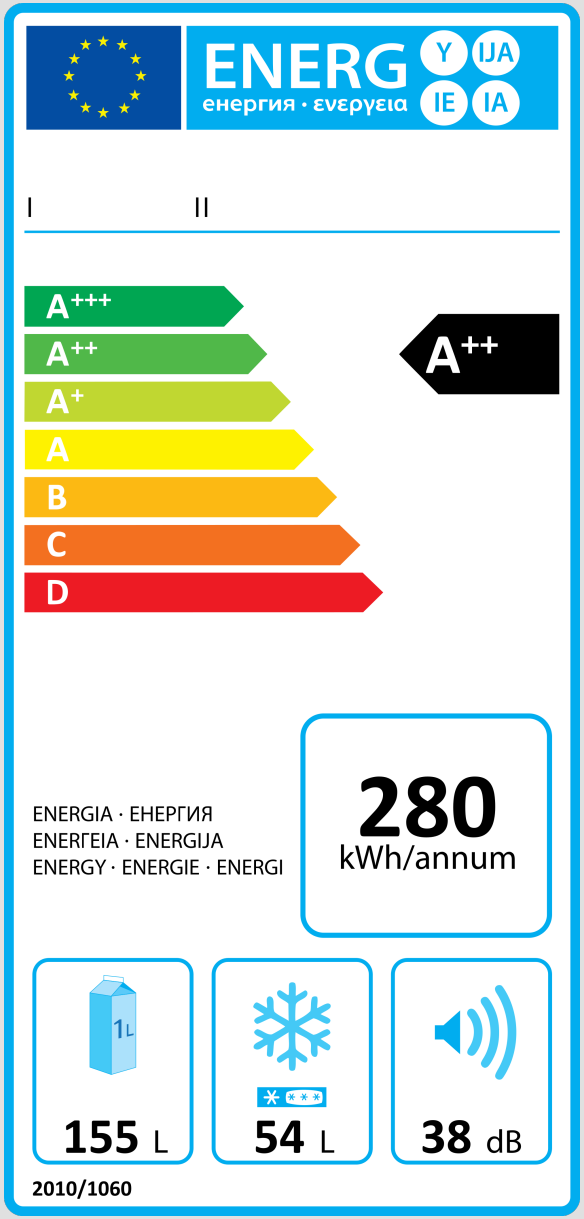
- In-use environmental impact of DR
- Simple conceptual model (see paper)
- Case-study: domestic battery storage in Irish power system

Demand response scenario	Demand response marginal emissions factor (kgCO2/kWh)	Annual emissions impact of load-shift (kgCO2/kWh/yr)
1. Peak shaving and trough filling	0.07	25.4
2. Avoiding wind curtailment	-0.49	-179.3
3. New CCGT plant built, replaces average grid-mix	-2.6	-955.2

Accelerating structural impact



Smart functionality: regulated but optional



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Thank you

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Further slides

DR to reduce curtailment of renewables

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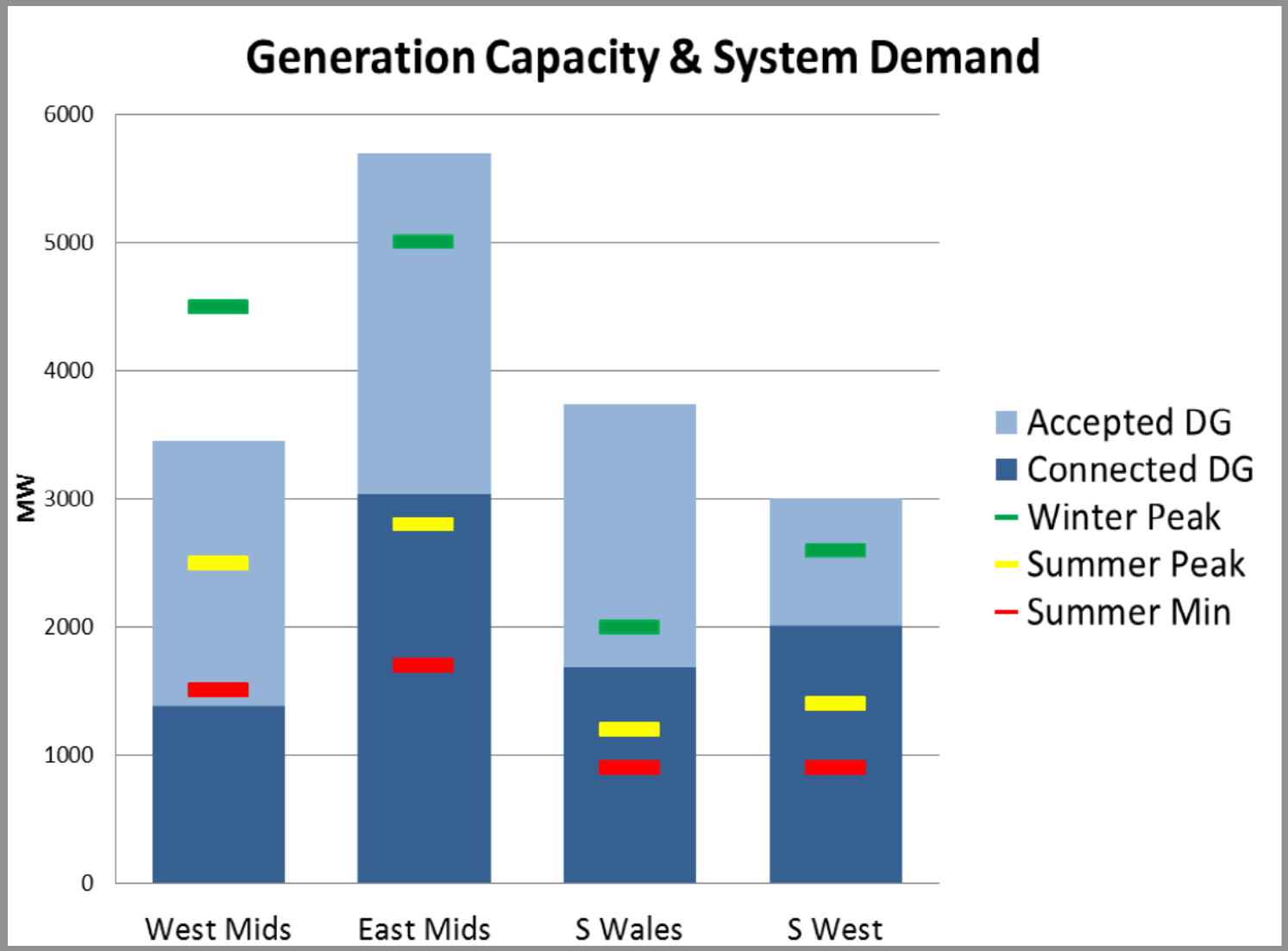
National Grid prepares for 'summer excess' with calls to use more power

share 1 Comment

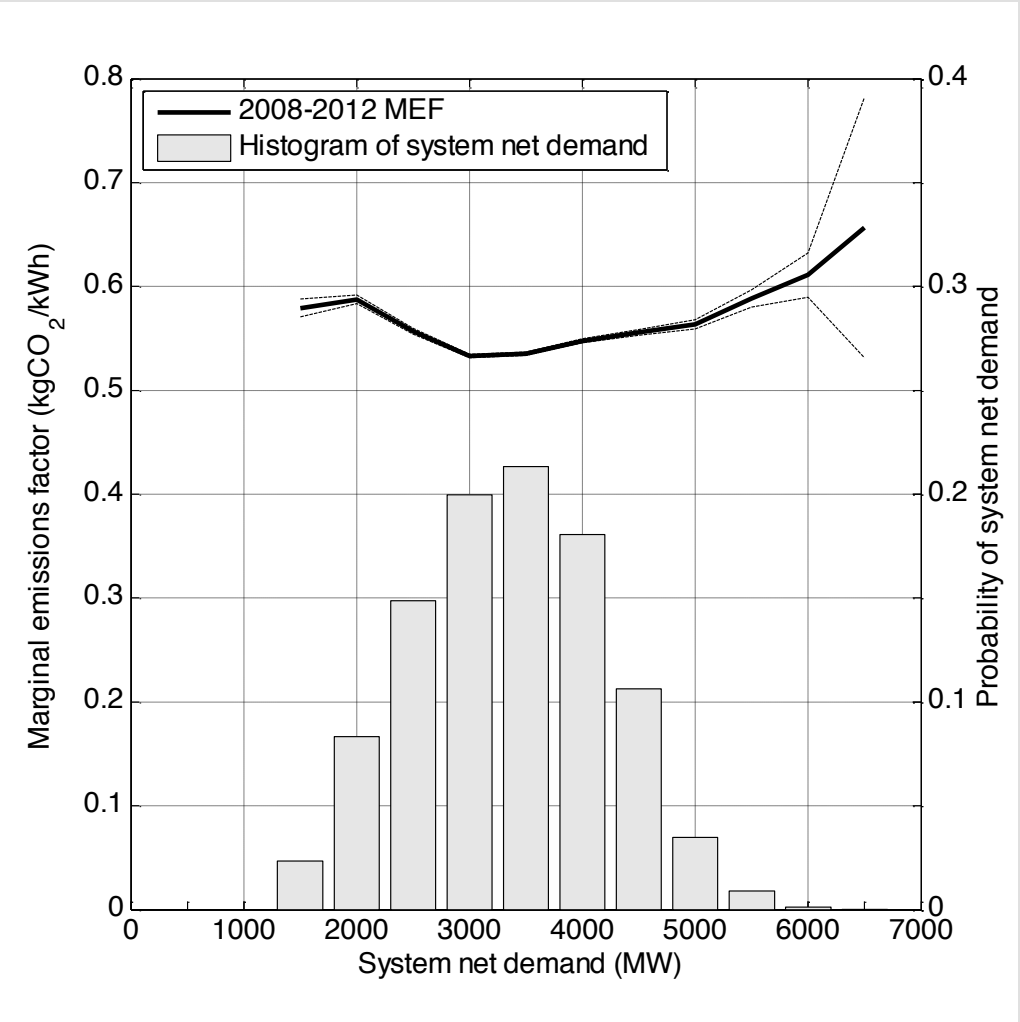
[Ambrose, J. 26 March 2017]

DR to increase renewables capacity



Source: Western Power Distribution, Distributed Generation Stakeholder Workshop, November 2016

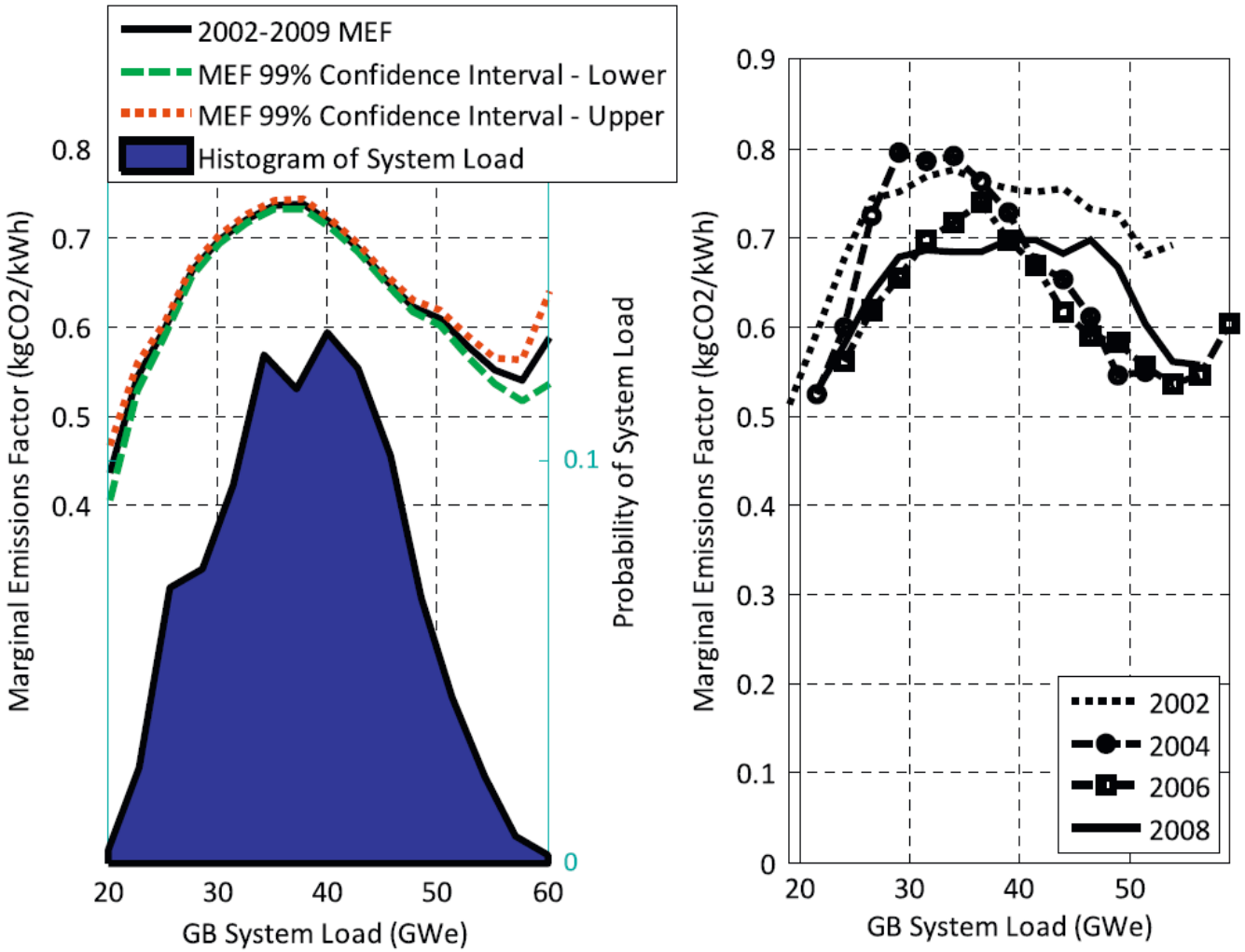
IRL marginal emissions



Irish power system – histogram of system net demand (right axis) and marginal emissions factor (left axis).

McKenna, Eoghan, John Barton, and Murray Thomson. "Short-run impact of electricity storage on CO2 emissions in power systems with high penetrations of wind power: A case-study of Ireland." *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy* (2016): 0957650916671432.

GB marginal emissions



ig. 4. Marginal emissions factor as a function of system load in Great Britain with corresponding confidence interval and Density of System Load (left) and by Year (right).

Source: Hawkes, A. D. "Estimating marginal CO 2 emissions rates for national electricity systems." *Energy Policy* 38.10 (2010): 5977-5987.

US marginal emissions

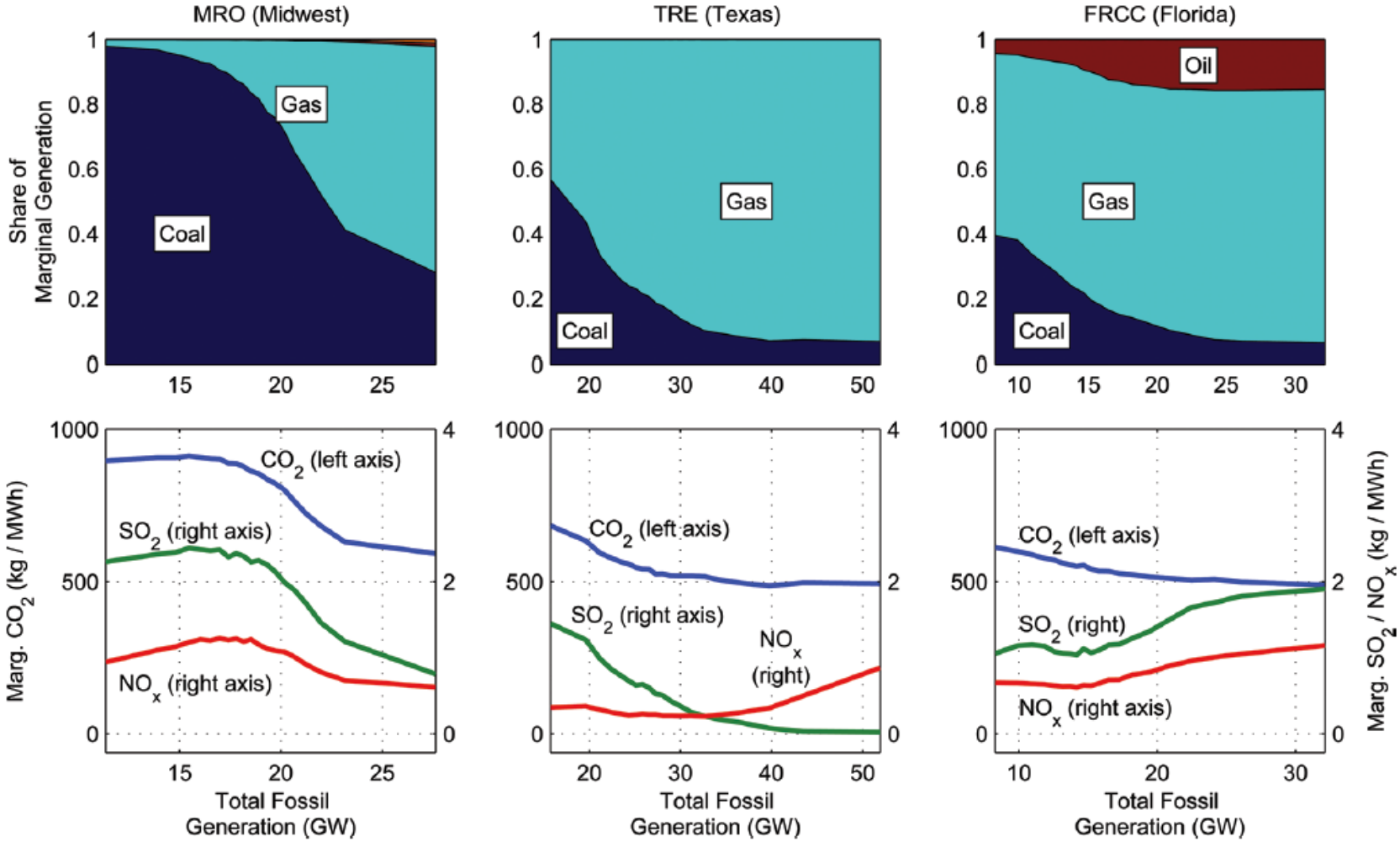


Figure 3. Share of marginal generation by fuel type (top) and MEFs (bottom) as a function of total fossil generation, a proxy for system demand. Results are based on data from 2006 through 2011, binned by every fifth percentile of total fossil generation. MEFs have two axes: the left axis applies to CO_2 and right axis applies to NO_x and SO_2.

Source: Siler-Evans, Kyle, Ines Lima Azevedo, and M. Granger Morgan. "Marginal emissions factors for the US electricity system." *Environmental science & technology* 46.9 (2012): 4742-4748.