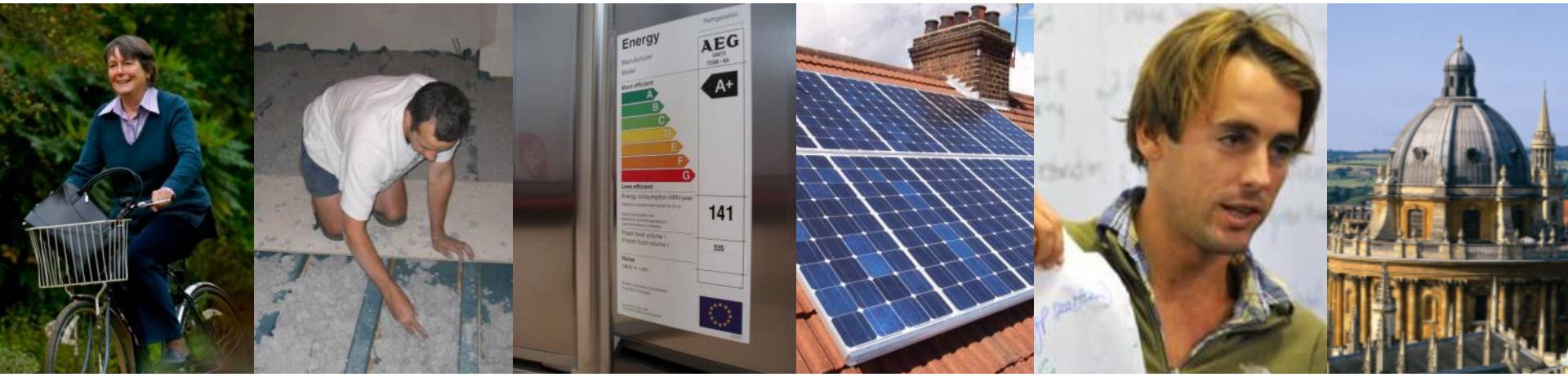
Environmental *Change* Institute

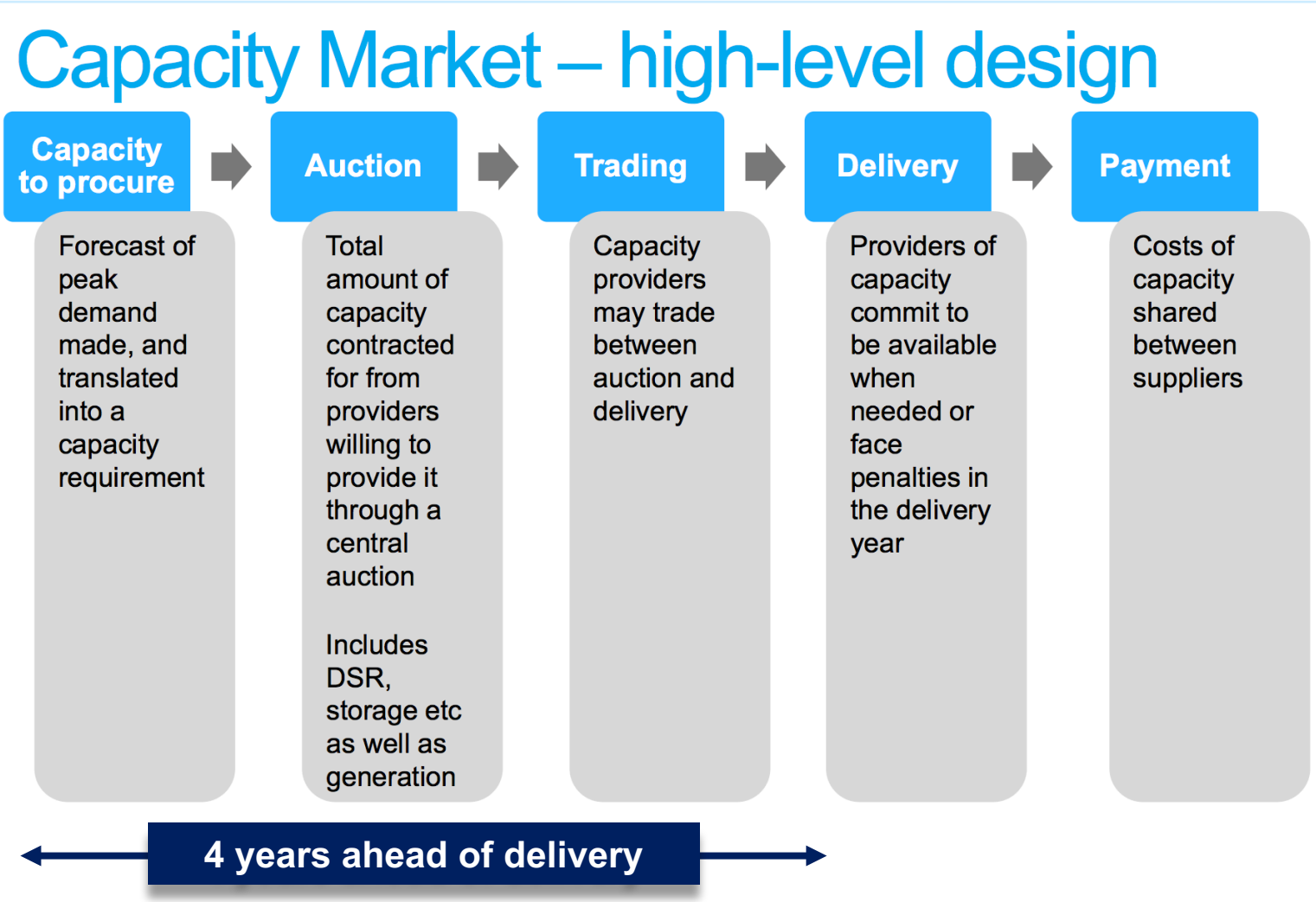
Forward capacity market and electricity demand reduction – Case of the UK



CEE Inaugural Conference ZHAW
22 September 2017

Forward capacity market uses auctions to procure resources to meet projected peak demand and reserve requirements in future years

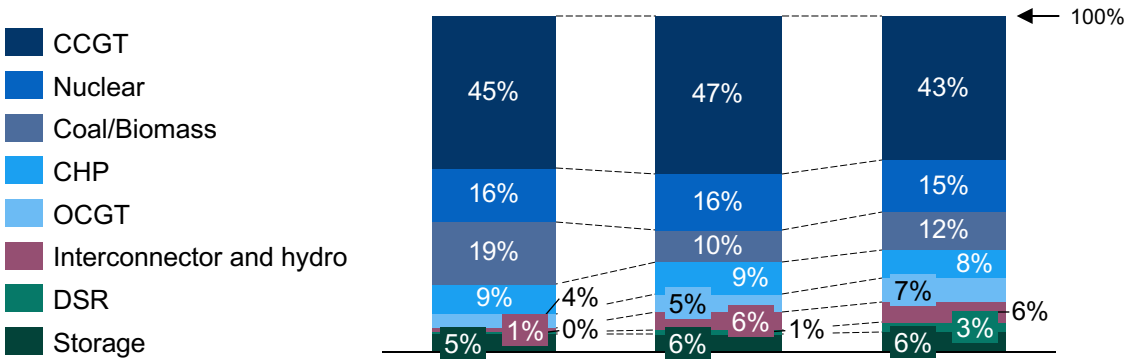
CASE OF GB



SOURCE: DECC

While participation of new build and DSR shows some growth, existing generation capacity has dominated in clearing all T-4 auctions

Most of capacity contracts went to existing generation, with limited success for new build CCGT



		2018-19	2019-20	2020-21
Total procurement (GW)		49.3	46.4	52.4
% Overall clearing		76%	80%	75%
% New build CCGT clearing		25%	18%	12%
Capacity price (£/kW-Year)		£19.4	£18	£22.5
% Cleared capacity	Existing generation*	64%	95%	89%
	Refurbishing**	30%	0.2%	2%
	New build generation	5%	4%	7%
	DSR	0.4%	1%	3%

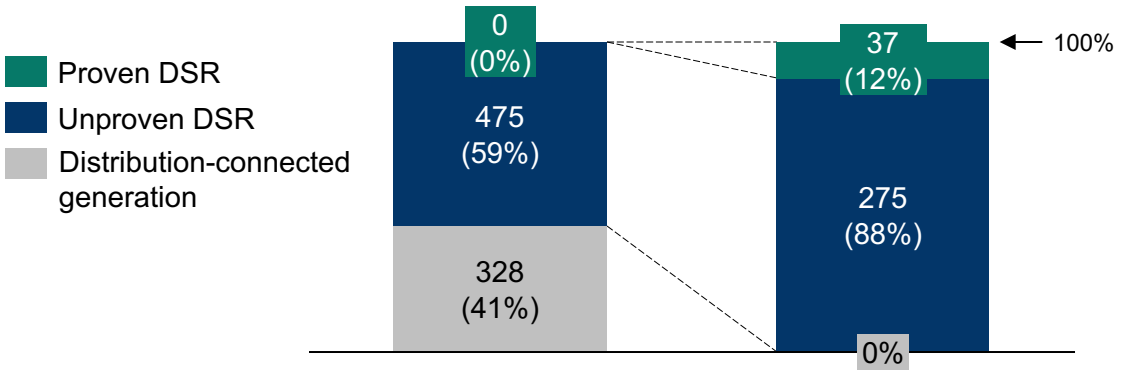
*Existing generation and existing interconnection **Refurbishing generation and pre-refurbishment
***Trafford (1.66 GW) CCGT was awarded contract in T-4 2018-19 but was terminated

- Eligible generation **not supported by renewable incentives** or **long-term STOR** contract
- Most of contracts are awarded to existing generation, with **limited success for new-build CCGT**. In T4 2020-21, only 1.2GW of new build CCGT has been brought forward***, while 1.3GW of new build distributed generation won capacity agreements
- **Growth in DSR** capacity, from 174MW for 2018-19 to 1.4GW for 2020-21. However, **most of its growth** is believed to come from **behind-metre generation**
- For the first time, new build **battery storage** (~500MW) cleared the T-4 auction for 2020-21

SOURCE: Ofgem; EMR Delivery Body

Transitional Arrangement (TA) auctions have only limited success in stimulating 'turn-down' demand-side response (DSR)

Time-limited 'turn-down' DSR only makes up a small share of capacity contribution



	2016-17	2017-18
Participating capacity (MW)	1,100	373
% Procurement target	122%	124%
% Overall clearing	72%	83%
Total procurement (MW)	803	312
% 2020-21 T-4 procurement	~1.5%	~0.6%
Clearing capacity price (£/kW-Year)	£27.5	£45

- TA auctions procure **time-limited capacity product** for 9am-11am and 4pm-8pm of winter working days in Oct-Apr
- In 2016-17 TA auction, **most of Unproven DSR** is expected to come from **behind-metre generation**
- **In 2017-18 TA auction, only 'turn-down' DSR was eligible**
- **Higher cost of 'turn-down' DSR**, suggesting the **commercial barriers faced by 'turn-down' DSR**, and **low liquidity** may have led to higher clearing price in the 2017-18 TA auction

SOURCE: Ofgem; EMR Delivery Body; DECC

SUMMARY

Forward capacity market can be a useful tool for ensuring reliability, but it is not a 'silver bullet' to promote capacity adequacy and demand-side resources

Key questions	Key points
Why do we need a capacity mechanism?	▪ **Capacity mechanisms** can be **one tool** helping ensure adequate capacity to meet projected peak demand and reserve margin ▪ However, they are preferred to be used to **address 'residual' market design inefficiencies** or **complement reforms in wholesale electricity markets** ▪ Focusing on peak demand, **capacity mechanisms are not necessarily well aligned with the need of flexible capacity**
How should we design a capacity mechanism to mimic a free market?	▪ An efficient mechanism should allow **market-wide participation of diverse resource types**, including **demand-side resources** ▪ Evidence exists that participation of **EE helps reduce the cost of capacity** and complements DSR in unlocking the potential of demand side
What is the effect of capacity market on energy efficiency (EE)?	▪ At best, **forward capacity market** can **only have a limited role in stimulating EE investment**, due to weak value proposition and complex procedure for accessing this potential funding source ▪ **Dedicated regulatory funding to support EE investment is needed**

Concern about future capacity adequacy fuels the debate on capacity mechanism in Europe

A mix of market and regulatory factors lead to concerns of future capacity adequacy

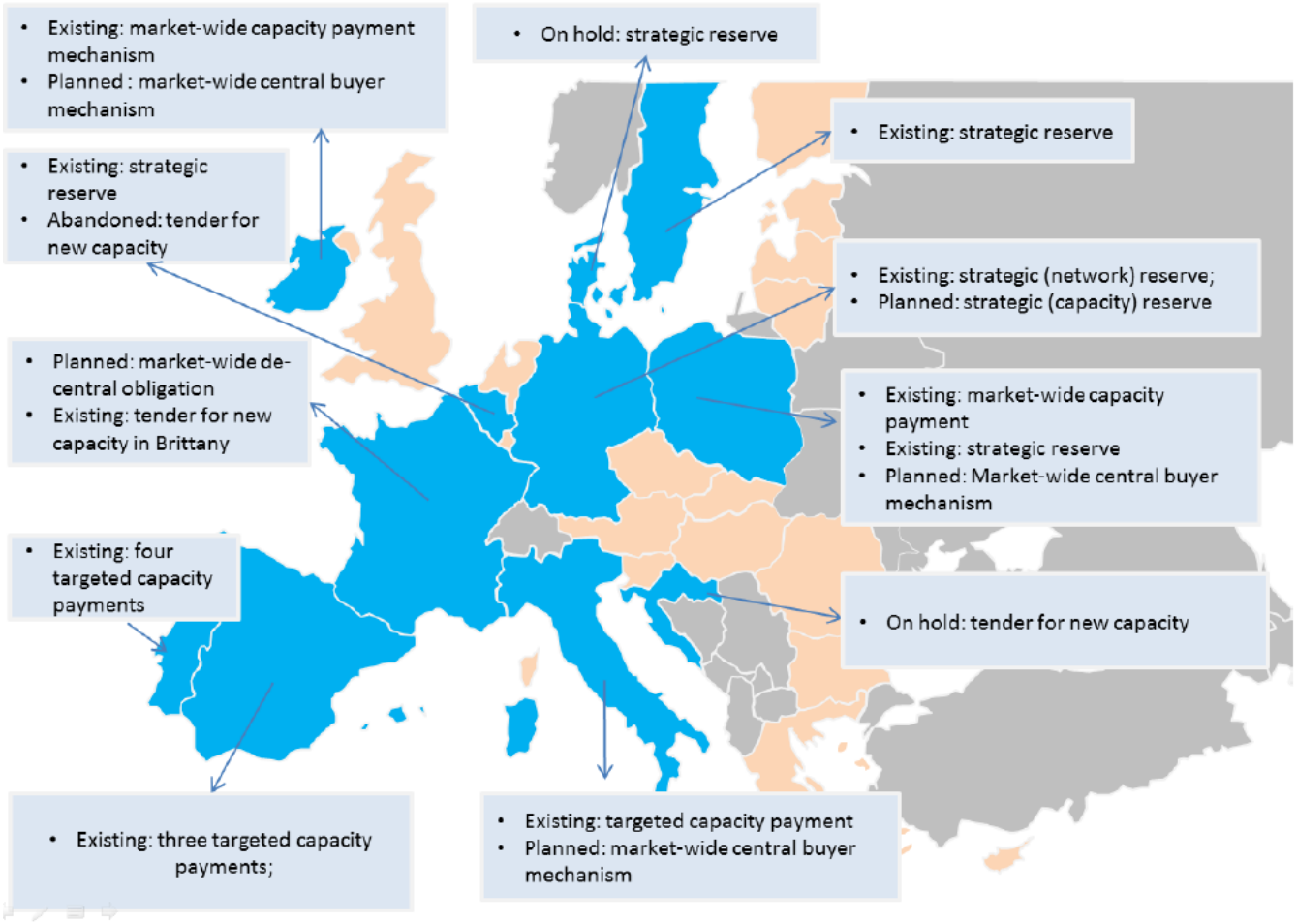
Factors	Descriptions
 **Weakened profitability** of **thermal generation**	▪ **Demand growing slowly/declining**. In EU, annual electricity generation between 2008 and 2013 decreased by 5%. ▪ **Increased installed capacity** and **growth of intermittent renewables** with low marginal cost lead to **lower wholesale electricity price** and **lower utilisation of thermal generation** ▪ **Impact on gas capacity is more pronounced** than coal
 **Planned retirement** of coal and nuclear generation due to **age and environmental regulation**	▪ Most nuclear plants will be over 30 years old by 2020 and **little investment for new nuclear** generation is planned ▪ **Environmental policies** lead to gradual **phase-out of coal** plants

 **Market design imperfections** creating investment barriers	▪ Imperfections in market design **undermining** the formation of **efficient market price**:
	  ▪ Price cap not based on Value of Lost Load (VoLL) or set much lower than VoLL
	  ▪ Out-of-market reliability mechanism
	  ▪ Inefficient bidding zone delineation
	▪ **Uncertainties** about future market and regulatory design

SOURCE: EC (2016)

Different capacity mechanisms are created in European countries but they are not 'silver bullets'

Existing and planned capacity mechanisms in 11 member countries of the EU



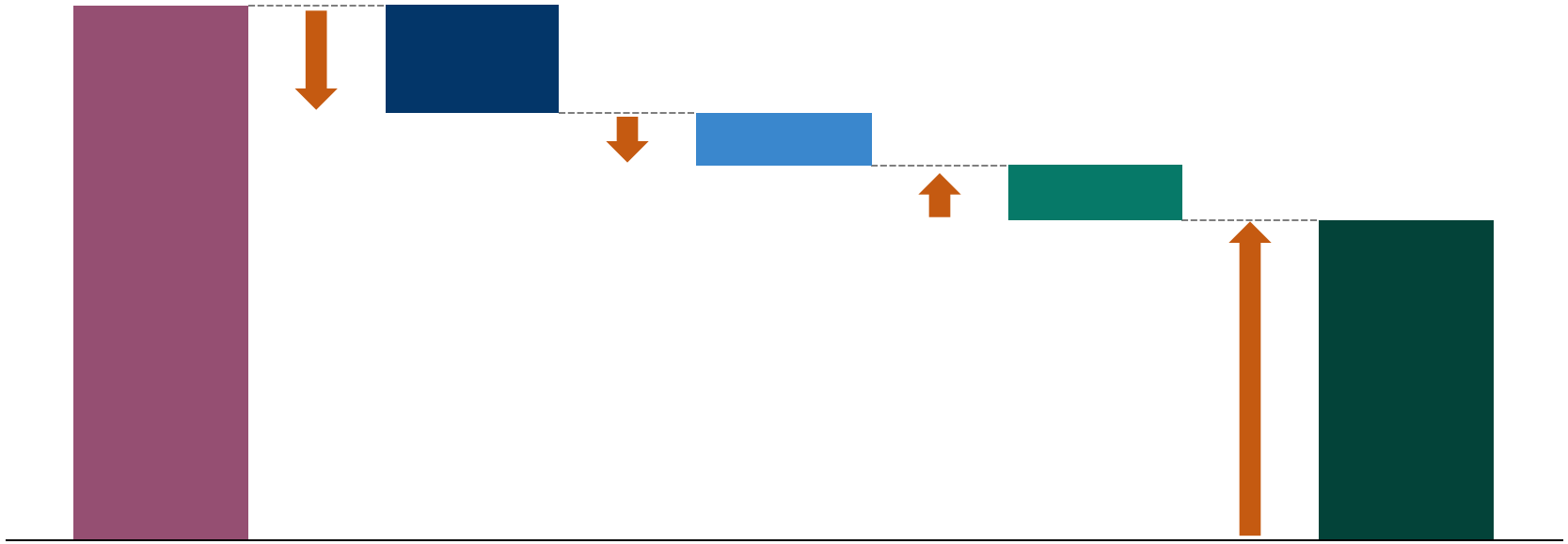
- **Robust reliability assessment** and **wholesale energy market reforms** should **precede** efforts to set up a **capacity market**
- Capacity mechanisms focus on peak demand rather than **flexibility**
- Apart from the UK, **none of identified capacity mechanisms** attempt to integrate EE

SOURCE: EC (2016)

Capacity markets should allow the participation of various resources, particularly that of demand-side resources

ILLUSTRATIVE

EE contributes to capacity adequacy by reducing system peak demand



Peak demand & reserve margin

- Highest annual peak demand plus reserve margin set by engineering standards

EE

- **Permanent, Non-dispatchable** reduction in electricity load

Other demand resources

- **Temporary** reduction in electricity load (e.g. DSR)
- Distributed generation

Others supply

- Interconnection and electricity import

Generation

- Various types of generation capacity (e.g. gas, nuclear, solar and wind)

Forward capacity markets show the potential of procuring EE as a capacity resource…

Definition of capacity product and EM&V protocols are key to the procurement of EE

	PJM	ISO-NE	GB Capacity Market
Start Year	▪ 2012	▪ 2010	▪ 2015
Peaking season	▪ Summer	▪ Summer	▪ Winter
EE in main auctions	▪ Yes	▪ Yes	▪ Electricity Demand Reduction (EDR) Pilot
Forward period	▪ 3 years	▪ 3 years	▪ 1 year (EDR)
Capacity product defined as the **average demand reduction on working days** in…	▪ **Basic Capacity (2012-20):** 3-8pm in Jun-Aug ▪ **Capacity Performance (2018-):** Lower of 3-8pm in Jun-Aug, and 8-9am and 7-8pm in Jan-Feb	▪ **On-Peak:** 1pm-5pm in Jun-Aug and 5pm-7pm in Dec-Jan ▪ **Seasonal peak:** During real-time system peak hours[1] in Jun-Aug and Dec-Jan	▪ 4-8pm in Nov-Feb
EM&V	Peak savings estimated using a combination of **'deemed'** and **measured** approaches		

SOURCE: DECC; PJM; ISO-NE; Liu (2017)

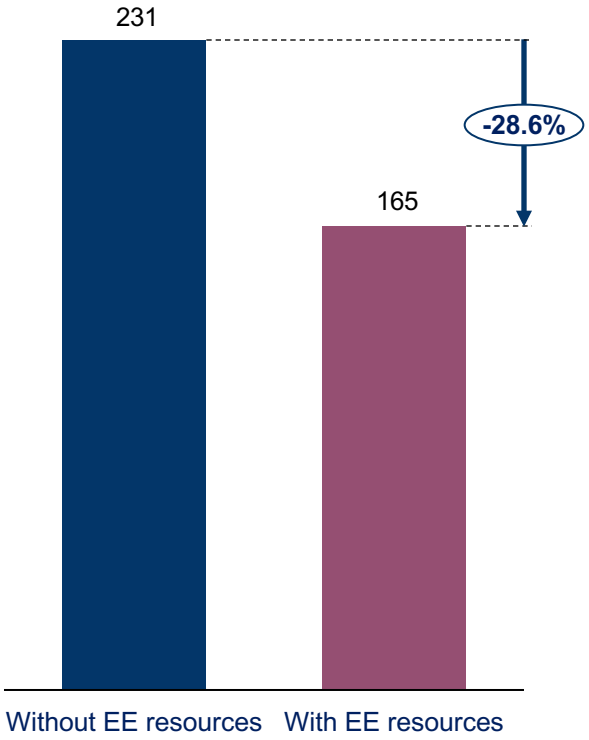
Procurement of EE as a capacity resource is valuable…

CASE OF PJM

EE resources can contribute to cost-effective capacity acquisition

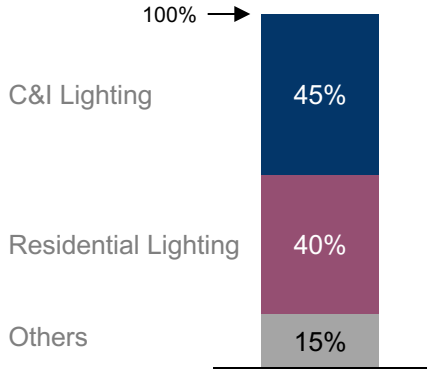
Clearing capacity price in unconstrained zones of PJM for delivery in 2018-19

Unit: $/MW-day

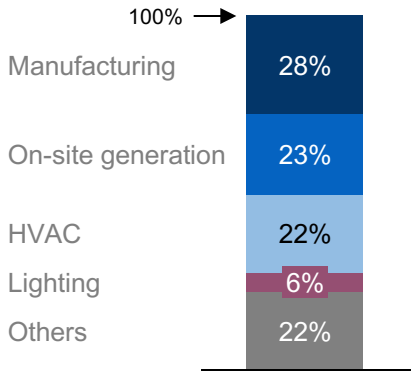


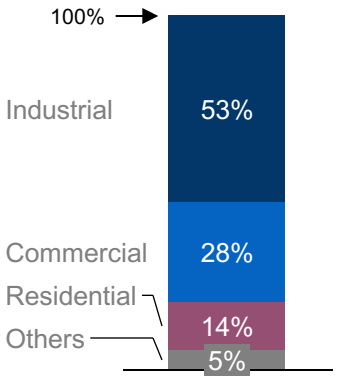
…EE can complement DSR in targeting end-use and customers, and unlocking the potential of demand-side resources

Breakdown of **EE resources** in the forward capacity market of PJM



Registered capacity of **Load Management Programme (DSR)** in PJM by end-use and sector for 2015-16





SOURCE: PJM; Keech (2015)

...but the forward capacity market may play only a limited role in promoting EE investment

X 'Follow-up' SUMMARY

Value proposition of the forward capacity market is weak, and its designs pose barriers for participation…

Key design features of the forward capacity market	Limitations and/or barriers	Implications for promoting EE investment
A Incentives based on **peak demand reduction**	▪ EE investment is rewarded for its capacity value only ▪ Peak- and energy-savings are **not well aligned**	▪ Strength of financial incentives is weak ▪ **Other funding sources are necessary** to promote EE investment ▪ Misalignment with customer payback and policy objective of energy savings
B Incentives based on **verified savings**	▪ Customers bear financial risks of not delivering committed savings, likely leading to **risk aversion** ▪ **Complex participation process** ▪ Customers responsible for EM&V, leading to **higher requirement for internal resources**	▪ Tendency to focus on simple measures ▪ **Certain customer segments** (e.g. residential or smaller organisations) may **not be able to participate**
Competitive auctions	▪ Risk of not clearing auctions and obtaining financial incentives	▪ Deterrent for proposing and bidding projects
Minimum project sizes	▪ Higher requirement for aggregating otherwise distributed EE resources	▪ Absence of viable aggregation model may lead to 'missed opportunities' for EE improvement

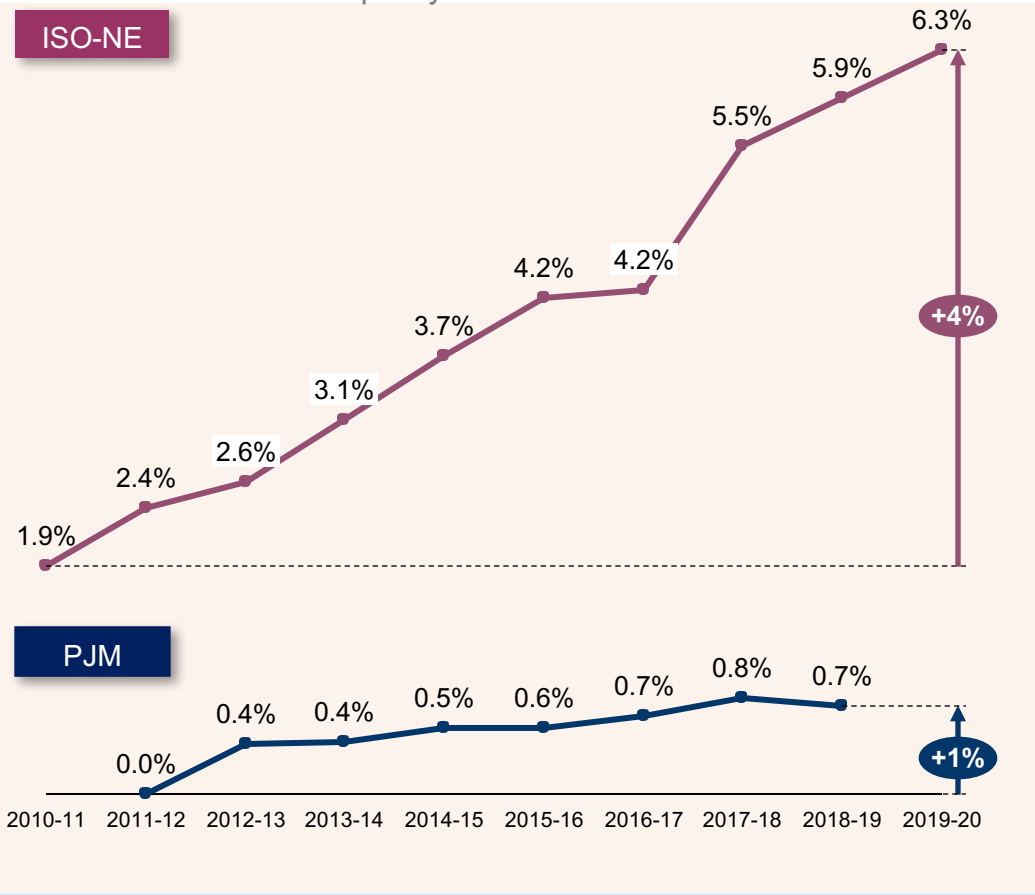
SOURCE: Liu (2016, 2017)

A Participation of EE is primarily driven by regulatory obligation to improve EE at customer end-uses

CASE OF PJM AND ISO-NE

ISO-NE leads in the procurement of EE in forward capacity markets

EE in main capacity auctions
Unit: % of total cleared capacity



Regulatory obligation and treatment of EE are key

- **Participation mainly from obliged utilities –** in ISO-NE, >94% of EE in main auctions for 2012-20 is from obliged utilities[1], with share growing to 99% for 2015-19
- **Strength of regulatory obligation for EE** – level of utility obligation for energy savings tends to higher in states covered by **ISO-NE** (median **1.6%** of annual sales in 2014), as opposed to those by **PJM** (median **0.6%** of annual sales in 2014)
- **Shorter eligibility of EE in PJM limiting financial returns** – in PJM, EE resources are eligible to participate for up to 4 years, whereas in ISO-NE, resources are eligible as long as they are operational

1 Includes 'quasi-government' entities obliged to undertake energy efficiency projects

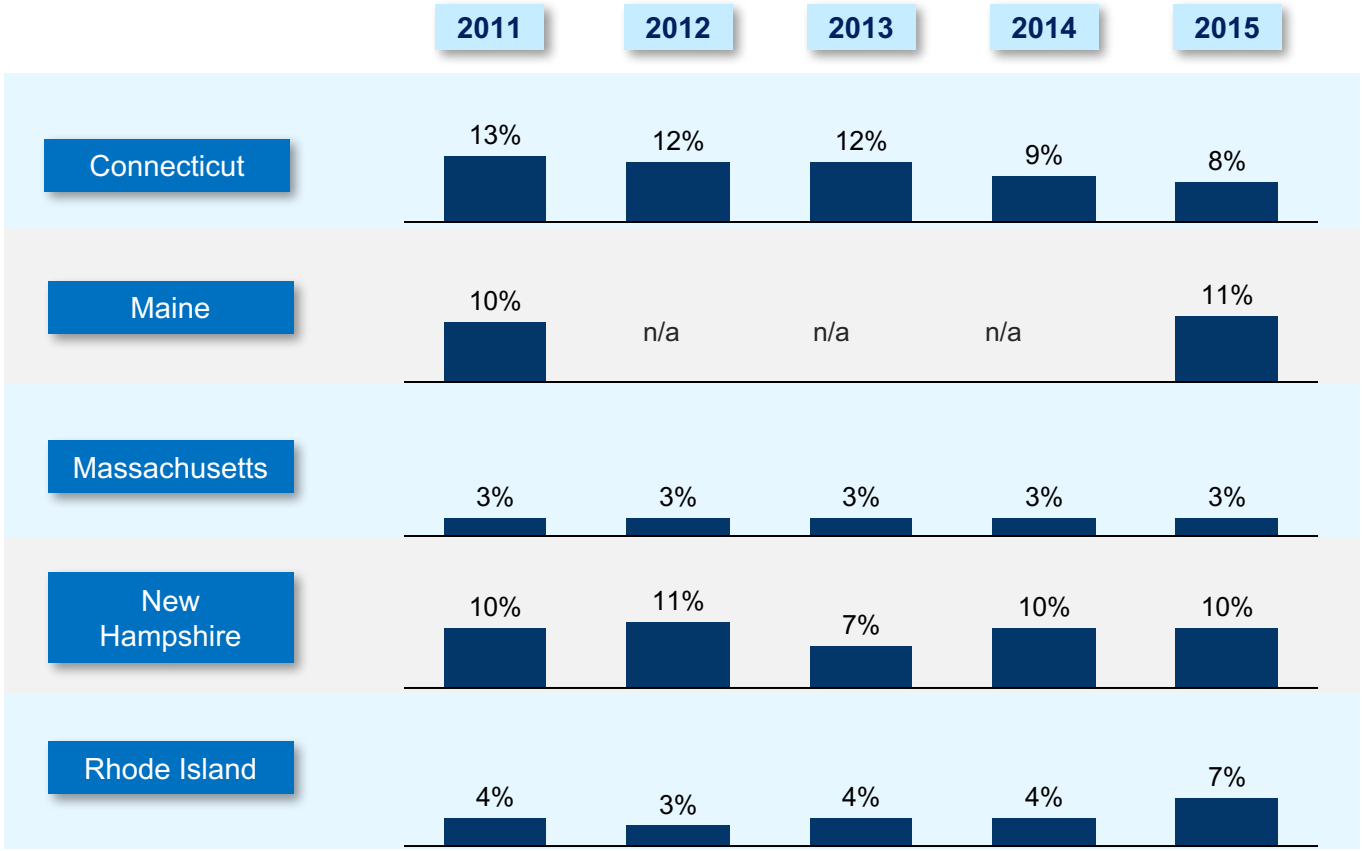
SOURCE: ISO-NE; PJM; Neme and Cowart (2014)

A Capacity market may not be adequate as a primary funding to drive EE

CASE OF ISO-NE

Capacity payment makes a small contribution to the costs of obliged utility EE programmes

Capacity payment as % of expenses of obliged utility energy efficiency programmes in 5 states of ISO-NE (2011-15)



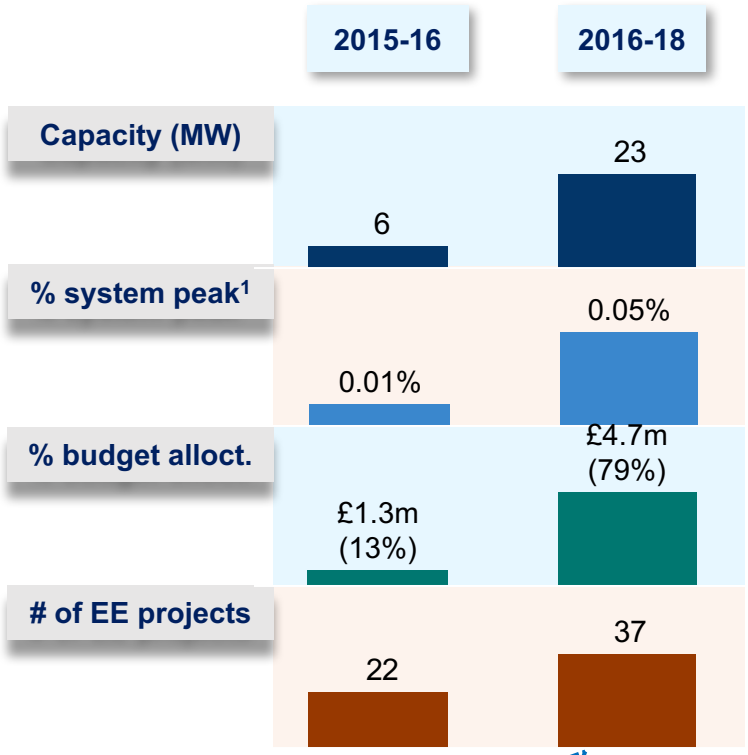
- **Motivation** to seek **capacity revenues** to **lower levy charges** on customer electricity bills to fund utility EE programmes
- In Vermont, capacity payment is channelled to support utility programmes focusing on thermal efficiency

SOURCE: EIA; Knight et al (2014); MAGEEPA (2015); REED

B Electricity Demand Reduction (EDR) Pilot in the UK is limited in incentivising EE projects

CASE OF GB

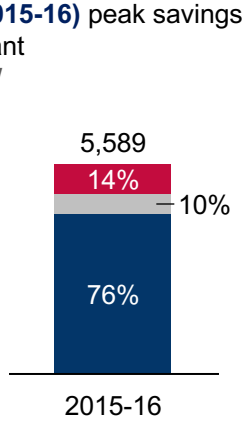
Uptake of EDR funding is low…



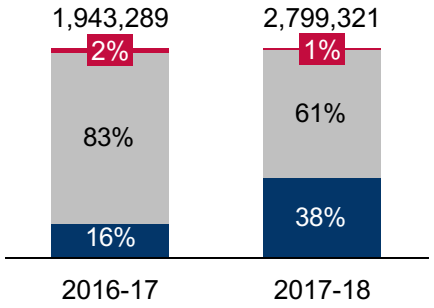
60% of budget allocated for projects **delivering in 2017-18**, highlighting the **challenge of a short forward planning**

…mainly targeting non-residential lighting

EDR (2015-16) peak savings by participant
Unit: kW



EDR (2016-18) allocated budget by participant
Unit: GBP



1. **Inadequate drive** for electric EE from **energy supplier obligation** limits size of potential to bid into EDR

2. **EDR** design creates **barriers:**
   - **Minimum** 50kW peak savings;
   - **Complex application and M&V** (e.g. focus on peak savings)
   - **Risks** related to capacity delivery and auction
   - Minimum payback (2 years)

- **Lighting** projects covering **>98%** of peak savings or allocated budget

1 GB system peak demand at ~50GW

SOURCE: DECC; Liu (2017); Stakeholder interviews

BACK UP

DR and EE differ in their capacity delivery and drivers

‘Deep-dive’ in next page

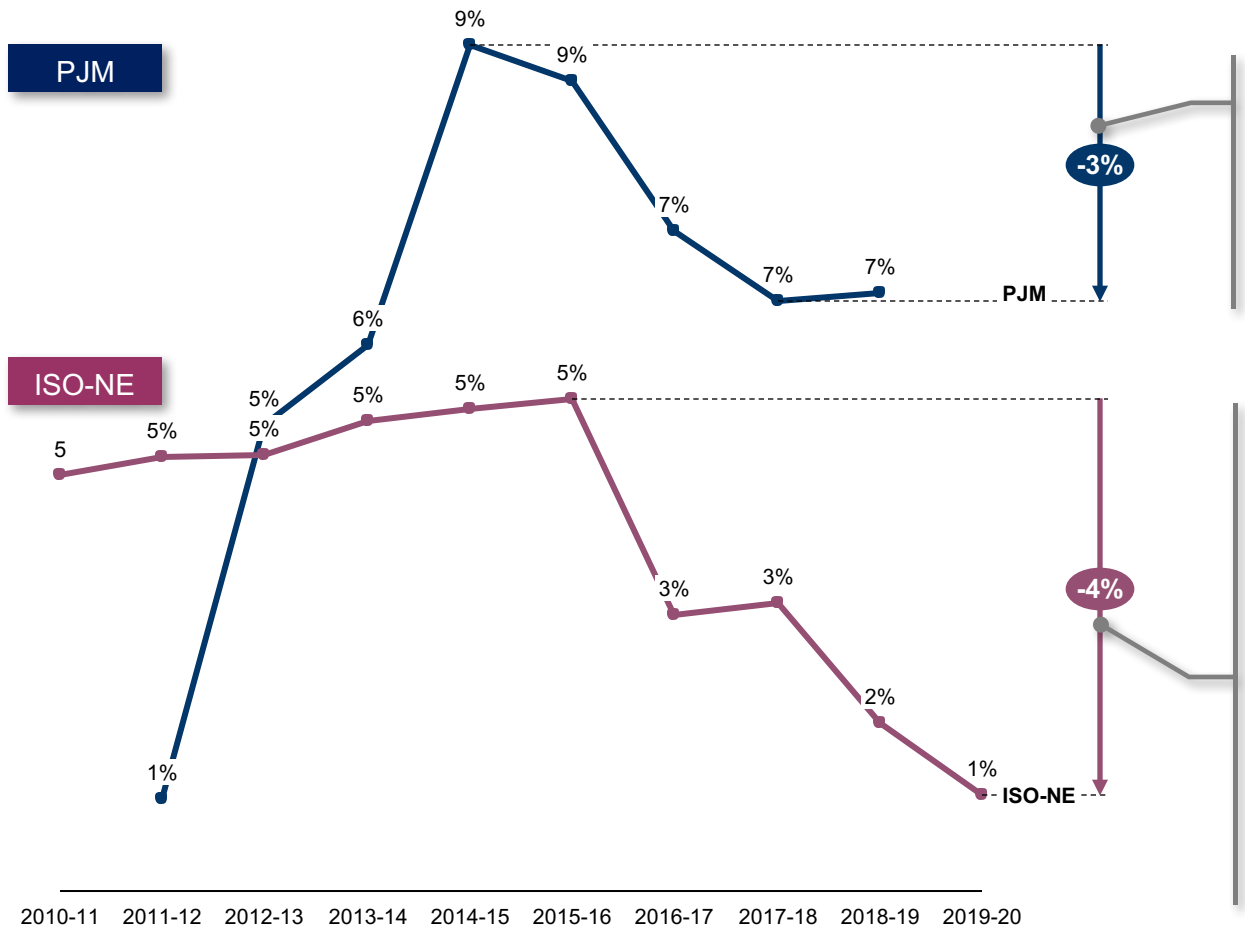
	Energy efficiency	Demand response
Nature	▪ **Permanent** peak savings	▪ **Temporary** peak savings
Key Parameters	▪ **Average** demand reduction during **peak hours**	▪ **Speed, duration and frequency** of reduction
Driver	▪ Regulatory **energy supplier obligations**	▪ Response **requirements** ▪ Capacity **price**

Source: Liu (2017)

High performance requirements limit potential for DR participation

Participation of DR in ISO-NE and PJM drops due to more stringent performance needs

Unit: % of total cleared capacity



Changes in requirements

- **Procurement caps** for limited DR
- DR **response lead time shortened** from 2 hours to 30 minutes

- **Must-offer' requirement** to offer into day-ahead energy markets
- Near **real-time performance data** reporting to PJM
- Removal of **auction floor price**
- Higher penalty in **Pay-for-Performance** design

Source: ISO-NE; PJM