# Effective Policy Options for Domestic Batteries in the UK

## Presentation to Powerswarm


*Dan Gardiner*

*dangardiner@btinternet.com*


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Transition Pathway Initiative

*d.r.gardiner@lse.ac.uk*
*www.lse.ac.uk/GranthamInstitute/tpi/*

EDISON

*dgardiner@edisongroup.com*
*www.edisoninvestmentresearch.com/*

# Context, Aims & Methods

**Context: Policy seen as an uncertainty and barrier to storage investment in academic/grey literature**

- e.g. REA Dec '17: *"numerous reports have been written on the significant potential for storing energy. None … have directly connected the roll-out of storage systems to specific UK Government policies, or attempted to qualify how policy might impact actual deployment"*
- National Grid says 4GW+ of storage capacity needed in UK by 2030 (two degrees scenario)

**Research Aim: To understand the impact of policy on the domestic battery investment case in the UK**

**Methodology: Twin track approach**

- Interview "experts" from across the industry. Supplement this with evidence from
    - *Submissions to BEIS/OFGEM's Smart, Flexible Energy System CfE*
    - *Review of policy issues in selected international markets*
- Build a techno-economic model[1,2,3] to assess the impact of policy on the investment case.

# Results (1): Policy Issues and Investment Base Case

**Six key policy issues identified (see note 4):**

1. Enabling Time-of-Use (ToU) tariff
2. Cutting the VAT rate
3. Introducing a subsidy
4. Removing “deeming”
5. Creating a “Peak Shaving” market
6. Lowering cost of financing

**Investment base case established:**

£3,638 investment in 2020 in a 4kWh battery

Implies a system cost of £2,383 or £596/$794 per kWh

Paired w/4kW residential PV system

Just provides increased Self-consumption.

Annual income (IYI) =£112

Highly uneconomic. Returns (R) = -68%

# Results (2): Impact of Policy Issues on Investment Case

Impact on investment case modelled

Four metrics used:

IYI = Annual income

R = Returns

BY = Breakeven Year

BIC = B'even investment cost

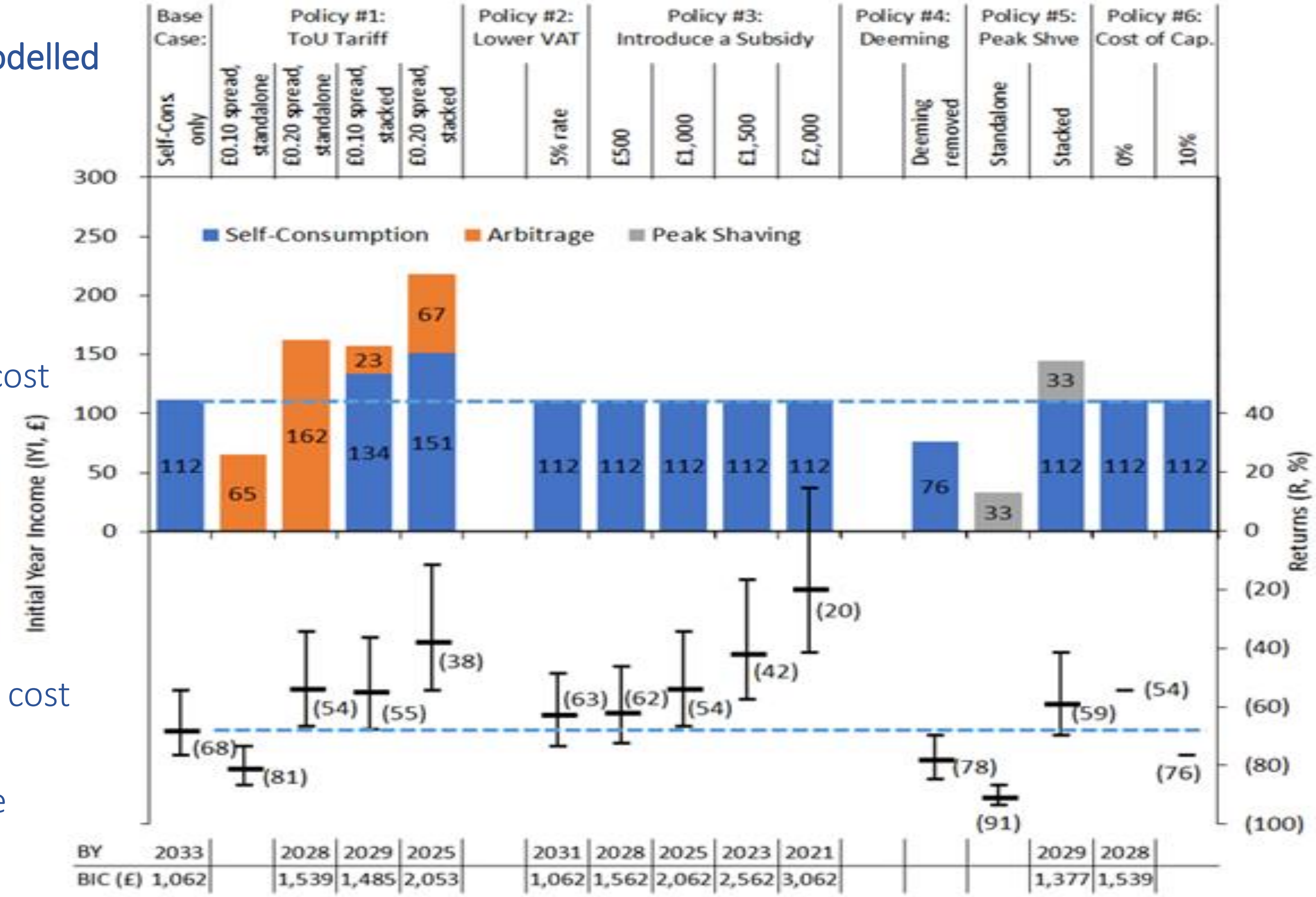
Discount rate:

Assumed 5% base case

varied from 0% to 10%

Policy increases IYI or reduces cost

No single measure turns R +ve



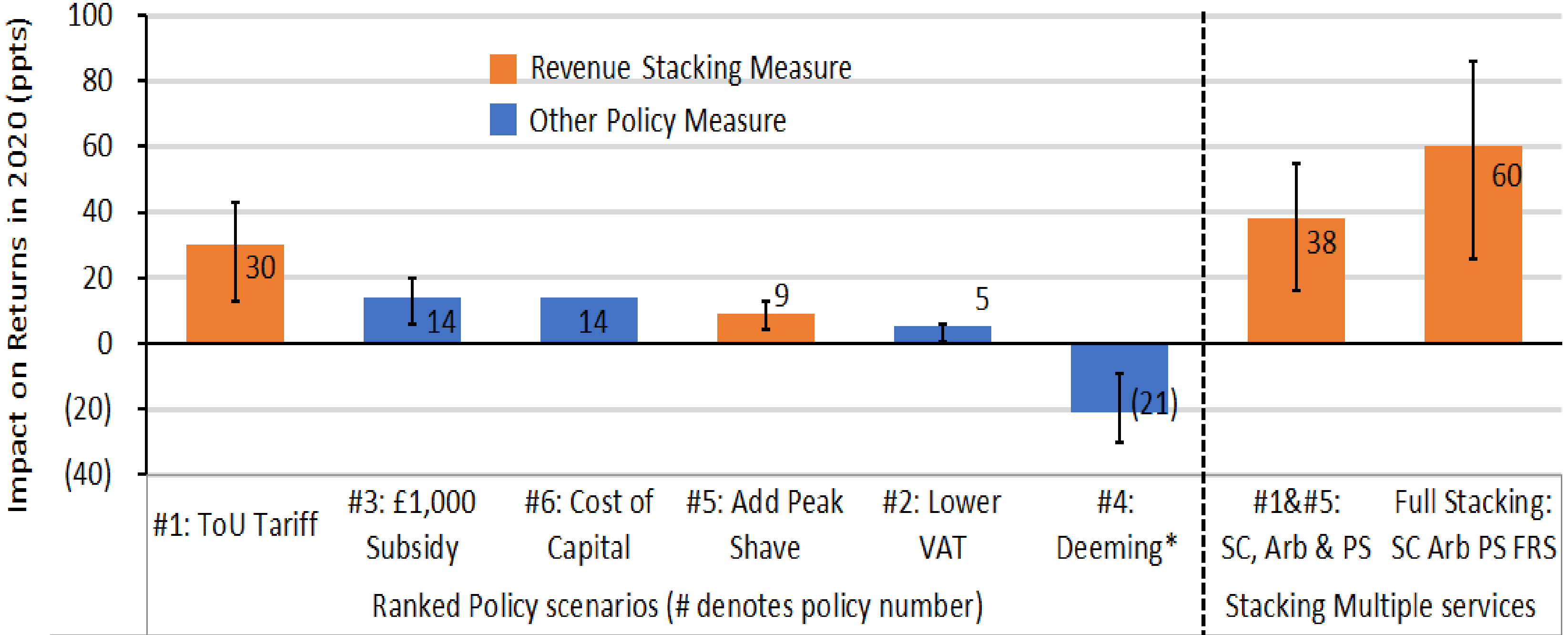
# Results (3): Comparing Policy Options

## Enabling ToU tariffs has the biggest impact on R

- 30ppts boost, 2x the impact of £1,000 subsidy
- Much more cost effective!

## Combining multiple services (“Stacking”) …

- A notional £75pa for FRS boosts R by 21ppts
- R remains –ve (-8%)

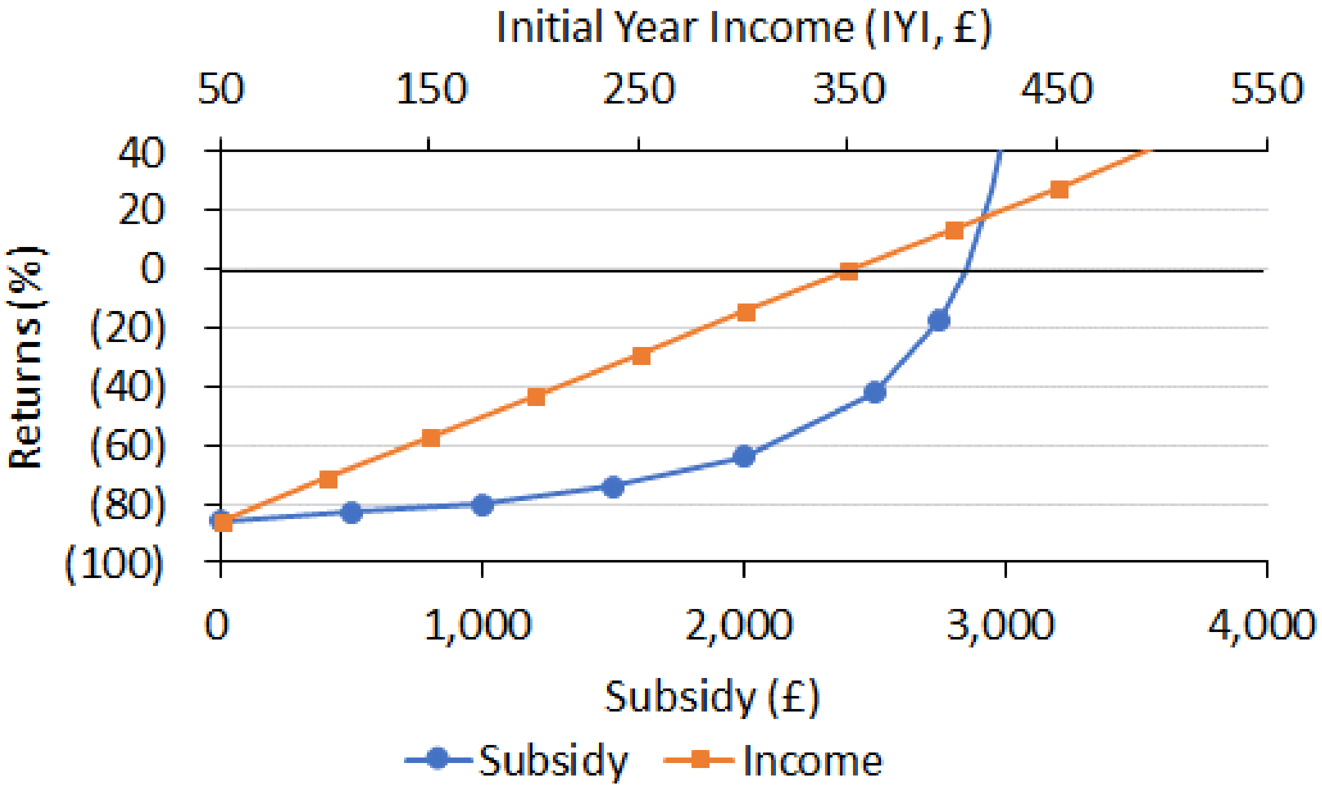



| | #1: ToU Tariff | #3: £1,000 Subsidy | #6: Cost of Capital | #5: Add Peak Shave | #2: Lower VAT | #4: Deeming* | #1&#5: SC, Arb & PS | Full Stacking: SC Arb PS FRS |
|---|---|---|---|---|---|---|---|---|
| BY | 2025 | 2025 | 2028 | 2029 | 2031 | | 2024 | 2021 |
| BIC (£) | 2,053 | 2,062 | 1,522 | 1,377 | 1,062 | | 2,336 | 3,047 |

# Results (4): Contrasting income boosting and cost reduction policies

**Measures that boost income (IYI) have a very different impact on R vs cost reduction …**

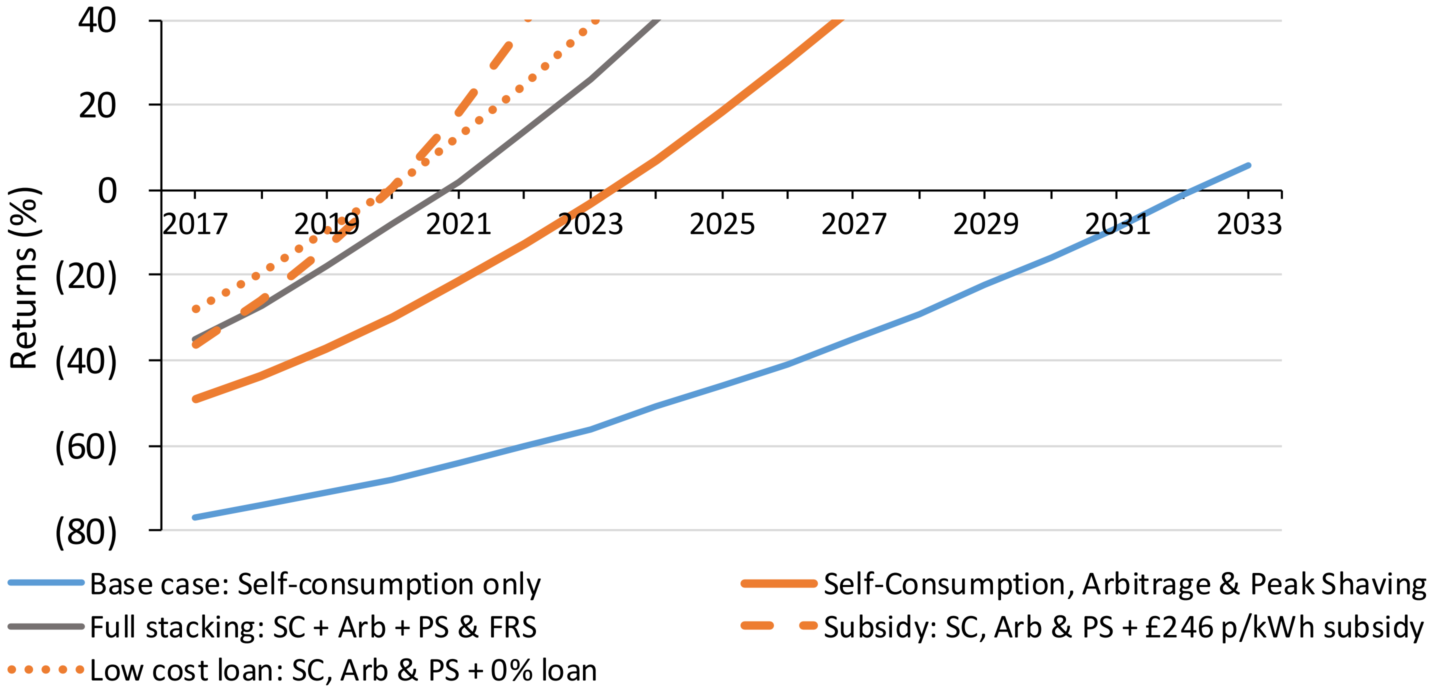
- Boosting IYI has a consistent benefit on R (every £50 raises R by c.15ppts)
- Measures reducing investment cost (e.g. subsidies) increasingly effective as R rises
- Suggests policy priority should be to raise IYI through stacking, then explicit support



# Results (5): Combining Policies to bring forward deployment

## Modest additional explicit policy support could significantly accelerate deployment …

- Stacking three services brings breakeven forward by nine years!
- Additional policy support (low cost loans/subsidies or combination) brings breakeven to c. 2020
- With stacking domestic batteries become very profitable post 2025. Widespread deployment?



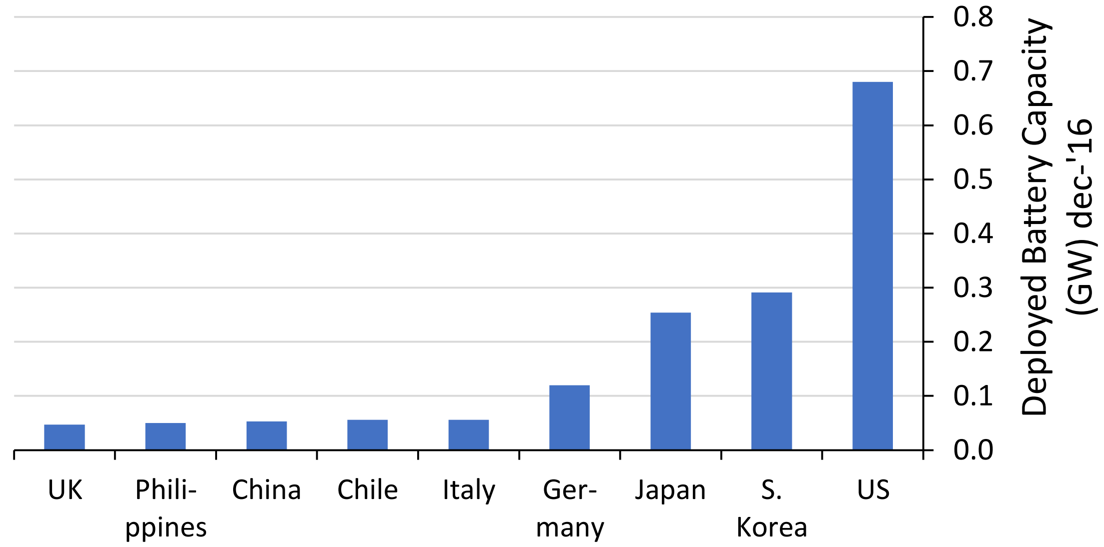
# Conclusions & Discussion Topics

## Conclusion: Deployment of domestic batteries likely to need additional policy support in the near term

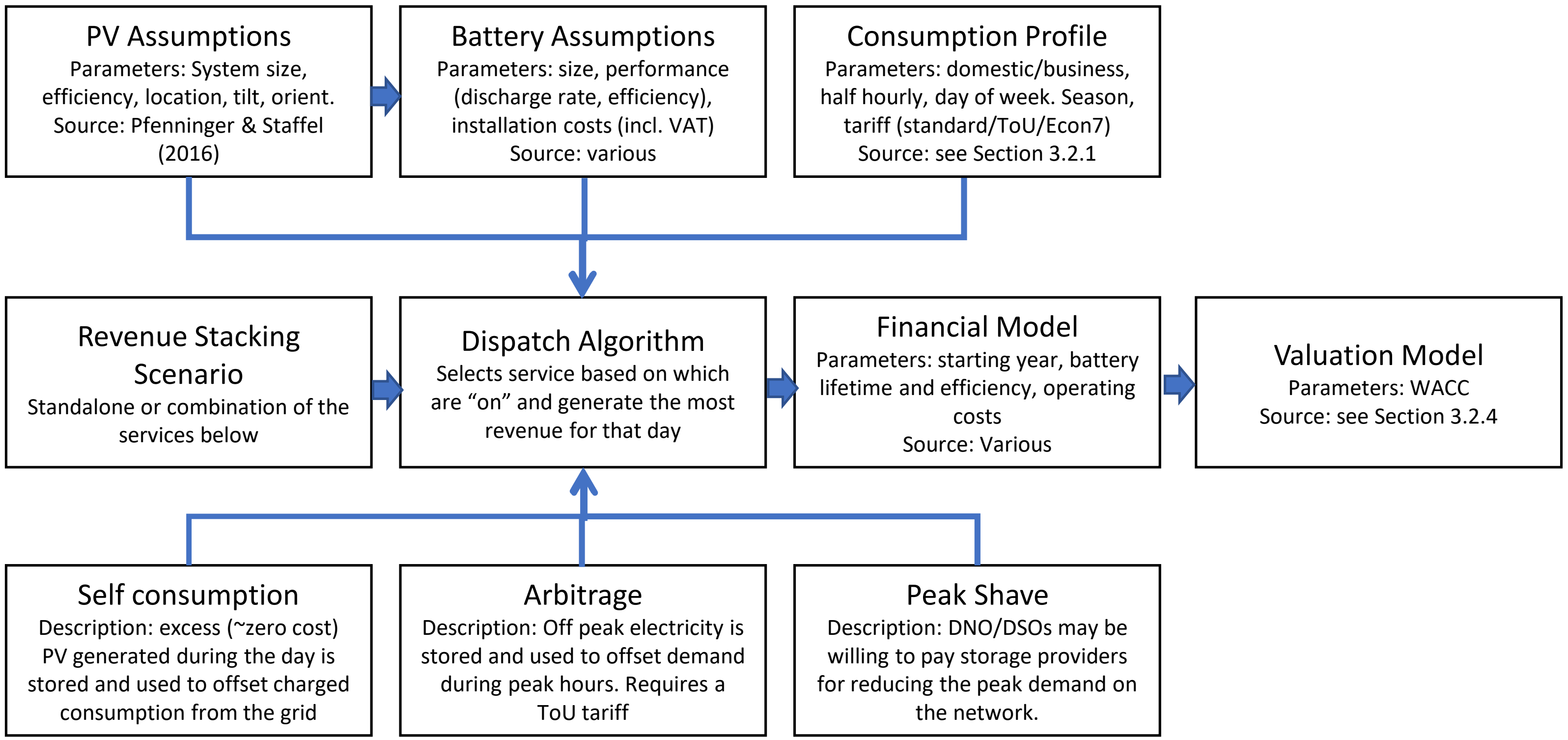
- Enabling "stacking" is where policy should focus
- A combination of "light" subsidy/low cost loans could then be effective
- Domestic batteries likely to become (very?) attractive beyond 2025 (with stacking)

## Discussion: What value does accelerating domestic battery deployment actually create?

- for the UK electricity system
- for Post Brexit UK plc.
- for UK consumer



# Note 1: Techno-economic model of a domestic battery



# Note 2: Model Assumptions

## The Battery:

- Lithium-ion 4kWh battery paired with a 4kW AC-coupled inverter
- Minimum charge of 10%
- 15 year lifespan with 1% pa decline in capacity
- 81% round trip efficiency

## Initial costs (IC):

- 2017 system cost of £3,940, or £985 ($1,280) per kWh
- System costs decline 12.4% annually
- Flat–rate installation charge of £385 plus 20% VAT

## Electricity consumption profile:

- Elexon “Standard” “Consumer” profile = 4,082kWh annually
- Flat rate tariff = BG Eastern region tariff of 14.2p per kWh (£595 annual bill)
- ToU tariff = TIDE from Green Energy (20p spread between peak and off-peak)

# Note 3: Measuring Policy Impacts

The Initial Year Income (IYI) adds together the electricity costs avoided through the use of the battery through Self-Consumption (SC) and Arbitrage (Arb), any payments the battery owner receives for grid services like Peak Shaving (PS) or FRS. This is potentially reduced by the impact the battery might have on PV export revenues (Exp) where $Exp_{pvstorage}$ is the income generated from PV after storage is installed and $Exp_{pv}$ is the original PV export income.

$$1)\quad IYI = SC + Arb + PS + (Exp_{pvstoraage} - Exp_{pv})$$

The income generated in the initial year (IYI) is unlikely to be constant in subsequent years. Degradation of the battery reduces capacity over the investment lifespan of the while real terms growth in electricity prices (assumed to be zero in the base case) can potentially increase annual income

Returns (R) is calculated as

$$\frac{\sum_{i=1}^{n} \frac{CF_i}{(1+r)_i} - IC}{IC}$$

The initial costs (IC) are subtracted from the net present value of the cashflow (CF) generated over the battery lifespan (n) discounted at rate (r). IC includes all system costs (battery plus inverter), installation charges, VAT and any subsidy. If $R < 0$ the investment loses money: the cash generated does not recoup the original investment. Dividing the net cash generated by the initial investment (IC) enables the performance of investments of different sizes to be compared equally

# Note 4: Interviewees' Responses

| Policy Barrier | Policy Issue | Evidence to Support Change | Potential Barriers to Implementation | Impact on modelling |
|---|---|---|---|---|
| 1) The availability of ToU tariffs | Most UK residential customers are currently on flat rate tariffs - they pay the same price for electricity in peak hours as in off-peak. Without peak and off-peak price variations EES cannot be used to provide Arbitrage and Self-Consumption benefits are reduced. | REA - "A lot of our members want ToU tariffs … its a simple way of monetising the benefit to the consumer … ToU tariffs would be really useful." MX - "Smart Batteries … can deliver an immediate ToU benefit and a customer benefit to households" | PV - "A few suppliers offering ToU but it is not genuine HHS - buying blocks of power at an average. Speeding move to HHS is a big issue" MX - "There is a real potential issue that bills will become uncertain and confusing by adding a new 'time' dimension. Such complexity strategies have been used in the mobile industry to raise prices" | Model ToU with different peak/off-peak spreads |
| 2) The appropriate VAT rate for retro-fit installations | Retrofit EES projects are currently charged VAT at a standard 20% rate vs 5% on PV with battery. However the ECJ ruled the UK needed to take items off the discount VAT list and solar was proposed. Current rules arguably make EES expensive, disadvantages standalone providers and creates uncertainty. | PV - "We think we can argue fairly objectively, that this is putting us, as a standalone provider, at a considerable disadvantage" MX - "needs to be harmonized … a 5% rate on installing solar with a battery could negate the EU legal case on discounted VAT rates" | PV - "… unlikely to be resolved soon. ECJ ruled that we need to take items off the VAT list and solar was offered to be bumped up to full rate. With the current hiatus there is unlikely to be [a decision] soon. | Model 5% vs 20% scenarios |
| 3) The applicability and level of any subsidy | The high cost of storage makes it uneconomic for consumers currently. Deployment of solar in the UK was originally supported by FiT (Feed in Tariffs) and export payments that reward homeowners for generating electricity. Other markets such as Germany and California have similar support mechanisms for storage | MX - "A light 'subsidy' would be the cheapest way for UK to ensure convergence, consistent delivery [and track installations]. Innovative domestic solutions [could] lose out to US or other markets with a temporal subsidy." PV - "The FiT has been cut so low, there is huge underspend currently, there would be budget available. Its more a question of political will". | PV - "I think there is a view in the industry that we don't want a [low cost loan/subsidy] given the history of FiT. When they are cut it does enormous damage to the industry" MX: "No or low subsidies … is ironically helpful in enabling companies and technologies to deliver a 'subsidy free' solution" | Model different levels of subsidy |
| 4) The potential reform of "deemed" of PV export tariffs | Currently homes with solar are "deemed" to export 50% of PV to the grid. Adding storage reduces the level of PV exported but homeowners are currently still paid the deemed 50% export rate ie, they are paid for electricity they are not exporting. | REA - "surprised that the FiT tariff reforms in Feb-16 didn't mandate everyone to get a smart meter but that was probably good for storage" PV - "BEIS start thinking about … full price export tariff … once the FiT runs out in 2Q2019" | REA - "Storage devices are … benefitting the system as a whole. Deeming is a big motivation to get storage – you get an extra payment for that 50% … don't change it until you have something sustainable in its place." | Model the impact of removing deeming |
| 5) The need to establish a market for network savings | ~ 26% of the average electricity bill is network charges. Residential demand in the evening and solar peaks during the day are putting pressure on the network in some areas and forcing DNOs to upgrade. | PV - "Markets for [deferring network spending] will see immediate and tangible savings for consumers. It's a sort of a win-win-win situation" MX - Network peaks could be cut by 1) DNO incentives under RIIO 2) payments for BTM installers 3) allowing storage provision to cut network charges 4) cutting charges for new towns with lower peaks 5) Enabling asset finance | PV - " … the networks have spotted that they don't actually need to upgrade this any more so Ofgem has cut their funding" | Model the introduction of Peak Shaving |
| 6) Financing costs | The high upfront capital cost combined with a long payback lifetime means that cost of capital assumptions have a big impact on the value of the investment. Different investors in the market will have very different cost of capital eg operators with 1% vs consumers or equity investors at 7-9% | MX - finance a critical factor … "NIC (National Infrastructure Commission) also needs to play a role in systemic asset financing issues" REA - "UK businesses have consistently faced a 'Valley of Death' in the commercialisation … good support for R&D … for projects which are near to market … there has been a lack of adequate financing" | MX - provision of finance might need a separation in the role of "Battery Asset Provider" and "Battery Operator" REA - "key to this is sorting out … longer term revenue streams" | Model returns with different cost of capital |

# Note 5: System Cost Assumptions

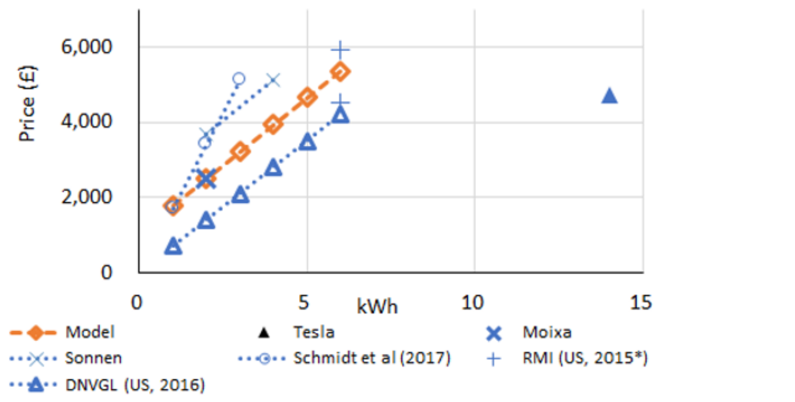



***Figure 7: Published Residential Storage System Prices in the UK***

*Tesla and Moixa prices from company websites (see Tesla, 2017; Moixa, 2017), Sonnen from distributor (CCL, 2017). Prices include battery and inverter but exclude installation and VAT. Prices compared with costs modelled by Schmidt et al., (2017), RMI (Rocky Mountain Institute, 2015), DNV GL (2016) and our modelling assumptions. * RMI's 2015 prices discounted by 10% to reflect an additional year of cost declines.*

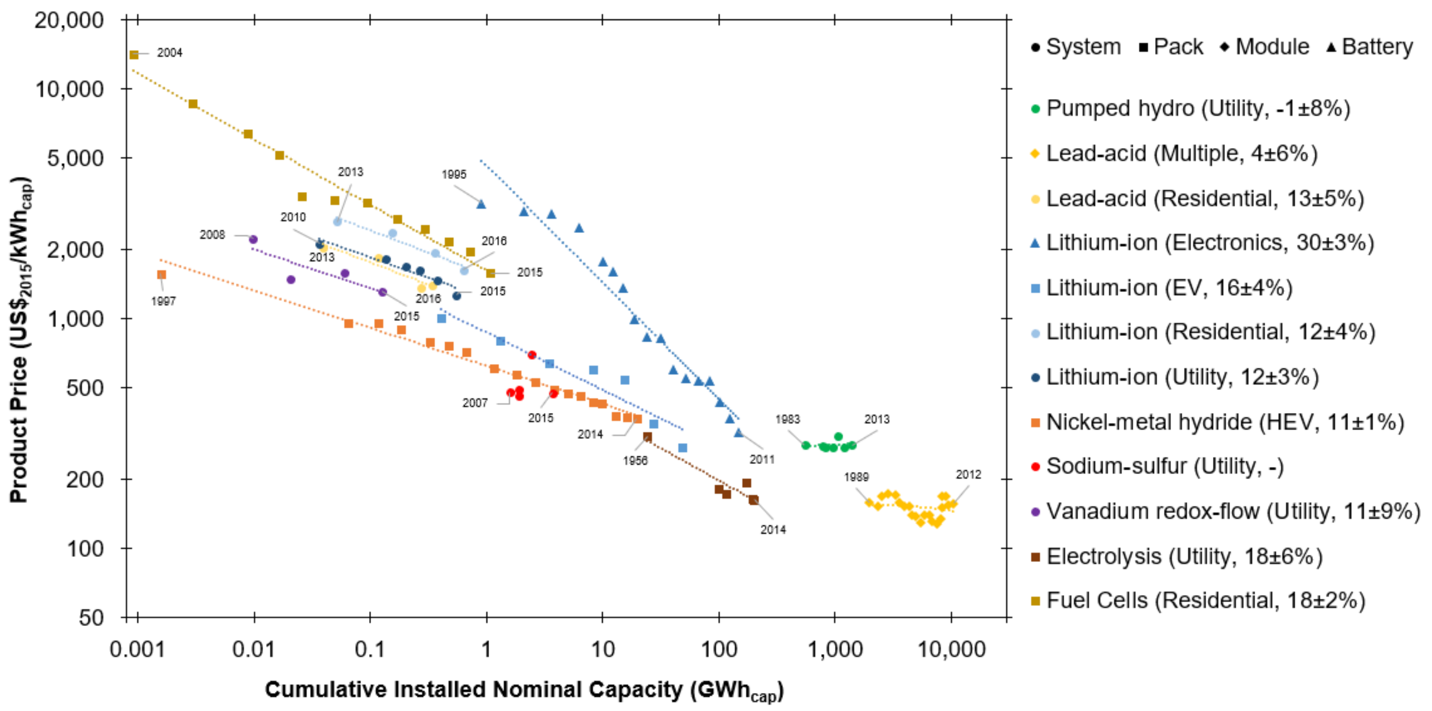



**Figure 1. Experience curves for EES technologies.**

Schmidt, O., Hawkes, A., Gambhir, A. & Staffell, I., 2017. The future cost of electrical energy storage based on experience rates. Nature Energy, 2(17110), pp. 1-9.