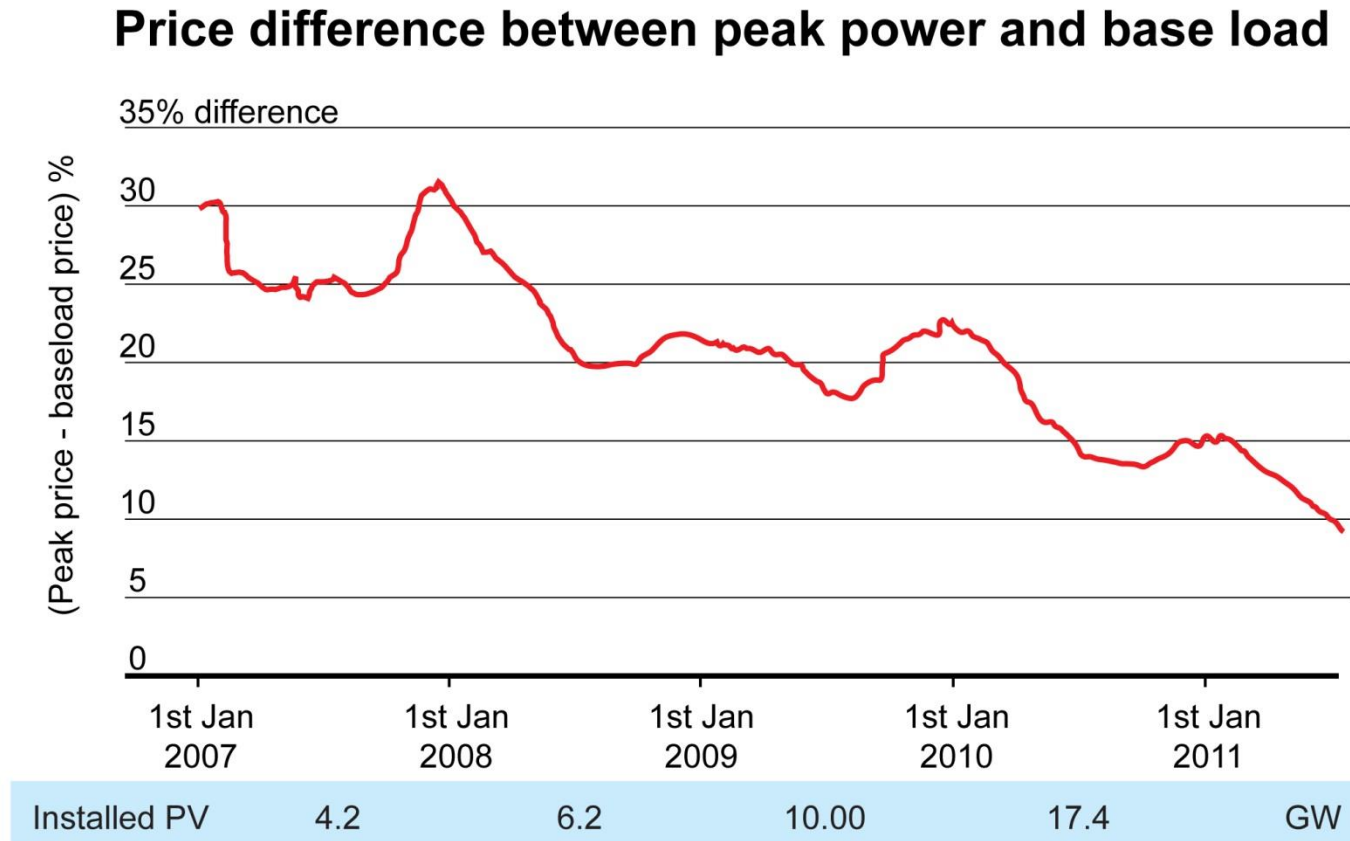


All You Need is Light

- Sunlight heats different regions of the earth's surface to different temperatures: gives us **wind power**
- Sunlight + photosynthesis: give us **bio-electricity**
- Sunlight + positive electricity: give us **solar PV**
- *Get it from the sun (GIFTS)*: all you need is **wind, bio-electricity & solar PV** to supply UK electricity demand
- Could **PV & bio-electricity** help Scotland achieve its 2020 renewable target?

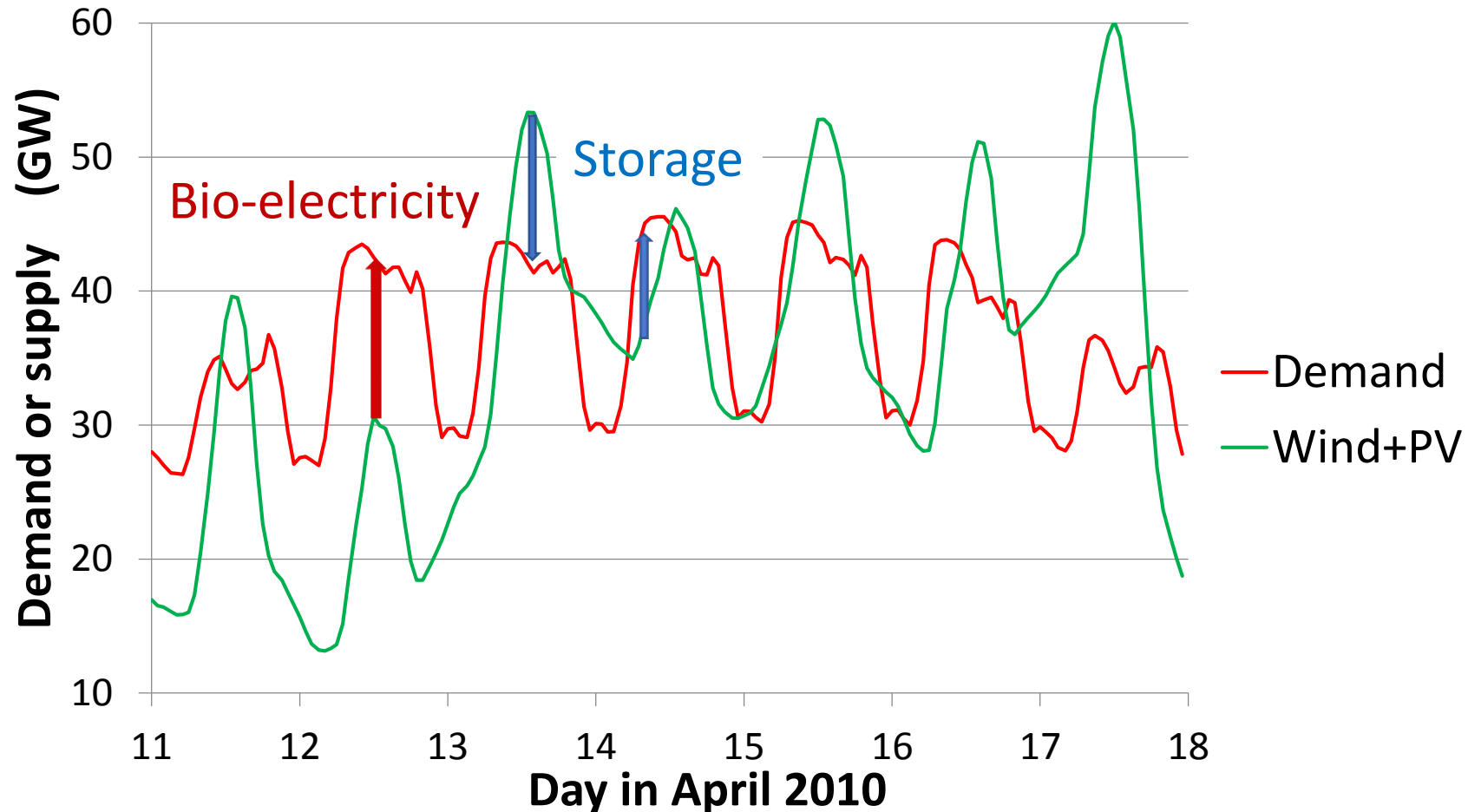
Germany shows PV is important - even in Scotland



- Germany 2011 PV **3%** of electrical energy but peak fall **20%**

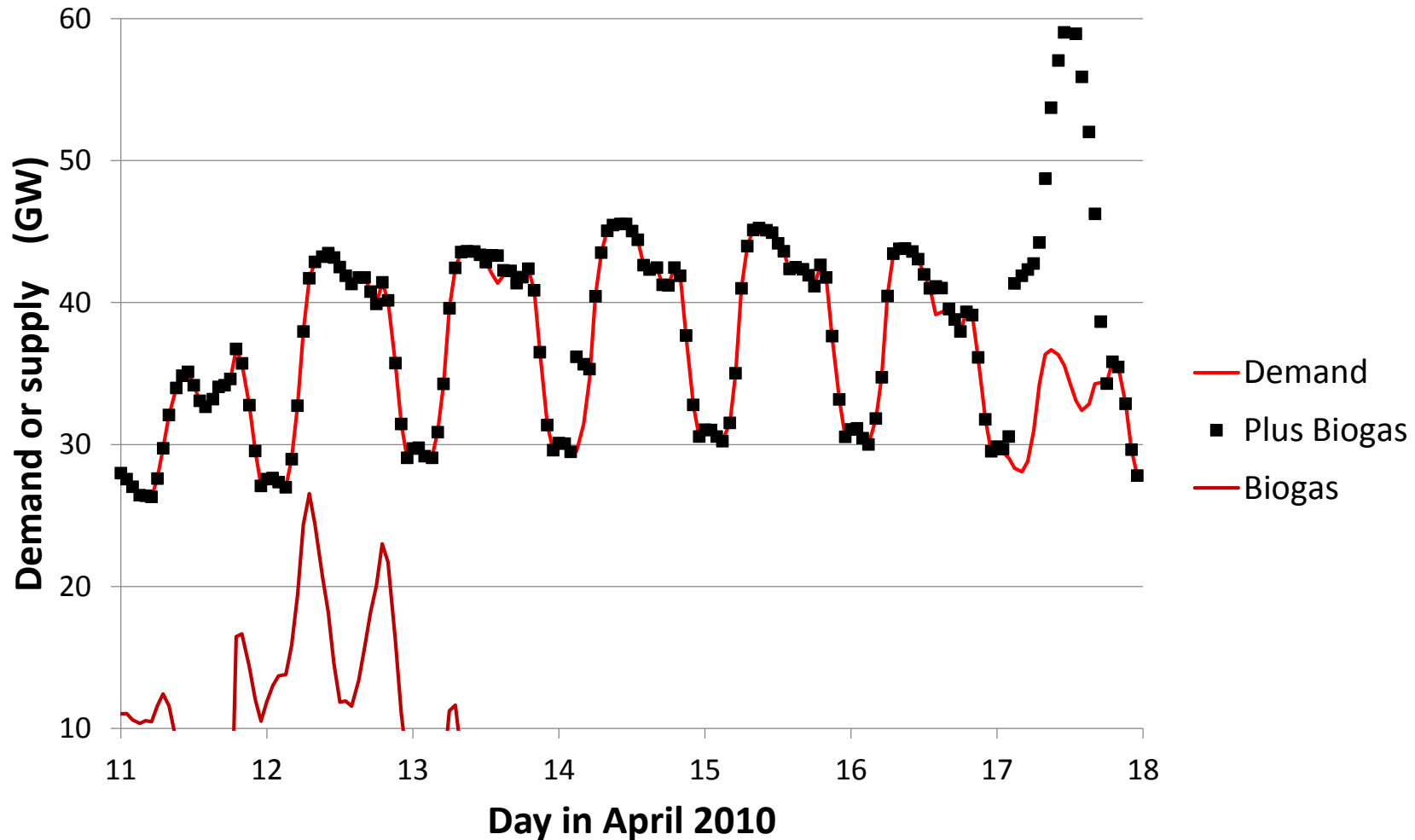
GIFTS spreadsheet balances hourly power supply & demand

Phil James (CAT), Jamie Taylor (Sheffield Solar), Orrin Lancaster (University of Queensland)



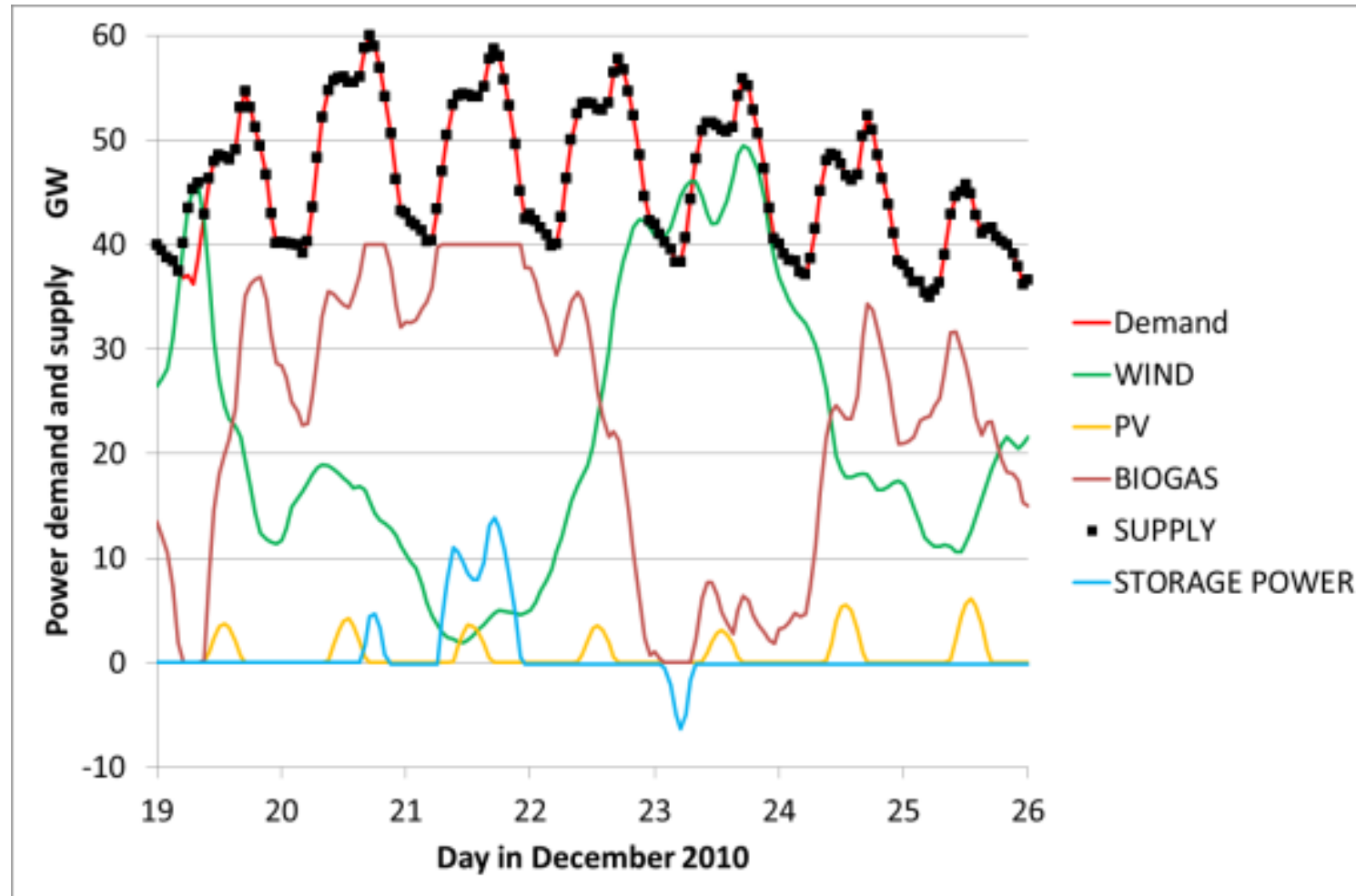
- (PV & Wind) = **78%** is first approx. to April week's demand
- Excess to **storage around 6%** needed if **16% bio-electricity**

Supply less than demand: bio-electricity



- (15-16)% biogas back-up 24/7, 52 weeks/year as in Germany
- Back-up *flexible* & from anaerobic digestion (AD) farm waste

Worst week for wind – pre Christmas 2010



- For 8 hours nuclear competes with cheap wind for storage
- Over 10% of Christmas dinners cooked by solar PV!

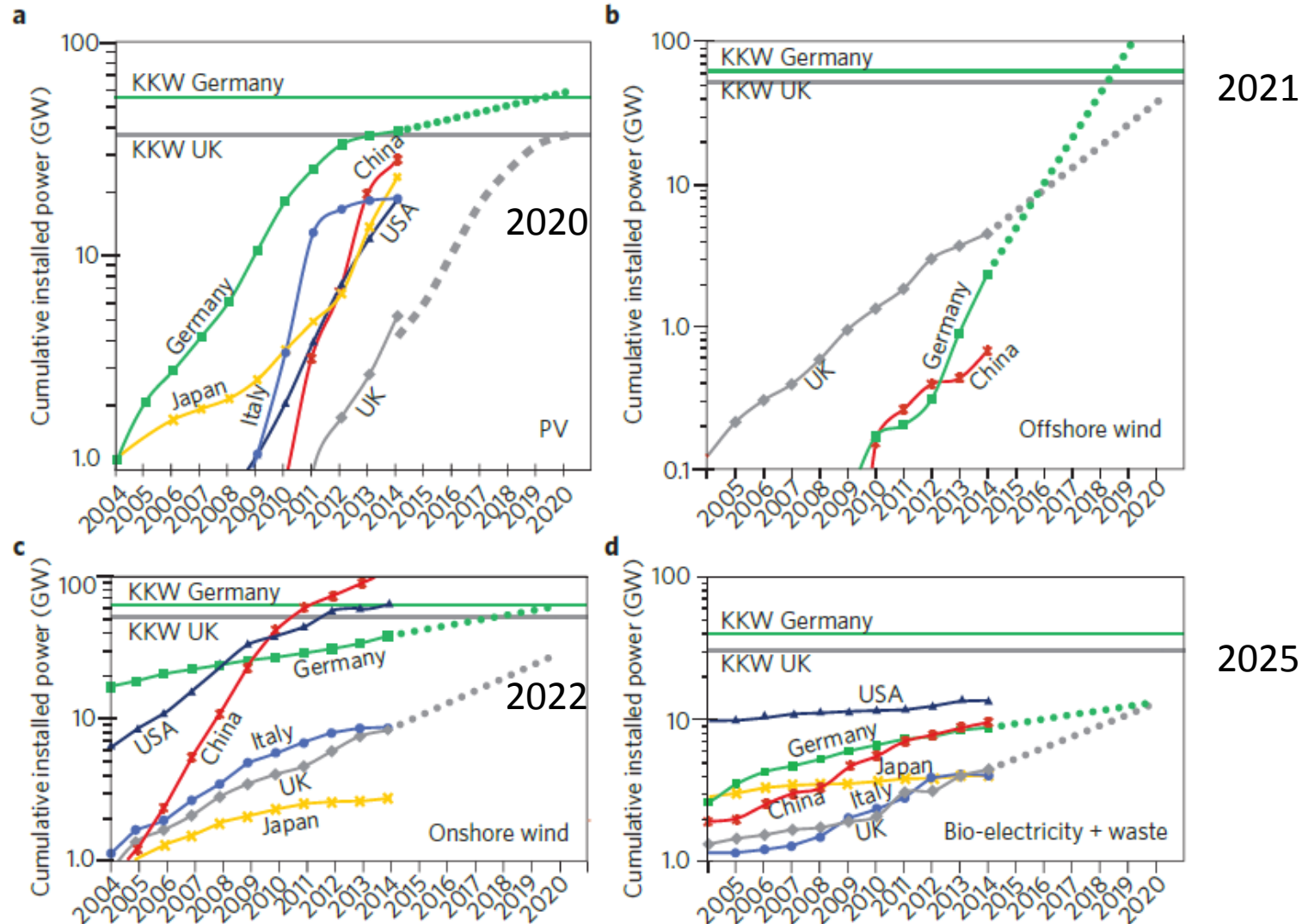
Bio-electricity from anaerobic digestion (AD)

- Farm animal & crop waste + food waste => AD
=> **bio-methane** for **electricity** and **gas** grids
- Very low carbon footprint: avoids waste rotting on ground or in landfill to produce greenhouse gases
- AD constant supplying gas grid when not electricity
- Cheaper than fracking and already delivering



But for Westminster's cuts UK could have had all-renewable electricity by 2025

Keith Barnham et al. *Nature Materials* 15, 115, 2016

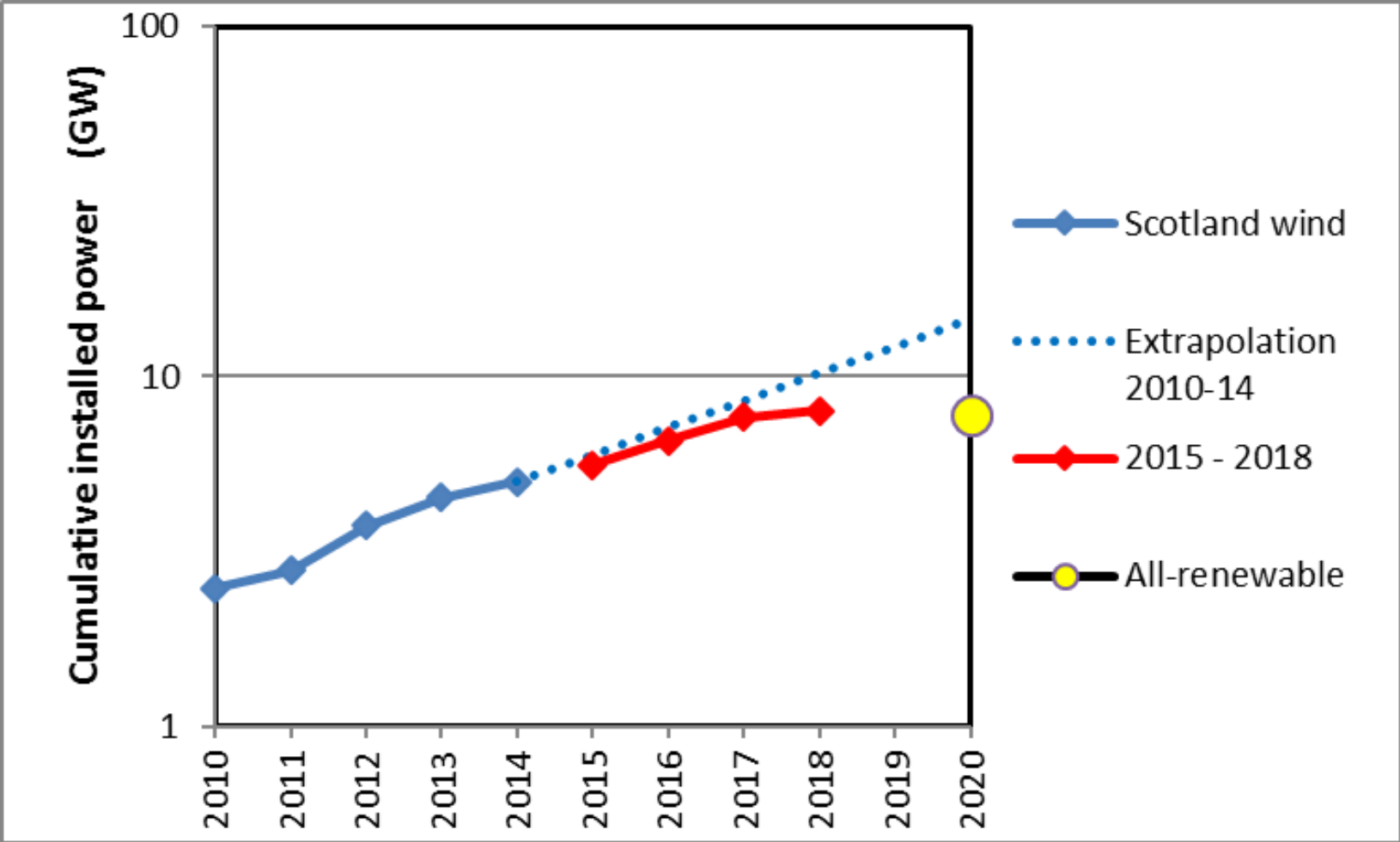


Scotland's all-renewable 2020 target

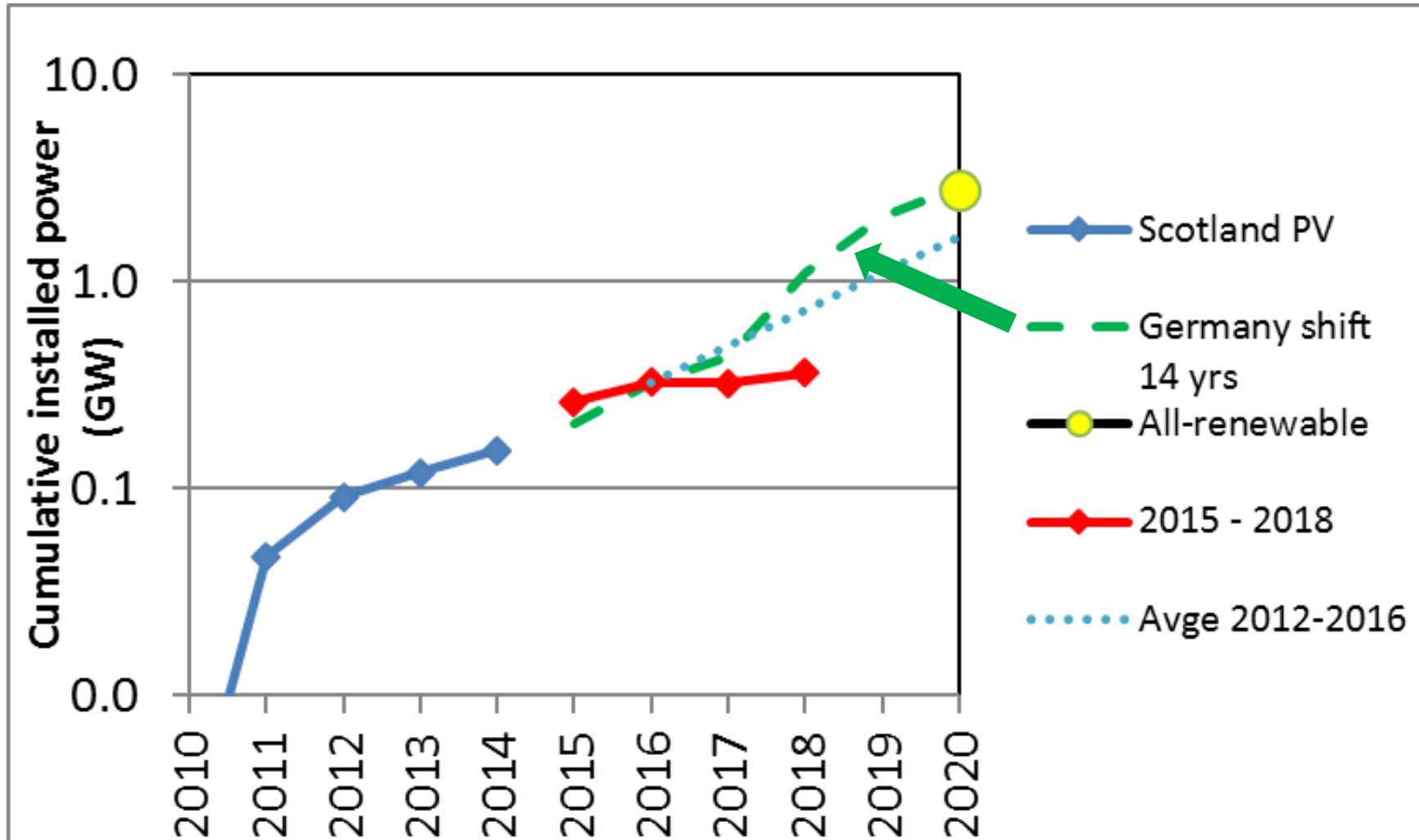
Presented to Energy Deployment Division of the Scottish Government on 2-2-18

- Scotland aims to generate as much electrical **energy** from wind in 2020 as total energy demand that year
- Last year Economics team, suggested falling behind
- Scottish wind & solar PV are on course to hit **GIFTS** all-renewable, hour-by-hour **power** target by 2020
- However, faster expanding flexible back-up required
- How **GIFTS** can help Scotland hit the target

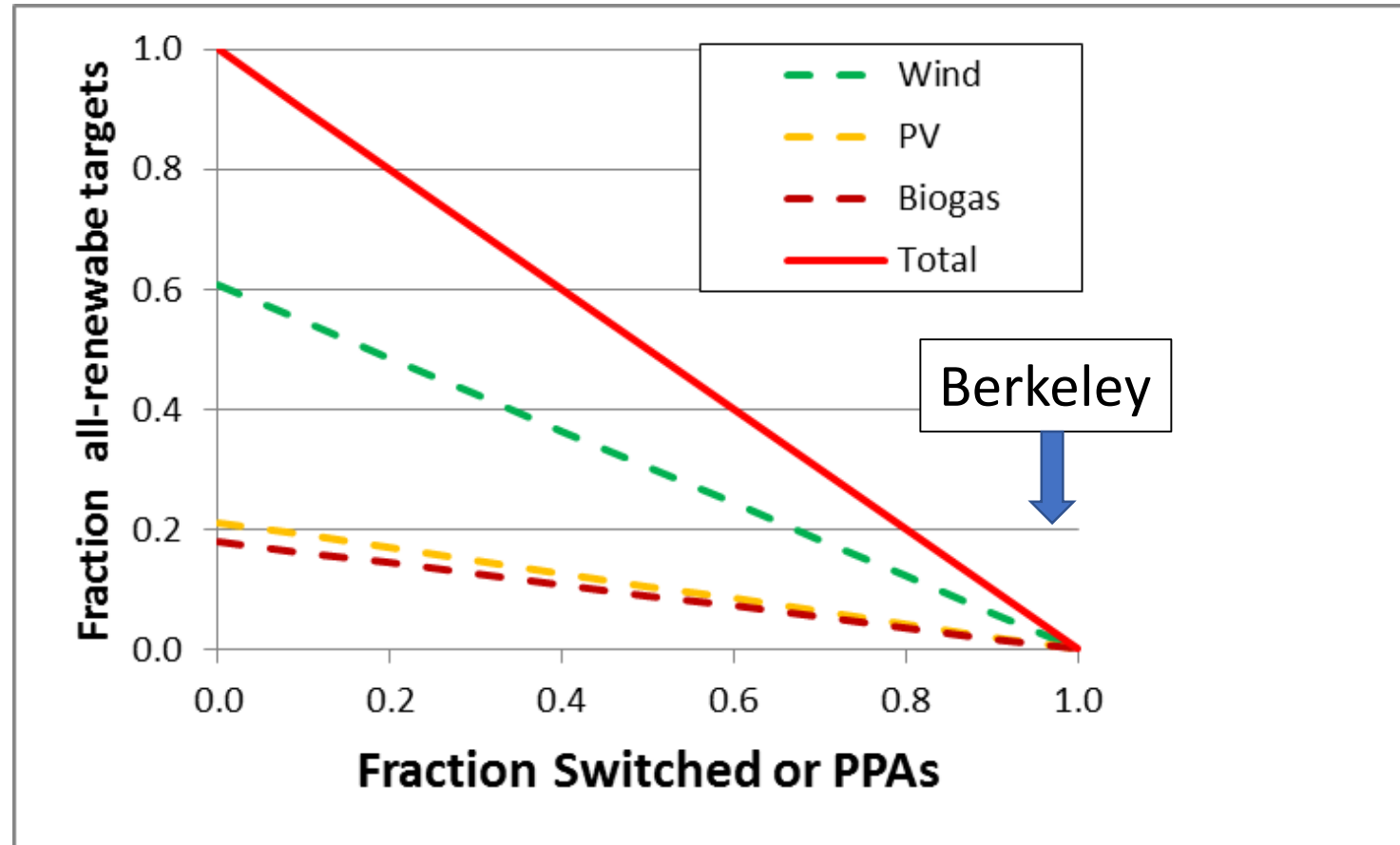
Installed wind power in Scotland



Installed PV Power in Scotland



GIFTS shows how Scotland can achieve target



- Biogas includes farm/food waste => AD (electric equivalent)
- Wind, PV, biogas targets reduce as homes & industry switch

Points for discussion

- Scottish wind on course for *GIFTS* 2020 target
- Please can SSEG help me get over to MSPs:
 - 1) PV, and bio-electricity targets reduced if count how many companies and households switch
 - 2) Scotland behind on bio-electricity but electricity equivalent of waste sent for AD counts in *GIFTS*
 - 3) Scotland up on storage if hydropower flexible
- Tomorrow's MSC workshop will use *GIFTS* to find PV & bio-electricity needed with 2020 wind
- Can SSEG help with Scottish hourly PV data?

Can solar cells contribute to Scotland's all-renewable electricity target in 2020?

- Scotland aims to produce as much electrical energy by wind power in 2020 as it consumes in that year
- **All-renewable electricity supply:** renewable power equals power demand every hour of the year
- ***Get it from the Sun (GIFTS)*** is a 8760 line spreadsheet matching demand and renewable supply
- ***GIFTS*** shows how important solar photovoltaics (PV) is to an all-renewable electricity supply

Westminster's hopes for Scotland's target

Keith Barnham, The Independent, 9th May 2016

- 1) By end **2016** UK had **36.8** GW of renewable power
- 2) Renewables increased over **7** times in the past **10** years
- 3) BEIS/DECC hope they **will not even double** in **20** years
- 4) BEIS hopes net renewable installations in **2030** zero

