Explanation of rate of return calculation for domestic PV

1. The consultation proposes solar PV generation tariffs that aim to provide around a 4.5% rate of return on capital for well-sited installations up to 4kW systems, and an approximate 5% rate of return on capital for larger installations.

2. The tariff calculations are based on a 'reference installation' with a defined set of characteristics (see Table 1 below for assumed characteristics for up to 4kW installation).

3. In order to determine the generation tariff level required to deliver a particular rate of return on capital for solar PV, the following information is required to estimate cost and revenue streams:-

    - Revenue streams:
        - Generation tariff income
        - Income from exported electricity
        - Bill savings (from avoided electricity imports)

    - Cost streams:
        - Capital cost (CapEx)
        - Operating cost (OpEx)

Rate of return calculation – detail

The methodology returns a required generation tariff for a given target rate of return on capital. The required generation tariff must make up the difference between the value of all other cost and revenue streams at the intended rate of return (RoR).

Step 1- calculate levelised generation costs

The levelised (p/kWh) cost is of the project is calculated as follows:-

Levelised cost =
[Annuitized CapEx + Annual OpEx]
÷ Annual kWh generation
x 100 (to convert this result from £/kWh into p/kWh)

Capital expenditure is a one off payment in the first year. By annuitizing this expenditure, the costs are spread over the lifetime of the project. This is done using the PMT function in excel, using a discount rate at the intended RoR, over the 35 year expected life of the technology.

Opex covers maintenance, labour and any running costs and is assumed to be constant over time. There are no other elements of costs. To deliver the target return over 25 years, the cost over 35 years is squeezed into a 25 year period.

Dividing through by the system's annual generation provides the levelised cost in £/kWh. Multiplying through by 100 converts this into p/kWh.

Step 2- calculate revenues

The revenue stream from all sources is calculated as:

Revenue stream =
[% onsite use x retail electricity price over 25 years]
+ [% export to grid x export tariff over 25 years]
+ [annuitized post-tariff lifetime revenue]

The annuitized post-tariff lifetime revenue is the annual stream of bill savings between years 26 and 35. This is assumed to accrue over the 25 year tariff lifetime. The annuitized revenue stream is divided by total annual electricity generated to derive revenue per KWh electricity produced.

Step 3 calculate generation tariff

The required generation tariff is the difference between the levelised cost and the revenue stream. This ensures that levelised costs equal levelised revenues, where costs include a return on capital of 4.5/5%.

Example sub- 4kW retrofit solar PV

Table 1: assumptions / data sources for calculating required generation tariffs for a sub-4kW retrofit solar PV (2012-13 installation)

Metric	**Assumption**
Capital cost (£/kW)	A fixed £1,470 plus £2,811/kW (2010 prices, for 2012-13 installation)
Annual operating cost (£)	£70 (2010 prices)
Load factor	850 kWh/kW/year
Technology lifetime	35 years
Reference installation size	2.6kW
Assumed use	50% onsite, 50% export
Export tariff	3.1p/kWh in 2011/12, will rise with RPI in April 2012
Domestic retail electricity price	15.4p/kWh (projected 2012/13 value, 2010 prices)
Annual post FITs revenue – bill savings and export	£251 annual revenue from years 26 to 35

Projected RPI between 2010/11 and 2012/13	9.9% over 2 year period

These assumptions are derived from DECC projections, the consultants Cambridge Economics Policy Associates (CEPA) and Parsons Brinckerhoff (PB) who DECC engaged to work on the comprehensive review of FITs, and OFGEM. The reference case used is a 2.6kW installation which starts generation in 2012-13 and is expected to generate 2,210kWh per year (50% of which is assumed to be used onsite and 50% exported back to grid), has a capital cost of £8,779 and an annual operating cost of £70 (2010 prices). The installation lasts for 35 years, the tariffs last for 25 years and the target rate of return is approximately 4.5%[1].

Step 1

Levelised cost =
[-PMT(0.0445, 35, £8,779)[2] + £70] x
[PV(0.0445,35,1)[3]/PV(0.0445,25,1)]
÷ 2,210 = £0.304/MWh
-> to convert this result from £/MWh into p/kWh, multiply by 100
= approx 30.4p/kWh

Step 2

Annuitized post tariff revenue =
[£251 x { PV(0.0445,35,1) – PV(0.0445,25,1)} / PV(0.0445,25,1)]
÷ 2,210 = £0.020/MWh
-> to convert this result from £/MWh into p/kWh, multiply by 100
= approx 2.0p/kWh

Required generation tariff =
[30.4 – (0.5 x 15.4) – (0.5 x 3.0) – (2.0)]
= approx 19.1p/kWh

This value is in 2010/11 prices. It is inflated by multiplying it by 1.099 to 2012 prices to give the FIT rate **21.0p/kWh.**

Some values may not match up exactly due to rounding of the assumptions in the tables above. It should also be noted that the above calculation methodology and derivation of rate of return implicitly assumes that the project is 100% equity financed. In reality, individual returns to investors in particular projects may differ according to financing approach e.g. the debt/equity ratio.

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[1] NB 4.5% is approximate only. The actual rate used in the calculation is 4.45%.

[2] Annuitized capex can also be calculated using the formula $A = P(i + \frac{i}{(1+i)^n - 1})$ which is equivalent to the PMT function in Microsoft Excel.

[3] Present value of a stream of payments can be calculated using the formula $PV = C\frac{i-(1+i)-n}{(i)})$ where C is the value of payments, n is the number of payments and i is the interest rate .). This is equivalent to the PV function in Microsoft Excel.