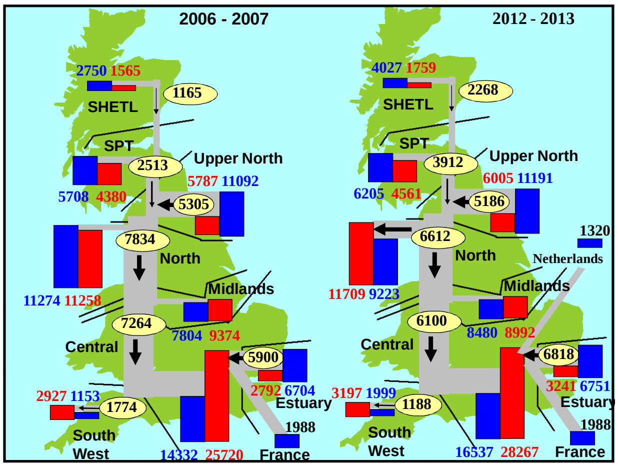
NBS-M009 – 2010 LOW CARBON BUSINESS REGULATION AND ENTREPRENEURSHIP

Transmission issues for the Future

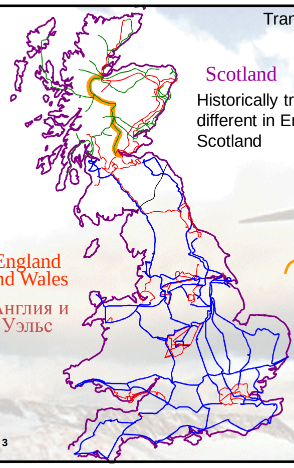
Mechanisms to Promote Renewable Energy

- Non Fossil Fuel Obligation
- Renewable Obligation
  - Marine Supply Obligation (Scotland)
- Feed in Tariffs
- Renewable Transport Fuel Obligation
- Renewable Heat Incentive?
- An Integrated Obligation?

1



Transmission Network in the UK



Scotland

Historically transmission networks have been different in England and Wales compared to Scotland

400 kV

275 kV

132 kV

Beauly Denny Line is a constraint – upgrade has raised over 18000 objections

Transmission throughout England, Wales and Scotland became unified on April 1st 2005

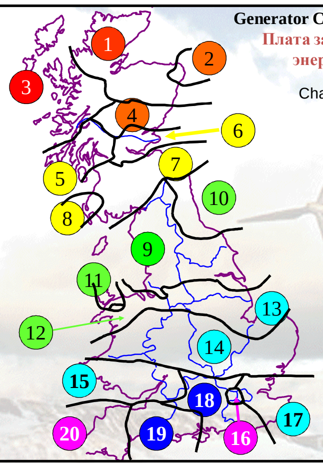
3

3

Generator Connection Charges under BETTA

Плата за подключение к генератору энергоснабжения по BETTA

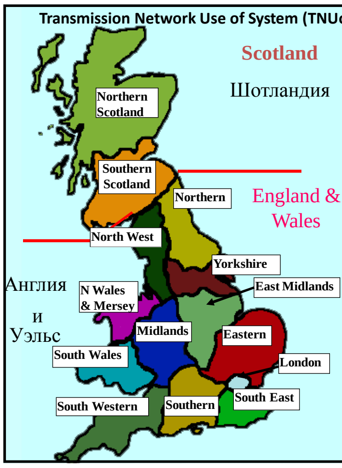
Charges from 1st April 2010



- A > £20 per kW
- B £15 to £20 per kW
- C £10 to £15 per kW
- D £5 to £10 per kW
- E £0 to £5 per kW
- F - £5 to £0 per kW
- G - £10 to -£5 per kW

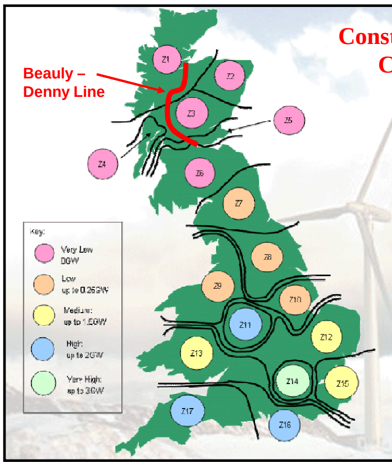
4

Transmission Network Use of System (TNUoS) Demand Charges (2010 – 2011)



Zone	TRIAD Demand (£/kW)	Energy Consumed (p/kWh)
N. Scotland	5.865932	0.790954
S. Scotland	11.218687	1.547861
Northern	14.523126	1.993796
North West	18.426326	2.552189
Yorkshire	18.344745	2.520788
N Wales & Mersey	18.891869	2.625780
East Midlands	20.934125	2.886193
Midlands	22.692635	3.184194
Eastern	21.835099	3.026211
South Wales	22.524989	3.028765
South East	24.633810	3.377343
London	26.756942	3.602492
Southern	25.494450	3.537180
South Western	26.057832	3.553243

Constraints on Grid Connections



Opportunities for Grid Connection in different regions of UK.

Much of Renewable resource is in Scotland where constraints are high.

Critical is lack of capacity on Beauly – Denny Line which needsu rgent upgrading but is facing protracted delays – over 17000 objections lodged.

6

REGULATED POWER ZONES

- Transmission and Distribution Networks are critical to electricity security.
- Losses on line:
  - $= I^2 R$ where I is the current and R is resistance
- the power transmitted $P = V * I$ - V = voltage
  - Typical UK domestic voltage - 240V
  - European Voltage - 220V
  - North American Voltage 110V
- These are nominal voltages and system must control voltages within a narrow band of this.

Losses are reduced by increasing voltage

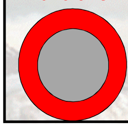
Voltage	%loss relative to 240 V
240	100.0%
11000	0.047603%
33000	0.005289%
132000	0.000331%
400000	0.000036%

7

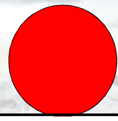
REGULATED POWER ZONES

- The consequence of resistive losses is that the transmission and distribution cables heat up and may typically be running at 50° C+
- As they heat up they expand and the cables will sag more at mid-span with a the possibility of a flashover.
- This means that there will be less sag when the cable temperature is lower – i.e. in winter and also in times of higher wind speeds when the cooling effect of the wind will be greatest.

There is thus a maximum power load that any cable can take and this limits the number of connections that can be made.



A further problem with AC transmission is that current flows mostly through the skin with much of the cross section not used effectively.
Unlike DC



REGULATED POWER ZONES

Traditional way to allocate generation connections:

- Order of application according to potential maximum connection capacity up to total capacity of transmission/distribution line.
- A safe approach which ensures that transmission/ distribution lines are not overloaded.

BUT

- May not make optimum use of transmission capacity.

Example:

- Suppose a line has 2000 MW capacity - a typical twin circuit 400 kV line.
- Order of connection allocations:
  - Generator 1: 1000 kW – say with 2 x 500 kW sets
  - Generator 2: 500 kW
  - Generator 3: 500 kW – with 2 x 250 kW sets.

9

REGULATED POWER ZONES

	Generating Sets	Total installed capacity
Generator 1	2 x 500 kW	100kW
Generator 2	1 x 500 kW	500 kW
Generator 3	2 x 250 kW	500 kW

- If all sets are generating – 2000kW i.e. capacity of line and no more sets can connect without the expense of transmission line upgrade.
- If generating sets are fossil fuel, then they may have a relatively high load factor and traditionally that has not been a problem.
- BUT if say one of Generator 1's sets is not generating, only 1500 kW or the 2000 kW of the line capacity is used.
- BUT no new generators can connect as the inactive set may come back on line.

Grandfathering Rights

10

REGULATED POWER ZONES

Problem is exacerbated with generating plant of low load factor e.g. wind and was first identified in Orkney where significant renewable generation threatened to seriously overload distribution system.

Orkney is connected to mainland by 1 x 30 MW and 1 x 20 MW cable. A fossil fired power station on Flotta associated with the oil terminal must run for safety reasons typically around 4.5 MW.

Burgar Hill had historic rights of around 7 MW with the European Marine Energy Centre a further 7MW also in this category.

Thereafter there were several other wind developments which threatened to exceed total capacity of cables to mainland as it was assumed that one of the two cables might be out of action giving only a maximum potential connection capacity of 20 MW.

11

REGULATED POWER ZONES

Total Historic Generating Capacity ~ 18.5 MW
Minimum Demand in Orkney ~ 7 MW
Capacity of smaller cable to mainland ~ 20 MW

Maximum Generation on Orkney which would not overload single mainland cable is

27 MW – i.e 8.5 MW new capacity could be connected.

But EMEC capacity is often 0 MW, and rarely is Burgar Hill at its rated output.

If dynamic dispatch of generation capacity is used much more generation could be connected.

12

REGULATED POWER ZONES

Evaluate total system capability at any one time
C = mainland connection capacity (i.e. 20 or 30 or 50 MW)
+ instantaneous demand on Orkney

Subtract from this those generating connection which have grandfathering rights, but only up to the amount of instantaneous generation (NOT maximum connection rights)

This gives maximum additional capacity which can be connected at that time.

If this also is done on a first application first served basis, it would be possible to connect much more renewable generation than otherwise possible.

However, it may mean that wind turbines at the end of the queue may not be able to generate when wind speed is optimum and returns on investment are best

REGULATED POWER ZONES

Suppose C = 60 MW – i.e. both cables operating and demand is 10 MW

If Flotta output is 7 MW and EMEC is 7MW and Burgar Hill say 3.5 MW (i.e less than rated connection of 7MW as wind speed is low – i.e. instantaneous load factor is 50%)

Available additional connection is 60 – 17.5 i.e 42.5 MW

If this were taken by additional Wind at 50% load factor then 85 MW of additional capacity could connect.

BUT if wind speed increased to rated speed of wind turbines, Burgar Hill would now be at 7 MW and available capacity would be 39 MW.

If all of this were as wind turbines at rated output (i.e. 100% load factor) only 39 MW could actually generate and 46 MW would have to shut down at the time they were most productive.

14

REGULATED POWER ZONES

Consequence of Dynamic Regulation of Power Zone

- More effective use of transmission/distribution cables is made
- A greater proportion of renewable energy can be brought on line at an earlier stage

BUT

- Those connecting last may find return on investment poor.

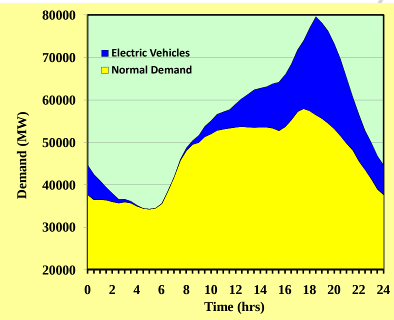
Lincolnshire RPZ operates only to transmit power from offshore wind farm

- Does not primarily address demand, but cooling effect on cables to minimise sag
- In winter – higher wind speeds – greater output capacity from wind turbines
- BUT weather is cooler and cooling effect of wind on cables is greater so cables can transmit more

15

SMART GRIDS – DYNAMIC REGULATION of DEMAND

ELECTRIC VEHICLES: Widespread deployment of electric vehicles could adversely affect the generation of electricity – leading to less effective use of generating capacity.



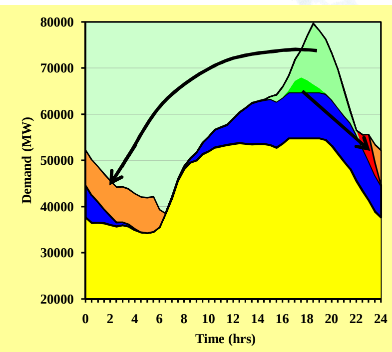
Existing peak demand occurs around 17:00 the time when most people return home .

Owners would potentially would start charging their vehicles potentially exacerbating the load profile

Electric Vehicle demand from Dave Openshaw http://www.eeegr.com/uploads/DOCS/778-20100726131949.pdf

SMART GRIDS – DYNAMIC REGULATION of DEMAND

Electric Vehicles with Smart Charging



Strategy 1:
Unrestricted charging as per previous slide

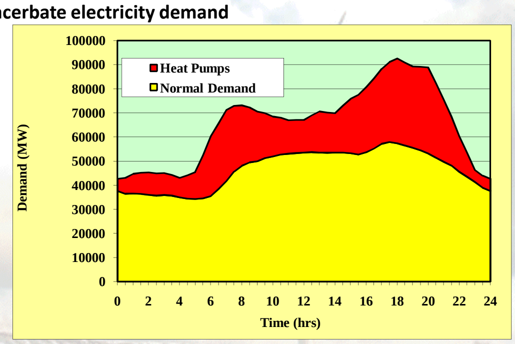
Strategy 2:
Encourage people not to charge between 17:00 and 21:00 with a reduced tariff. Assume 75% take this up ~ would remove light green area.

Strategy 3:
Discharge remaining store in car batteries to help existing peak. i.e. move green area to red – at further reduced tariff – example shows 25% of people adopting this.

17

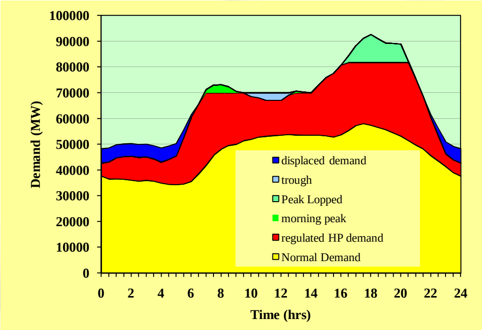
SMART GRIDS – DYNAMIC REGULATION of DEMAND

HEAT Pumps: Widespread deployment of Heat Pumps would exacerbate electricity demand



Heat Pump demand from Dave Openshaw
18 http://www.eeegr.com/uploads/DOCS/778-20100726131949.pdf

SMART GRIDS – DYNAMIC REGULATION of DEMAND



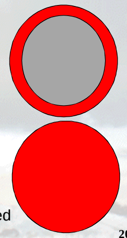
There is a less "peaky" demand from heat pumps than electric vehicles because of thermal store benefits from under floor heating,

Use of an additional thermal store could help further to fill mid-day peak and lop peak morning and evening periods for charge overnight.

AC : DC transmission of electricity 1000 MW over 100 km

5 AC cables each with 3 cores required

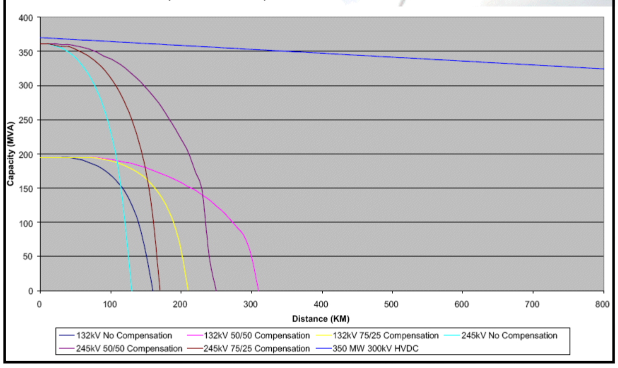
Equivalent DC

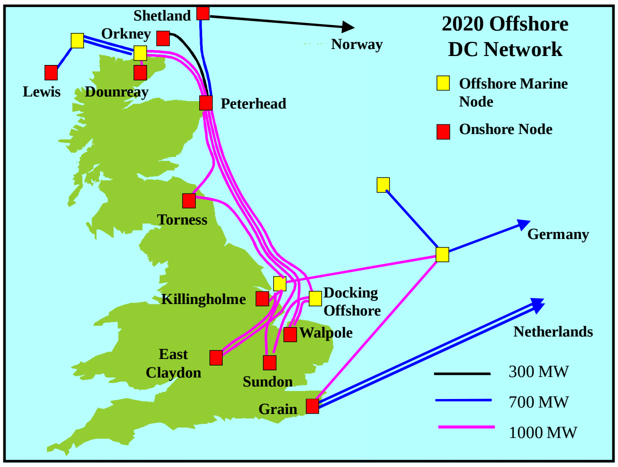


AC Transmission current flows in skin – much of cable is not used
DC Transmission current flows in whole of cross section

AC : DC transmission of electricity

- DC transmission is purely resistive and decreases slowly with distance
- AC transmission is inductive and resistive and power falls off rapidly even when compensation is provided





Costs of East Coast DC Network

- Stage 1 Core Network: £1.6b
- Stage 2 full Network: £4.8b
- Average cost £750 per MW-km
- Would be built in sectors:
- Typical Segment costs:
  - Peterhead to Walpole: £381M (1000 MW cable – 608 km)
  - Peterhead to North Scotland Offshore Marine Hub £412M (2000 MW cable – 245 km)
- For details see WEB Links

West Coast DC Links from North Scotland to Mersey are also being examined

LOW CARBON BUSINESS REGULATION AND ENTREPRENEURSHIP

Mechanisms to Promote Renewable Energy

- Non Fossil Fuel Obligation
- The Renewable Obligation
  - Marine Supply Obligation (Scotland)
- Feed in Tariffs
- The Renewable Transport Obligation
- Renewable Heat Incentive
- An Integrated Obligation?

Non Fossil Fuel Obligation: NFFO-1

- Introduced at time of Privatisation in 1990
- Initially seen as a subsidy for nuclear, but later termed NFFO with separate tranche for Renewables
- NFFO became associated only with Renewables and was subdivided into technology bands
- 5 Tranches: NFFO-1, NFFO-2, NFFO-3, NFFO-4, NFFO-5
- NFFO-1 (1990) required a minimum contribution of 102 MW from new "renewables"
- Contracts made 152 MW but by November 2000 the residual capacity was 144.5 MW.
- Fixed Price paid for electricity generated.
- Wind had highest guaranteed price of 11p per kWh compared with typical consumer price at time of 6 – 7p and wholesale prices around 3p. This meant that there was a substantial subsidy for wind.
- Potential generators had to submit applications for the subsidy, but not all ultimately received planning permission, or alternatively the schemes ultimately failed through lack of finance.
- Subsidy was paid until 31st December 1998 – a limit initially placed by the EU

25

Non Fossil Fuel Obligation: NFFO-2

- As with NFFO-1 a fixed price was paid to all generating capacity
- NFFO-2 (1991) was further divided the capacity by technology type and the outcome was as indicated in the table below.
- The payments under NFFO-2 also expired on 31st December 1998

Technology Group	NFFO-2 Requirement	Actual Contracts	Remaining in November 2000	price p/ kWh
	(MW)`	(MW)	(MW)	
WASTE Municipal/ industrial	261.48	271.48	31.5	6.55
Other Waste	28.15	30.15	12.5	5.9
Landfill	48.0	48.45	46.4	5.7
Sewage	26.86	26.86	19.1	5.9
Hydro	10.36	10.86	10.4	6.00
Wind	82.43	84.43	53.8	11.00
Total	457.28	472.23	173.7	

Note: Because payments started 1 year later, there was effectively 12.5% less subsidy than for NFFO-1

26

NFFO – 3 – January 1995

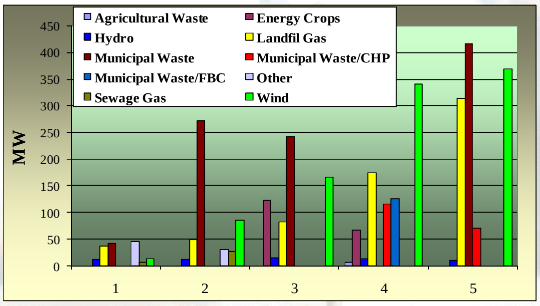
- As with previous tranches many of the schemes failed through planning permission etc.
- Clearance was given from EU for NFFO-3 to extend beyond 1998, and covers period up to 30th November 2014
- Unlike NFFO -1 and NFFO-2, the price paid for renewables was not a fixed price. Each potential supplier had to bid to supply electricity.
- Within any one technology band, there were a number of different bids.
- Total tranche was 627.8 MW divided between technology bands- successful ones were those which required the least subsidy to provide this amount of installed capacity.

NFFO –Orders 4 and 5

- NFFO orders 4 and 5 were announced in mid 1990s and came into effect in 1996 and 1998 respectively.
- Very similar to NFFO-3 and both have a twenty year timescale finishing in 2016 and 2018 respectively.
- The bid prices were noticeably lower than for NFFO-3.

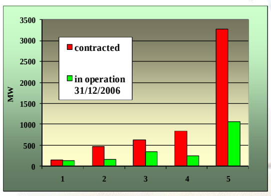
27

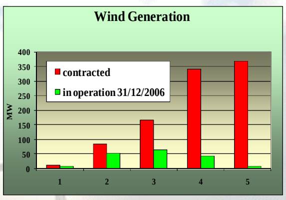
Actual Contracts for different NFFO Tranches



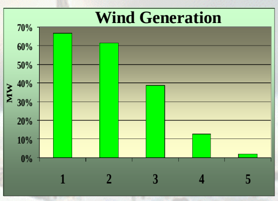
28

NFFO Status as at end of December 2006





- Overall actual position as opposed to contracted
- Many NFFO projects did not get off ground because contracts to supply were made before planning and grid issues had been addressed.
- Situation with wind even more dramatic.



29

Renewables Obligation

1999/2000 UK Government considered different mechanisms to promote renewables following end of NFFO.

- NFFO 1 and NFFO 2 were a form of feed in tariff now used by Germany
- NFFO 3, 4, and 5 were a derivative of this - generators bid to supply and cheapest were given a guaranteed price for whole of life of project up to 20 years.

Other mechanisms considered

- Climatic Change Levy (CCL) goes a small way to encouraging renewables, but only applies to businesses and is at a fixed rate of 0.43p per kWh.

  Charge was neutral to businesses overall as there was a rebate for the Employers National Insurance Contribution. Energy Efficient business with large staff numbers benefitted.
- Direct Grants for Renewable Energy Projects
- Energy Taxes/Emissions Trading
- Renewable Obligation – targets set for each year and a mechanism of payments for failure to comply.

30

Renewables Obligation

On whom should Obligation Fall

- Generators
- System Operator (National Grid)
- Distributed Network Operator
- Supplier
- Consumer

For various reasons the obligation fell on Suppliers

For an enhanced move towards low carbon an obligation on large businesses may be more effective but retaining obligation on suppliers for small businesses and domestic market.

>> An integrated renewable obligation ?????????

Decision taken that only Suppliers should be Obligated

31

Renewables Obligation

- Requires all suppliers to provide a minimum percentage of electricity from Eligible (New) Renewables.
- Each 1 MWh generated by renewable qualifies for a Renewable Obligation Certificate (ROC)
- Obligation increases each year – currently it is 10.4% of electricity supplied to consumers. Accounting Period is 1st April – 31st March
- Compliance can be achieved by:

Either

- Generating sufficient renewable energy to get required number of ROCs
- Purchase ROCs from another generator
- Pay a Buy – Out Fine

- Buy-Out set initially at £30 / MWh but indexed linked each year. This is decided by OFGEM usually in January preceding accounting period and is currently (2010-11) set at £36.99

32

Renewables Obligation

	% Obligation	Buy Out Price (£ / MWh)
2002-2003	3	30
2003-2004	4.3	30.51
2004-2005	4.9	31.39
2005-2006	5.5	32.33
2006-2007	6.7	33.24
2007-2008	7.9	34.30
2008-2009	9.1	35.76
2009-2010	9.7	37.19
2010-2011	10.4	36.99
2011-2012	11.4	
2012-2013	12.4	
2013-2014	13.4	
2014-2015	14.4	
2015-2016	15.4	

The percentage obligation was initially set as far as 2010 – 2011, but later extended to 2015 – 2016.

The scheme has now been extended to 2037, but with a

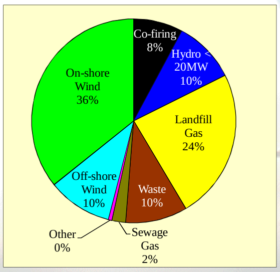
Buy Out Price is increased annually by OFGEM and is approximately equal to RPI.

Total market has a value of around £300M+

33

Renewables Obligation

Proportion generated by each technology 2009 - 2010



Biomass	0.00005%
Co-firing	7.80%
Hydro < 50kW	0.017%
Hydro < 20 MW	9.83%
Hydro > 20 MW	0.196%
Micro Hydro	0.344%
Landfill Gas	23.80%
Sewage Gas	2.22%
Waste	9.84%
Off-shore Wind	10.20%
On-shore Wind	35.73%
Wind < 50kW	0.0037%
Photovoltaic	0.0018%
Photovoltaic < 50kW	0.0022%
Tidal Flow	0.0054%
Wave	0.0002%

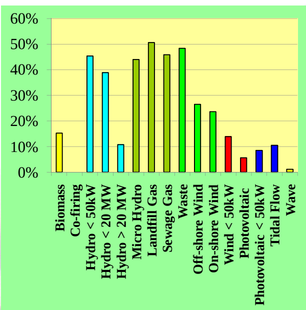
Proportion generated by different technologies. Some were very small amounts – see table

Link to ROC_Register

34

Renewables Obligation 2009 - 2010

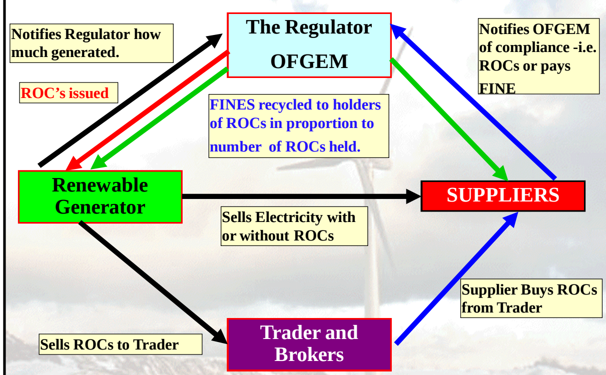
Load Factors 2009 - 2010



Biomass	15.23%
Hydro < 50kW	45.35%
Hydro < 20 MW	38.85%
Hydro > 20 MW	10.72%
Micro Hydro	43.96%
Landfill Gas	50.61%
Sewage Gas	45.81%
Waste	48.36%
Off-shore Wind	26.45%
On-shore Wind	23.56%
Wind < 50kW	13.80%
Photovoltaic	5.61%
Photovoltaic < 50kW	8.48%
Tidal Flow	10.42%
Wave	1.05%

35

Renewable Obligation Certificates



Because of recycling, ROCs have value greater than their nominal face value

36

Potential Value of Renewable Generation

- £15 - 18 per MWh Recycled fines -
- ~£1.50 per MWh Embedded benefits - less losses
- £4.85 per MWh Climatic Change Levy Exemption
- £36.99 per MWh Face value of ROC (2010 – 2011)
- £39.96 per MWh Wholesale Electricity Price (average daily price 01/08/2010 – 24/08/2010)

Value of Renewable Generation ~£95- £100 per MWh
Less BETTA Imbalance charges ~ £2 - £5 per MWh
Current Net Value of Renewable Generation ~£95 per MWh

37

The Value of the ROC Market

	2003-04	2004-05	2005-06	2006-07	2007-08	2008 - 09
Total Obligation (% of demand)	4.3%	4.9%	5.5%	6.7%	7.9%	9.10%
Total obligation (MWh)	12,387,720	14,315,784	16,175,906	19,390,016	22,857,584	25,944,763
Total number of ROCs presented	6,914,524	9,971,851	12,232,153	12,868,408	14,562,876	16,813,731
Shortfall in ROCs presented	5,473,196	4,343,933	3,943,753	6,521,608	8,294,708	9,131,032
Buy Out Price	£30.51	£31.39	£32.33	£33.24	£34.30	£35.76
Value of ROC Market	£167M	£136M	£128M	£217M	£280M	£321.00
Markup value	£22.92	£13.66	£10.21	£16.04	£18.65	£18.61
Full Value of ROC	£53.43	£45.05	£42.54	£49.28	£52.95	£54.37
% compliance	55.80%	69.70%	75.60%	66.40%	63.71%	64.81%

Note: 1) Values in last two columns are updated values from handout
2) Data for 2009 – 10 will be available in March 2011
3) The Figures in the "Value of ROC Market" are slightly lower than predicted for data because of non-payment by companies who ceased trading. This figure amounts to around £5M a year.

38

ROC Market: How total value of ROCs is estimated

- An Example what is likely value by March 2010
- Buy out price for 2009 – 2010 £37.19 per MWh
- Estimated demand is 360 TWh Obligation is 10.4%
- Requirement from renewables is 360*0.104 TWH = 37440000 MWh

NOTE: Simplified Version – assuming all technologies have same load factor

- At April 1st 2008 there were 6250 MW installed having an average load factor over all technologies of 30%.
  In 2009 – 2010 will generate 6250*8760*0.3 = 16425000MWh
- Assume 1500 MW installed in 2008 – 2009
  At same load factor will generate 3942000 MWh in 2009 – 2010
- Assume 2500 MW installed mid way through 2009 - 2010
  At same load factor will generate 3285000 MWh in 2009 – 2010
- Total generated by renewables = 23652000 MWh
- A shortfall of 13788000 MWh on which Buy Out would be payable

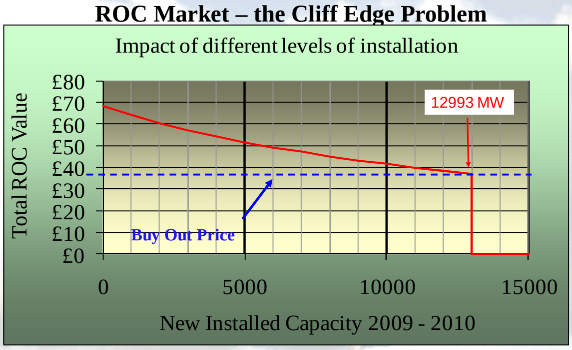
39

ROC Market: How total value of ROCs is estimated

- shortfall of 13788000 MWh on which Buy Out would be payable
- Buy Out Price: £37.19
- Total value of Buy Out Fund = £512781235
- ROCs presented = 23652000 MWh **Recycled value = £21.68 per ROC**
- **Total value of ROC = £58.87**
- If 5000 MW were commissioned instead of 2500 in 2009 – 2010
- Total Buy Out Fund would be £390610771
- **Recycled Value per ROC would be £14.50**
- **Total Value of ROC = £51.69**
- **Note: with banding analysis is a little more complicated.**
- **What happens if generation exceeds compliance level?**

40

ROC Market – the Cliff Edge Problem



Target could be exceeded in particularly favourable weather conditions.

Buy Out Fund would have no money in it and ROCs would become worthless leading to instability in price.

41

ROC Market – the Cliff Edge Problem

- **Headroom Principle: Set target annually with a a percentage above expected generation level – would reduced likelihood, but Banding would increase likelihood of Cliff Edge being reached.**
- **Solution: The Ski-slope principle**
- **If over compliance occurs,**
  - **All holders of ROCs pay Buy out Prices into Pool**
  - **Pool money is then recycled in proportion to ROCs originally held.**
- **In example and without Ski-Slope, value of ROCs would fall to 0 if more than 12993MW were commissioned in 2009 – 2010.**
- **With Ski-Slope mechanism, 15000 MW would cause ROC to only fall in value from £37.19 to £34.74**
- **At 20000MW, price would be £29.85**

42

Developments in the Renewables Obligation

- Banding System wasintroduced from 1st April 2009.
- Reference projects such as on-shore wind will continue to get 1 ROC per MWh,
- Technologies such as offshore wind get 1.5 ROCs per MWh,
- Solar PV, advanced gasification Biomass get 2.0 ROCs per MWh,
- Co-firing generates 0.5 ROCs per MWh
- With no banding: incentive only to exploit established technologies
- Banding will enhance returns for developing technologies.
- If targets are kept the same, it is easier to achieve targets and "Cliff Edge" Problem could become acute.
- Targets for a given % of renewables in terms of MWh will not be met under current legislation if there is an upward drift in banding.
- Only if reduced ROCs from co-firing balance enhanced ROCs from newer technologies will system remain stable.

Scottish Renewable Obligation

- Scottish Renewable Obligations are largely similar but there are some differences > SROCs but introduced concept of a Marine Supply Obligation covering Tidal and Wave.
- The MSO was to set an obligation (up to the output from 75MW) on suppliers as a part of the Renewable Obligation.
- Problem
  - How do you set a target at a time when no devices are yet operational - everyone would have to pay buy – out
- Solution:
  - Use the capacity of devices due to come on line in year and use this as basis of obligation.
  - Need to incorporate Headroom Principle to avoid "Cliff Edge" problem

NOTE: the HEADROOM Principle is now planned for use with ROCs

Marine Supply Obligation: Example of Headroom

- Assume Marine devices have a load factor or 33% and use a 30% headroom of the projected output
- Assume that in 2008, 5 MW are initially assumed to be commissioned, but only 2.5MW are in reality.
- On basis of 5MW @ 33% load factor, 14454 MWh would be generated and the headroom would be set at 30% of this i.e. 4336 MWh.
- The actual amount generated from 2.5 MW would be 7227 MWh and the headroom would in fact be 60% in this first year.
- i.e. the total on which buyout would be paid would be 4336 MWh

Year	Planned new capacity (MW)	Achieved new capacity (MW)	Cumulative capacity installed (MW)	Delivered Output* (MWh)	calculated Headroom for current year (MWh)	Headroom as a percentage of output
2008	5	2.5	2.5	7,227	4,336	60.0%

Marine Supply Obligation: Example of Headroom

- In subsequent years a similar procedure is adopted
  - initial obligation is determined from the actual installed capacity at the end of previous year plus the expected new capacity to come on stream. [NOT THE ACTUAL END OF YEAR CAPACITY]
  - i.e. in year 2

  projected capacity = 2.5 (existing) + 10 (projected) = 12.5 MW
  - So calculated headroom for year 2 @ 33% load factor and 30% headroom = 12.5 *0.33*8760 *0.3 = 10841 MWh

Year	Planned new capacity (MW)	Achieved new capacity (MW)	Cumulative capacity installed at end of year (MW)	Delivered Output* (MWh)	calculated Headroom for current year (MWh)	Headroom as a percentage of output
2008	5	2.5	2.5	7,227	4,336	60.0%
2009	10	7.5	10	28,908	10,841	37.5%
2010	15	12.5	22.5	65,043	21,681	33.3%
2011	20	17.5	40	115,632	36,858	31.9%
2012	25	22.5	62.5	180,675	56,371	31.2%
2013	0	12.5	75	216,810	54,203	25.0%

Feed in Tariffs – Introduced 1st April 2010

Energy Source	Scale	Generation Tariff (p/kWh) to 31/03/2012	Generation Tariff (p/kWh) after 01/04/12	Duration (years)
Anaerobic digestion	≤500kW	11.5	11.5	20
Anaerobic digestion	>500kW	9	9	20
Hydro	≤15 kW	19.9	19.9	20
Hydro	>15 - 100kW	17.8	17.8	20
Hydro	>100kW - 2MW	11	11	20
Hydro	>2kW - 5MW	4.5	4.5	20
Micro-CHP*****	<2 kW	10	10	10
Solar PV	≤4 kW new	36.1	33.0	25
Solar PV	≤4 kW retrofit	41.3	37.8	25
Solar PV	>4-10kW	36.1	33.0	25
Solar PV	>10 - 100kW	31.4	28.7	25
Solar PV	>100kW - 5MW	29.3	26.8	25
Solar PV	Standalone	29.3	26.8	25
Wind	≤1.5kW	34.5	32.6	20
Wind	>1.5 - 15kW	26.7	25.5	20
Wind	>15 - 100kW	24.1	23.0	20
Wind	>100 - 500kW	18.8	18.8	20
Wind	>500kW - 1.5MW	9.4	9.4	20
Wind	>1.5MW - 5MW	4.5	4.5	20
Existing generators transferred from RO		9	9	to 2027

***** for first 20000 installations

Feed in Tariffs – Export and Issue of Deeming

Payment for tariffs will be from a levy on Utility Companies which MAY see a cumulative rise in bills of around £1 billion or more.

In addition there will be a payment of 3p per kWh for any electricity exported as opposed to consumed on premises.

BUT an export meter is needed to identify this.

Householder will save on imported electricity at ~ 11 – 12p per kWh, so optimum financial model may not be to generate as much as possible

i.e. for each unit generated and consumed it is worth 41.3+ 11 = 52.3p /kWh
for each unit exported it is worth 41.3 + 3 = 44.3 p/kWh

If no export meter is fitted – a transition arrangement of deeming that 50% of generation will be exported will be made
- that may well not be as attractive to consumer.

http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/feedin_tariff/feedin_tariff.aspx

From the National Infra-Structure Plan 2010 following Comprehensive Spending Review

- The Government will reform the electricity market, so that it attracts the private sector investment necessary to meet the UK's energy security and climate change objectives, including the investment in nuclear, carbon capture and storage and renewable technology.
- In addition to supporting the carbon price, this will also assess the role that revenue support mechanisms (such as Feed-In Tariffs), capacity mechanisms and emission performance standards could play.
- For complete information see Section 4 of http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf

49

From the National Infra-Structure Plan 2010 following Comprehensive Spending Review

The Government will assess proposals against the criteria of cost-effectiveness, affordability and security of supply;

- to ensure that regulation of national electricity networks enables the investment needed in transmission infrastructure to connect new low-carbon generation, such as nuclear power stations and offshore and onshore wind turbines;
- maintain the Feed-In-Tariffs to support investment in emerging small-scale generation technologies in electricity, saving £40M by improving their efficiency, and complement this with the Renewable Heat Incentive to reward ground-source heat pumps and other renewable heat sources, while making efficiency savings of 20% by 2014-15 compared with the previous government's plans.

For complete information see Section 4 of http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf

50

From the National Infra-Structure Plan 2010 following Comprehensive Spending Review

The Government will (para 4.18):

- Support investment in low carbon energy supply by:

  maintaining Feed-In Tariffs for small-scale generation, funded through an obligation on electricity suppliers equating to a levy of almost £900 million over the period to 2014-15. At the same time, the efficiency of Feed-In Tariffs will be improved at the next formal review [2012], rebalancing them in favour of more cost effective carbon abatement technologies.

Equivalent to £36 per household

May be an issue for PV as carbon abatement using PV is around £700 per tonne saved way above many other strategies – see German Example

For complete information see Section 4 of http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf

51

From the National Infra-Structure Plan 2010 following Comprehensive Spending Review

The Government will (para 4.18):

- Support investment in low carbon energy supply by:

  maintaining Feed-In Tariffs for small-scale generation, funded through an obligation on electricity suppliers equating to a levy of almost £900 million over the period to 2014-15. At the same time, the efficiency of Feed-In Tariffs will be improved at the next formal review [2012], rebalancing them in favour of more cost effective carbon abatement technologies.

Equivalent to £36 per household

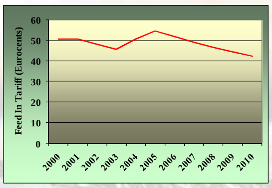
May be an issue for PV as carbon abatement using PV is around £700 per tonne saved way above many other strategies – see German Example

For complete information see Section 4 of http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf

52

Experience of German Feed In Tariff

- Feed in tariff guarantees a fixed income for unit of electricity generated for 20 years.
- Promoted as a means to promote renewables and in particular Solar PV.
- Tariff for new entrants decreases each year – existing generators continue with their agreed levels
  - Tariff different for Wind (8.5 cents/kWh) and for Solar PV (51.5 cents/kWh) in 2006
- Feed in Tariff for PV increased in 2004



- Tariff remains constant for any device for 20 years
- Subsequent years tariff for new installations decreases by 5%.
- Encourages developers to rush in to get highest return before devices have been optimised rather than optimising performance.

53

German Feed In Tariff

- Each household with no PV is subsidising those with by £6 – a figure which will rise progressively
- Subsidy for PV alone in Germany is costing consumers approaching €2 billion (£1.5 billion) a year in subsidy. For all green electricity it reaches ~€10 billion a year
- In UK under ROCs consumers paid an addition £0.3 billion a year or around 1% extra.
- Secondary aim was to promote German Industry
  - In early years this was true
  - However high proportion are now manufactured overseas
- In May 2008, German Government increases reduction rate in feed-in tariff following concerns over cost.
- Cost of carbon dioxide abatement of subsidy by German Feed In Tariff for PV is ~ £750 per tonne way above the majority of other technologies
- See article in Ruhr Economic Series for a critique

  "Germany's Solar Cell Promotion: Dark Clouds on the Horizon"
- http://www2.env.uea.ac.uk/gmmc/energy/energy_links/renewables_Obligation/Feed_in_Tariffs/PV_Cost_critique_Ruhr_papers.pdf

54

Renewable Transport Fuel Obligation (RTFO)

- Came into force 1st April 2008
  - EU Directive 2003
  - Consultation Document April 2007
  - See also UEA's response on WEB
- Ambition to save 1 Mtonnes CO_2 by 2010/2011

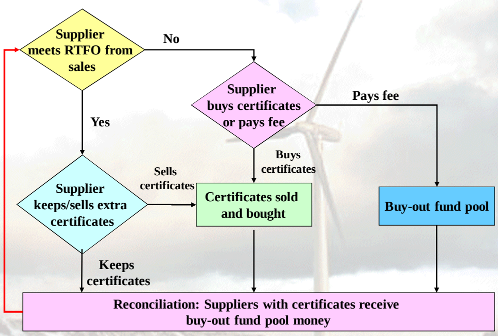
Financial year	UK Target (by volume)
2008 – 09	2.75 %
2009 – 10	3.5 %
2010 – 11	5 %

Obligation on Suppliers as with Renewables Obligation

Note: EU requirement is for 5.75% by Energy Content
Represents 8% by volume.

Energy content per litre for bioethanol is very different from energy content of petrol

RTFO mechanism



The level of the obligation?

- Calculated as percentage of volume of fossil fuel sales, rather than of total sales of all fuels
  - 5 % of total fuels represented as 5.2651 % of fossil fuel sales
  - Reduces UK commitment further
  - Reason
    - Duty paid in terms of volume
    - Need to switch to energy based pricing
    - Would make comparison between petrol, diesel and biofuels more rational
  - Maximum 5 % by volume additive is already permitted in EN-standard petrol and diesel fuels -
    - Warranty issues
- Unlike RO, where recycled money is used in UK, recycled RTFO money is likely to go abroad

Renewable Heat Incentive

Small Scale Installations – Table of Tariffs

	Scale	Proposed Tariff (p/kWh)	Deemed/or metered	lifetime (years)
Solid biomass	Up to 45 kW	9	Deemed	15
Bioliquids	Up to 45 kW	6.5	Deemed	15
Biogas on-site combustion	Up to 45 kW	5.5	Deemed	10
Ground source heat pumps	Up to 45 kW	7	Deemed	23
Air source heat pumps	Up to 45kW	7.5	Deemed	18
Solar thermal	Up to 20kW	18	Deemed	20

Tariffs for Large Installations are less.

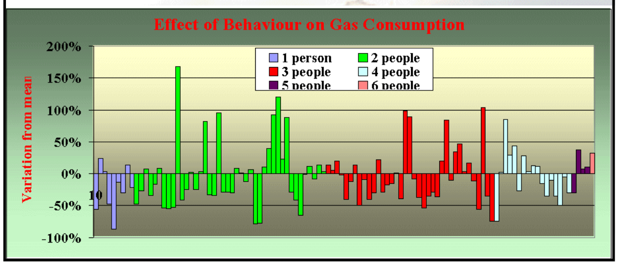
Awaiting response from Government following Consultation – information above may well change .

Original target date for implementation – 1st April 2011

Renewable Heat Incentive

- To achieve a 15% Renewable Energy Target by 2020 will require tackling heat (40+% of total energy demand) in addition to transport and electricity.
- RHI aims to tackle this for heat pumps, biomass boilers, solar thermal
- Problem of metering. Government suggests "Deeming" for small installations

  - would be open to abuse as it does not account for behaviour



An Integrated Obligation

- Obligations for RO and RTFO fall on suppliers
- Is this most effective way to promote low carbon strategies?
- Probably realistic for domestic and small businesses.
- If placed on large business and integrated then
  - Effective strategies could be implemented
  - Trade off between the different obligations to promote cheapest solutions to carbon reduction
  - ROCs, RHICs, RTFOCs should be tradeable between each other
- Need to have RTFO buy out based on Energy rather than volume.
  - Bring accounting period for RTFO from April 17th to April 1st,
- Rationalise Buy Out Prices according to primary energy (or carbon emissions to provide one unit of delivered energy (heat).
  - 1 kWh of delivered electricity has carbon factor of 0.52 kg
  - 1 kWh of delivered gas for heat has carbon factor of 0.19 kg
  - Buy out price for Heat should be 36.5% of price for ROC