UKERC

UK Energy 2050 Revised Scenario Set

The original set of UKERC 2050 scenarios was developed some 2-3 years ago, after which a number of developments have taken place, both for the UK MARKAL model as well for the policy environment that is being modelled. In light of this, a small set of the scenarios will be developed, using the latest version of the UK MARKAL model and updating policy and technology assumptions to match the recent developments. Additional scenario variants will also be constructed to test the impacts of alternative gas price trends and explicit resilience measures.

General model update

As all scenarios will include the same base data and implemented policies, the changes described here apply to all scenario variants. It needs to be noted that since a number of changes has already been implemented in to the model during the past few years, and even more will be added during the model update, the resulting scenarios are not likely to be directly comparable to the UKERC 2050 scenarios.

The first significant update concerns a **migration to the most recent version of the model (3.26)**. This version includes a range of data updates for most of the sectors. In addition to technology parameters, also a number of other assumptions were altered, e.g. for demands, policies and resource potential constraints. As the second step, modellable, **already implemented policies will be included** for the reference case. While a bulk of these is already reflected in the latest version of the model, some updates and additions are also necessary. Next, we will include an **additional policies** scenario, which assumes additional implementation measures. Increasing the ambition level further, we introduce **two low carbon scenarios**, implementing larger framework policies on top of the individual instruments. The social discount rate of the model will be adjusted and 3.5 % will be used instead of the 10% that was in place for the original UKERC runs. Finally, the latest version of the model uses sector specific **hurdle rates**, the exact level of which will be reassessed and updated. The most important information for the updates and implemented policies is given below:

Policies:

For the policies to be implemented, four levels are defined; “reference”, “additional measures”, “low carbon” and low carbon “policy gap”. The table below shows what policies are included under these variants, as well as suggests how the given policy will be implemented for UK MARKAL. Generally speaking, the “reference” and “additional measures” scenarios rely on individual implementation instruments, whereas the low carbon scenarios also include system wide framework policies, such as carbon targets.

	Reference (firm and funded) (REF)	Additional measures (beyond Reference) (ADD)	Policy Gap (GAP)	Low Carbon (LC)
Carbon targets	• None	• None	• First two carbon budgets met. For 3rd and 4th budgets and 2050 target 70% of target reductions starting from 2015 baseline are achieved.	• First four carbon budgets met; 2050 reduction target of 80 % (compared to 1990); equal annual percentage trajectory 2025-2050.
Renewable energy directive/targets	• Renewable obligation (15 % of electricity renewable by 2015 and until 2050), with a buy out price of 28 £(2000)/MWh included. Max. 12.5 % of the renewable production can be from co-firing.	• As reference	• 70% achievement of RED (matches current RO achievement). 21% by 2020 and 28% by 2030. • Min. targets for 2020 for onshore wind (20 % of renewables), offshore wind (30 %) and biomass (30 %). • The limit on co-firing is removed	• 100% achievement of RED. Target for renewable electricity is 30 % for 2020, 40% by 2030 (and after that) and the buy-out option is removed. • Min. targets for 2020 for onshore wind (20 % of renewables), offshore wind (30 %) and biomass (30 %). • The limit on co-firing is removed
Electricity Market Reform	• Carbon price floor for electricity emission. Trajectory (in £ 2009) £15.70/tCO2 (in 2013), £30/tCO2 (in 2020) and £70/tCO2 (2030 - 2050). Interpolated linearly between the years.	• Emissions Performance Standard – Building of unabated coal power plants prohibited (in addition to the carbon price floor)	• As additional measures	• As additional measures
CCS demonstration plants	• 1st demonstration plant (400 MW) forced in	• Three additional CCS demos (total 1.3 GW), at least one of which will be a gas fired CCS plant	• As additional measures	• As additional measures
Renewable Heat Incentive	• No policies included	• Some renewable heat generation is forced in.	• 70 % achievement of RED leading to a target of 8 % renewable heat by 2020	• RED target for renewable heat is set at 12 % by 2020
Small scale Feed in Tariffs	• Feed in tariffs (in £2009) for micro CHP (10 p/kWh), solar PV (res. and comm. sectors (36.1 p/kWh)), micro wind (34.5 p/kWh) and micro hydro power (11 p/kWh). Starts in 2010, linearly reduced to zero by 2030.	• As reference	• As reference	• As reference
Household energy efficiency	• CERT/CESP are assumed to be reflected in the reference case hurdle rates	• Green Deal, hurdle rates in the residential sector reduced from 15 to 5 % and annual deployment constraints relaxed by 20 %.	• As additional measures	• As additional measures
Industry	• Climate Change Levy included	• As reference	• As reference	• As reference v
Services	• Carbon Reduction Commitment at £12/tCO2 (in £ 2011), for 60 % of the emissions from the service and for 18 % of the emissions of the industry sector.	• As reference	• As reference	• As reference
Transport	• Renewable transport fuel obligation, 5 % renewables in road transport • Fuel duties are kept constant	• As reference	• The target for renewable transport is increased to 10 % in 2020	• The target for renewable transport is increased to 10 % in 2020

In the LC scenarios emissions are reduced 80 % by 2050 (compared to 1990) and from 2025 to 2050 emissions follow a trajectory based on equal annual percentage of emission reduction. The GAP scenarios represent a variation of the LC restrictions, in which there remains a gap between the

original ambition and actual achievement. For these scenarios it's assumed that until 2015 emission targets are reached as in the LC scenarios. After this, however, the gap scenarios are assumed to follow an emission trajectory that corresponds to **70 % of the reductions achieved in LC scenario** (calculated from the point of divergence, 2015). The gap therefore applies to the final target in 2050, as well as to the 3rd and 4th carbon budgets.

As already the reference case assumes a number of policies, we also run a set of sensitivity runs in which some of the policies are removed. This is done in order to determine what the impact of some of the individual policies might be:

1. REF-P1: The Renewables Obligation (RO) is removed, other policies implemented as before
2. REF-P2: The Carbon Price Floor (CPF) is removed, other policies implemented as before
3 REF-P3: Both, the RO and the CFP are removed
4. REF-P4: The RO and the CFP as well as the Carbon Reduction Commitment (CRC) are removed

Hurdle rates:

Currently the hurdle rates used in the model are 5 % for the residential and private transport sectors, 7 % for public and commercial transport and 10 % for the power sector, industry and service sectors. The numbers suggest that the logic is of the hurdle rates is based on a social cost-benefit approach (as opposed to trying to emulate behaviour of agents).

The fact that many existing policies (e.g. subsidies, taxes) are included in the model suggests, however, that the modelling approach is not only that of a social planner and the goal is to represent also the incentives that may encourage agents to do decision that would be deemed economically inefficient on the system level. In other words, the existing modelling approach mixes the prescriptive, social planner approach with a descriptive policy approach, in which policies are used to "overrule" the optimal decision of the social planner.

Taking into account the existing approach to modelling policies, for consistency's sake one should use hurdle rates that represent the implicit discount rates used by the agents. This indicates that higher rates should be implemented, as a number of hidden costs and uncertainties would almost certainly lead the agents to implement higher rates than what is currently in the model. More specifically, **hurdle rates are increased to 12.5 % for the private transport sector and to 15 % for the residential sector**.

Scenario variants, decoupled gas prices (GAS) and resilience targets (R)

It is currently assumed that unconventional gas resources are as large as the conventional ones and unconventional gas already makes up about 60 % of marketed production in the US. Assuming further positive technological developments, the price linkage between crude oil and natural gas may eventually be broken, at least in some parts of the world. In light of this, we construct variant scenarios, in which the gas price is decoupled from the oil price and a significantly lower trajectory is assumed for the former as compared to the reference case. Oil and coal prices are unchanged from the reference scenario. The qualitative logic and price trends are adapted from IEA 2011, "World Energy Outlook Special Report, Are we entering the golden age of gas?" but we implement our variant in reference to our baseline assumptions. More specifically, we assume that the time period specific, annual growth in gas prices in the reference scenario is reduced by 75 %, effectively almost levelizing the gas prices (price in 2030 is now only 6 % above the price in 2010, whereas in the reference case the difference is close to 30 %). Oil prices are assumed to keep increasing steadily also in the **GAS** scenario, reaching a bit over 100 $US(2005)/bbl by 2030. Trajectories for the prices are shown below (price level after 2030 remains constant).

Natural gas import price assumptions £(2000)/GJ

	2010	*2015*	*2020*	*2025*	*2030*	*2035*
Reference	4.5	4.9	5.2	5.5	5.7	5.7
GAS	4.5	4.6	4.6	4.7	4.8	4.8

Oil import price assumptions £(2000)/bbl

	2010	*2015*	*2020*	*2025*	*2030*	*2035*
All scenarios	39.1	41.9	44.7	47.5	50.3	50.3

For the "resilient" (**R**) variants we implement an explicit constraint targeting the diversity of the energy portfolio. This constraint limits the share of a) each fuel at the primary energy level and b) technology class in power generation, each below 40 %. In addition to this the use of final energy needs to be reduced by 3.2 % per year from 2010 onwards.

Full scenario set

Summarizing the above, we have two resilience levels (reference (**REF**), resilient(**R**)), four climate variants (low carbon (**LC**), policy gap (**GAP**), additional policies (**ADD)**, reference (**REF**) scenario) and two gas price variants (reference, decoupling of gas prices (**GAS**)) thus reaching all in all sixteen scenarios, summarized in the table below.

	Conventional gas assumption		*Gas price decoupled*	
	Resilience --------->		*Resilience --------->*	
Debarbonisation ----->	**REF**	**REF-R**	**REF-GAS**	**REF-R-GAS**
	ADD	**ADD-R**	**ADD-GAS**	**ADD-R-GAS**
	GAP	**GAP-R**	**GAP-GAS**	**GAP-R-GAS**
	LC	**LC-R**	**LC-GAS**	**LC-R-GAS**