Department of Energy & Climate Change

An early view on the results of the 2050 Calculator International Outreach

Final report

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Ricardo Energy & Environment

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Any enquiries regarding this publication should be sent to us at correspondence@decc.gsi.gov.uk.

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Executive summary

In August 2012, support from the International Climate Fund (ICF) was approved for international outreach on the 2050 Calculator. This work consisted of two elements:

- 2050 Calculator country outreach, whereby a number of developing countries were supported to develop their own versions of the UK 2050 Calculator;
- The Global Calculator project, extending the basic approach used for the UK 2050 Calculator to a global level.

Ricardo Energy & Environment and University College London were commissioned by the Department of Energy and Climate Change to carry out an evaluation of the 2050 Calculator International Outreach work. The purpose of the evaluation was to assess the results achieved to date from the 2050 Calculator country outreach and the development of the Global Calculator and to suggest potential next steps for the further support for 2050 Calculator international outreach.

Status of work

The country outreach work has progressed to different timetables for different countries. The first of the ICF-supported countries to publish national Calculators were India (February 2014) and South Africa (March 2014). Since then, other countries have published their Calculators, including Thailand (November 2014), Bangladesh (January 2015), Vietnam (January 2015), Indonesia (December 2014) and Colombia (March 2015). Algeria, Nigeria, Brazil, and Mexico have yet to publish their Calculators. India is currently preparing a new version of its Calculator, which will incorporate costs.

The aim of the Global Calculator was to extend the basic approach used for the UK 2050 Calculator to a global level. This would enable users to explore the options for reducing global emissions associated with land, food and energy systems in the period to 2050. By illustrating the impacts of climate change associated with these choices, the ultimate aim of the Global Calculator was to energise the debate on climate change in the run up to the Paris climate change conference in late 2015. The Global Calculator was launched in January 2015.

Expected outcomes

The ICF Business Cases set out the intended results of the ICF 2050 Calculator international support, including demonstrating feasible and credible low carbon development pathways, improving the understanding of policy makers and other stakeholders around low carbon development, greater engagement with the topic of climate and energy pathways and increased government capacity for building evidence-based low-carbon development scenarios, all of which should lead to both a strengthened political mandate for action and improved capacity for action.

Methodology

The evaluation was carried out through qualitative research combining document analysis and semi-structured interviews with stakeholders. The interviews formed the core of the evaluation, enabling a detailed and in-depth examination of a range of issues. A total of 44 interviews were undertaken, of which 35 were with national Calculator stakeholders, two were with current DECC staff, two were with former DECC and FCO staff and five were with stakeholders involved in the development or review of the Global Calculator. The scope of the evaluation included 10 national Calculators; it was agreed with DECC that Algeria should be left out of the evaluation as DECC's immediate involvement had been more limited.

Conclusions

1. The evaluation focused on the three core outcomes: Low Carbon Development Viability (demonstrating feasibility of low carbon pathways), Government Capacity (to build evidence, share with stakeholders and incorporate into policy), and Strengthened Mandate (with key stakeholders more supportive of low carbon development). The evaluation concluded that aspects of all three core outcomes have been achieved across the different countries. Results were highly dependent on the individual country contexts, depending on local institutional structures, national objectives for energy security and access, and resources required to mobilise engagement of national stakeholders. The challenges of developing the Calculators included data availability and reliability, political support, and how to involve stakeholders in the scenario development.
2. The national Calculator development teams were overwhelmingly positive about their experience and the level of support provided by DECC.
3. In terms of process, the research found that the 2050 Calculator international outreach was well managed by DECC and FCO and in particular that the technical support from DECC was viewed positively. The process of stakeholder engagement was a key benefit for those involved in developing the Country Calculators. Ability to adapt the Calculators to fit national contexts was seen as another strength of the tool.
4. In terms of the Global Calculator, we concluded that the development of a tool of this nature was itself a significant challenge that was delivered effectively by the team. Interviewees viewed the tool as credible and well-balanced between user friendliness and rigour. By working with it, interviewees reported gaining new insights around low carbon development at a global level. However, it is too early to judge whether it will achieve its intended outcomes, namely that: policy stakeholders will improve their understanding of low carbon development more widely; they will become more involved in the global climate and energy debate; and that the Global Calculator will make national Calculators more robust.

Our assessment of the extent to which the outputs, outcomes and impacts outlined in the theory of change (figure 1, page 11) have been met are as follows:

- Outputs:
    - Modelling capability – met. Despite modelling expertise already existing in most countries, the introduction of the 2050 Calculators has improved countries' abilities to present viable low-carbon development pathways.
    - Accessibility – met. Data has been made available in most cases, although there was still scope in some cases for accessibility and transparency to be improved.

- Peer review – partially met. Stakeholders were generally involved in the development of the Calculators although different levels of consultation were observed.
- Society engagement – not yet met. The priority for countries has been to develop and launch the Calculators. At this early stage, there has been little engagement by wider stakeholders with the completed Calculators.
- Low Carbon Development co-benefits – met. Many of the countries have included co-benefits in their calculators.

- Outcomes:
  - Government capacity – met. Evidence that Governments' ability to build evidence-based scenarios has been enhanced by the introduction of the Calculators.
  - Low carbon development viability – partially met. DECC ensured engagement and uptake of the Calculators partly by relinquishing control over the level of ambition. This has resulted in some Calculators not being very ambitious.
  - Strengthened mandate – not yet met, partly due to early stage of the Calculator roll out and also the lack of focus by the countries thus far on stakeholder engagement.

- Impact: The 2050 Calculators have provided a new, unique tool to these countries, helping them take a different and longer-term approach to policy making. An important element of the success in developing Calculators in these countries was the adaptability to local circumstances and contexts. However a natural result of this is loss of control from DECC on the level of ambition shown in the Calculators. It is therefore unclear to what extent the Calculators will encourage support for low carbon pathways in countries that do not already have a certain level of interest and support from stakeholders. This is magnified by the lack of stakeholder engagement with the completed Calculators in the countries so far, although there were clear signs that this would improve overtime.

1. Introduction

1.1 Background

In July 2010, the UK Government first published the 2050 Calculator, with the aim of allowing a range of audiences to explore how the UK can best meet energy needs while meeting UK emissions targets between now and 2050. The Calculator does this by presenting a system-wide approach to considering the choices and trade-offs about our energy use up to 2050. It allows users to explore the key options relating to emissions reductions based on technical analysis of what is considered to be physically and technically possible in each sector.

As stated on the UK Government website, the Calculator is a "*user-friendly model that lets you create your own UK emissions reduction pathway, and see the impact using real scientific data. The Calculator helps everyone engage in the debate and lets Government make sure our planning is consistent with this long-term aim*."[1] Since then, the Calculator has been improved and extended to incorporate new features including cost estimates for each pathway. The Calculator is now available in three versions: a user-friendly web-tool; a simplified My2050 simulation for those who want an overview; and the full Excel version of the Calculator for experts who want to look at the underpinning model.

Following interest from a number of overseas governments, and modelled on a project developed with the Chinese government to develop a Chinese 2050 Calculator, the decision was taken to carry out further international outreach based on the 2050 Calculator, supported by the UK Government's International Climate Fund (ICF)[2]. This outreach work consisted of two elements:

- 2050 Calculator country outreach, whereby a number of developing countries (11 in total) were supported to develop their own versions of the UK 2050 Calculator; and
- The Global Calculator project, which would extend the basic approach used for the UK 2050 Calculator to a global level.

The ICF provided £2 million over two years for the 2050 Calculator International outreach; £1.5 million of which went to the country Calculator outreach work, and £500,000 to the Global Calculator.

Table 1 provides an overview of the countries involved in the development of the country Calculators which received ICF support.

[1] https://www.gov.uk/2050-pathways-analysis

[2] https://www.gov.uk/government/policies/taking-international-action-to-mitigate-climate-change/supporting-pages/international-climate-fund-icf

Table 1. Overview of partners in the development of the country Calculators and the Global Calculator

Country	National government lead	Developers
Algeria (DZ)	*Sonelgaz* *	n/a[3]
Bangladesh (BD)	*Electricity Generation Board* *	Cardiff University (Lead)
		International Centre for Climate Change and Development (ICCCAD)
Brazil (BR)	Empresa de Pesquisa Energética	Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering (COPPE)
Colombia (CO)	Ministry of Environment and Sustainable Development (MADS)	Colombian Low Carbon Development Strategy, a programme led by MADS, the Department of National Planning (DNP), and the sectoral ministries of Colombia.
	United Nations Development Programme (Implementing agency)	
India (IN)	Niti Aaoyog (ex-Planning Commission)	C-Step
		TERI
		India Smart Grid Forum
		Prayas
		Shakti *
Indonesia (ID)	Ministry of Energy and Mineral Resources	Energy Economics Institute
		Pelangi Indonesia
Mexico (MX)	Secretaría de Energía de México	Centro Mario Molina
Nigeria (NG)	Energy Commission	Birmingham City University
South Africa (ZA)	Department of Environmental Affairs	*Energy Research Centre (University of Cape Town) (lead)* *
		Promethium *
Thailand (TH)	Thai Greenhouse Gas Organisation	Consultant
Vietnam (VN)	Ministry of Industry and Trade	National Target Program to Response to Climate Change (NTP-RCC)
		Consultant
Global Calculator	UK Department for Energy and Climate Change	World Resources Institute
		Chinese Energy Research Institute
		Climate-KIC *
		Imperial College London *
		Ernst & Young *
		Climate Media Factory *
		Climact *
		International Energy Agency *
		Potsdam-Institute for Climate Impact Research *
		London School of Economics and Political Science *
		Energy Research Institute China *

* not interviewed by the project team

[3] Algeria has been excluded from this evaluation (see section 1.2) and not much information on the parties involved is publically available. The ICF DECC Annual review of 10 December 2013 states that Belgian consultants are involved in addition to the team from Sonelgaz.

1.1.1 The Theory of Change

As part of the process of obtaining funding from the ICF, business cases were developed setting out 'theories of change' around the impact of the different aspects of the 2050 Calculator International Outreach programme. The key features of these are summarised below:

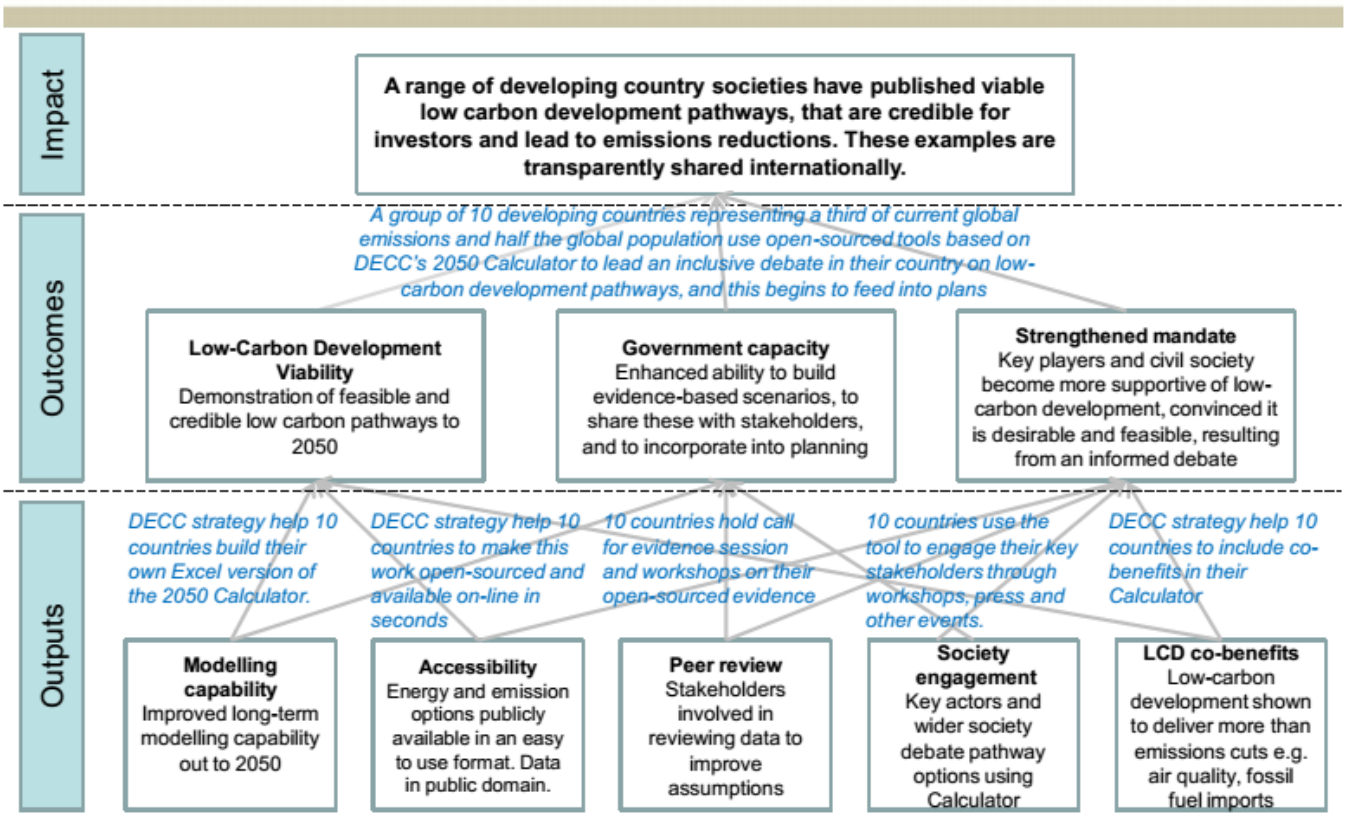
2050 Calculator Country Outreach

According to the 2012 Business Case, a number of developing countries – together accounting for over a third of global emissions and more than half of the global population – would be supported to develop an open-sourced 2050 Calculator. Supported by DECC, the tool would be used to establish a public debate on how to combine economic development with low carbon emission pathways.

With its focus on supporting developing countries to develop their own tools, which can evolve and be updated by teams within their national governments long after the initial intervention has occurred, this programme fits under 'capacity building', one of the ICF's cross-cutting themes. The business case stated that providing support for countries to develop their own tools, the Calculator approach offers a much higher chance that the results would be credible, owned and communicated to all actors in the system whose support will be needed to deliver low-carbon development. The benefits of the more transparent approach adopted by the UK 2050 Calculator were argued to be particularly suited to developing countries with limited technical capacity across government to understand the trade-offs between different development pathways. In particular, the business case stated that the Calculator would facilitate debate amongst a broader range of stakeholders about which low-carbon pathways were feasible and desirable in the context of the country's overall development strategy. This therefore necessitated a country-specific approach to ensure that the tools developed are fit for purpose, and respected, and fit with the aim of the ICF to improve capacity within developing country governments.

The theory of change, shown in Figure 1, outlined how the 2050 Calculator country outreach work was expected to improve the credibility of low carbon development plans in developing countries. It also revealed how the development of country-specific 2050 Calculators would be integrated into national planning.

Figure 1. Theory of Change – International 2050 pathways partnerships (DECC 2012[4])



The business case also contained a logical framework for the 2050 Calculator country outreach programme, which listed indicators, baselines and milestones. This 'logframe' can be found in Appendix B, and forms the basis of the quantitative component of this evaluation.

By the end of March 2015, 11 developing countries had been supported by DECC to develop a 2050 Calculator. These were: Algeria, Bangladesh, Brazil, Colombia, India, Indonesia, Mexico, Nigeria, South Africa, Thailand and Vietnam. In addition, several other countries had developed or had plans to develop a 2050 Calculator, these included Australia, Belgium, China, Ecuador, Peru, Taiwan, New Zealand and a group of seven countries in south east Europe.

The Global Calculator

In September 2013, the Global Calculator project was launched by DECC in partnership with international organisations and high-level representatives. The Global Calculator would extend the basic approach used for the UK 2050 Calculator to a global level. In so doing, it would enable users to explore the options for reducing global emissions associated with land, food and energy systems in the period to 2050. By illustrating the detrimental impacts of climate change associated with these global-level choices, the ultimate aim of the Global Calculator was to energise the debate on climate change.

[4] DECC (2012). Business Case and Intervention Summary – Sept 2012: International 2050 pathways partnerships and Global Calculator, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/49795/ICF_Business_Case_-_International_2050_pathways_partnerships.pdf.

The theory of change for the Global Calculator was set out in the separate Global Calculator Business Case, and is shown in Figure 2.

Figure 2. Theory of Change – Global Calculator (DECC 2013[5])

The Global Calculator business case also contained a logframe listing indicators, baselines and milestones. It forms the quantitative component of the evaluation and can be found at Appendix B, along with the logframe for the country Calculator outreach work.

1.2 Aims and objectives

The aim of this project, undertaken by Ricardo Energy & Environment and the Institute of Sustainable Resources at University College London (UCL), was to carry out an evaluation of the 2050 Calculator international outreach work, including the Global Calculator.

The evaluation consisted of two main objectives:

- To assess the results achieved to date of the outreach work, including whether the outputs and outcomes have been achieved and whether the work attained value for money; and,
- To suggest next steps for any further ICF-funded 2050 Calculator International support.

[5] DECC (2013). Global Calculator Business Case. Unpublished document.

The terms of reference for this project stated that the evaluation should address the following specific questions:

- How, where, why and to what extent has the 2050 Calculator strengthened capacity and supported transition to low carbon development pathway in developing countries?
- Did the 2050 Calculator country outreach and Global Calculator projects achieve their intended outputs and outcomes, and why/why not?
- To what extent are the 2050 Calculator and Global Calculator demonstrating value for money for UK development aid?
- To what extent has the development of the Global Calculator supported understanding of the global energy and climate challenge? Is there a case for extending funding for the 2050 Calculator International work beyond its original project lifetime, and if so what would be the most effective and efficient delivery mechanism?

Analysis of the performance of the 2050 international outreach project was to cover ten of the 11 countries funded by DECC. After discussion with DECC, it was decided that Algeria would be excluded from the evaluation because Algeria's Calculator was largely developed with help from other donors.

This evaluation is part of the overall DECC Monitoring and Evaluation work plan for the ICF.

1.2.1 Report Structure

The rest of the report is structured as follows.

- In Section 2, we outline the methodology adopted by this evaluation of the 2050 Calculator International Outreach work.
- Section 3 then provides an analysis of the 2050 country Calculators and the Global Calculator, structured around key themes to emerge from the interviews.
- Section 4 provides discussion drawing out the findings across the different countries that adopted a Calculator.
- In the final section of the report we draw some conclusions for the future of the 2050 Calculator International Outreach programme.

2. Methodology

In order to address the aims and objectives of the project, the evaluation of the 2050 Calculator country outreach programme and Global Calculator adopted a research approach that drew on both qualitative and quantitative methods. Specifically:

- Document review to provide contextual and background information on the programme;
- Semi-structured interviews to enable a detailed and in-depth examination of a range of issues; and,
- Quantitative information to inform the completion of the logframe.

A predominately qualitative approach was necessary not only because both projects had only recently been completed, which meant there were few quantitative data available – indeed, the Global Calculator was only launched at the end of January 2015 – but also because the aims and objectives of the evaluation required a more exploratory approach. This approach enabled the research team to conduct a detailed and in-depth examination of the 2050 Calculator international outreach work. Importantly, it also facilitated an understanding of the work from the perspective of those who had developed, or been involved in developing and/ or using, the 2050 Calculators.

The evaluation of the two components of the 2050 Calculator International Outreach work was conducted simultaneously between December 2014 and March 2015, and adopted similar methodologies. The subsequent sub-sections provide further detail on the evaluation methodology.

2.1 Methodology - 2050 Calculator Country Outreach

The first task was to review the relevant documents related to the 2050 Calculator country outreach work, in order to enable a greater understanding of the original rationale for the programme, as well as to assess progress to date. This included a review of publically available information on the Calculators and on general energy and climate policy in the countries which received the ICF funding. The documents identified generally included country policy documents provided to the UNFCCC, further national strategies and action plans, as well as press coverage and other mentions of the country Calculators on the internet. In addition, various documents were provided by DECC, including the Business Case for the Calculator outreach activities, which were submitted as part of the application for ICF funding. A member of the project team undertook a visit to the DECC 2050 Calculator team's office in December 2014 in order to identify further relevant internal documents on the country and Global Calculators on DECC's internal wiki, the DECCipedia. These documents provided a summary of the Calculator development in each country, as well as project plans, Memorandum of Understandings and Terms of Reference, press articles regarding the launch of the Calculator in different countries, and additional background documents.

Within the evaluation countries there were mostly no published documents around their 2050 Calculators and very few other mentions of the Calculators online, partly because during the time of review, most countries had not launched their Calculators yet. Most mentions of evaluation of countries' Calculators were in the form of press releases on their development and launch by government ministries or Calculator-developing organisations. It therefore became apparent that nearly all information on countries' rationales for adopting the Calculator and its

impact on government policy and stakeholder or public engagement would need to be gathered via the stakeholder interviews which were consequently prioritised.

Early on in the evaluation, informal interviews were also held with three members of the DECC 2050 Calculator team. These interviews provided important context for the evaluation, and included discussion of the background, current status, difficulties encountered and relative strengths of the country-specific 2050 Calculators. Building on this initial evidence base, the evaluation team was able to refine the methodology and develop the interview guide.

The core of the evaluation consisted of semi-structured interviews with selected individuals from ten of the eleven countries which received DECC support to develop a 2050 Calculator. The purpose of the interviews was to generate qualitative data on each country's experiences of developing a 2050 Calculator. Semi-structured interviews, which provide a flexible approach to interviewing, enabled the exploration of stakeholders' views and perspectives on the tool, as well as on the process of developing the Calculator.

In order to identify the interviewees a purposive sampling strategy was adopted following the framework generated by the DECC team who had worked on the project. This strategy enabled the identification of interviewees who would be able to provide a comprehensive and informed account of each country's 2050 Calculator, the process of developing the tool, as well as the challenges and benefits of using the tool. Interviews were therefore sought with individuals from the teams that had developed the Calculators (the developers), as well as with other government departments, private sector, academic and civil society groups (the user community). DECC provided an initial list of contacts to consider for interview, and typically this list included the project and/or technical lead in each country, as well as a contact in the British Embassy/High Commission. The research was designed to recruit a minimum of two interviewees per country, one from the developer and one from the user community. Wherever possible interviews were also sought with other organisations that had been involved either in the development of the Calculator or who had used the outputs of the tool. Further interviews were conducted with members of DECC's Modelling Integrity Team who'd worked on the development of India and South Africa's Calculators, as well as with former DECC and former FCO staff about their experience of the project. The qualitative sample structure is set out in tables 2 and 3 below.

Table 2: qualitative sample structure for country calculator interviews

	Total number of i	Developer	User community					
			National govt	User	Facilitator	Observer	reviewer	UK govt
Target (Minimum)	20	10	10					
Bangladesh	3	2						1
Brazil	3	1	1					1
Colombia	3	1	1		1			
India	9	4	2		1			2
Indonesia	3	2						1
Mexico	3	1	1					1
Nigeria	3	1	1					1
South Africa	3	1	1	1				
Thailand	3	1	1					1
Vietnam	4	2	1					1
DECC	3					2	1	
Total achieved	**40**	**16**	**24**					

Table 3: qualitative sample structure for global calculator interviews

	no. of interviews	Developer	User
Target			
Achieved	5	2	3

Since many of the Calculators had yet to be launched or had only recently been launched, in the event the majority of the interviews were carried out with those who had been involved in developing the Calculator. Of the 40 interviews that were carried out between January and March 2015, 18 were with government agencies or UK embassies, 13 interviews were with developers and nine were held with users, observers and reviewers (see Appendix A). At least two stakeholders were interviewed for each country. While the focus on developers is a potential limitation of the study, the fact that the evaluation took place prior to or shortly after the launch of most of the Calculators necessitated this focus. Since the 2050 Calculator country outreach work had only recently finished, the focus of the evaluation was on outputs and outcomes, rather than impacts. These outputs and outcomes address key issues such as accessibility of data, improvement to in-country modelling capability, and the involvement of stakeholders in the development of the Calculator. Based on the Theory of Change (see Figure 1), an interview guide was developed through an iterative process that involved all of the evaluation team and DECC. These questions were grouped according to the following categories:

- **Context (C).** This set of questions aimed to elicit background information, such as the interviewee's role within the organisation, the involvement of that organisation in the development of the Calculator, and the status of the tool in the country.
- **Rationale (R).** These questions explored the original aims and objectives of each country's involvement in the 2050 Calculator international outreach project, to provide additional understanding of what 'success' meant in each context.
- **Process (P).** These questions were to understand the process of each country's development of the Calculator, including stakeholder engagement, the challenges encountered, and lessons learnt. These questions also aimed to provide a greater understanding of how DECC designed and managed the outreach programme, in order to provide evidence on the performance of the process.
- **Effectiveness (E1).** These questions examined how, where, why and to what extent the cooperation with the ten developing countries had improved their capacity to understand and plan their low carbon energy and emissions pathways. This included whether the work around building these Calculators in countries had contributed to their national mitigation strategies.
- **Efficiency (E2).** The final set of questions aimed to understand whether DECC ICF support had provided an effective use of Government support, and to assess the extent to which the outputs and outcomes of the programme had been achieved.

The full interview guide is set out in Appendix C; the guide also indicates which of the above categories the questions relate to, and provides further details on the rationale behind each question. This master set of questions was then tailored for individual interviews depending on who was being interviewed, and their role in the development of each country's 2050 Calculator.

The interviews were held in a variety of settings. The global nature of the 2050 Calculator international outreach programme meant that the majority of the interviews were held over the

phone or via Skype. Two members of our team travelled to India, which was one of the priority countries for this evaluation. India released its version of the tool, India Energy Security Scenarios (IESS) 2047, in February 2014 and, together with South Africa, has the longest experience with the Calculator. This more in-depth study facilitated a greater understanding of the process in a country which had a longer history of the Calculator, and enabled a wider range of stakeholders to be interviewed. Nine face-to-face interviews were conducted in India during January 2015. Another two evaluation team members took part in the "International Conference on the 2050 Calculator", which was held from the 10-12 February 2015 in Taiwan. This international conference not only provided the opportunity to conduct face-to-face interviews with representatives of several countries that had developed a Calculator, but also to learn more about the work of the wider 2050 Calculator community. In total, 12 stakeholders involved with the development of the country Calculators were interviewed in Taiwan. All interviews lasted between half an hour and two hours.

After seeking the interviewee's consent, interviews were recorded and later transcribed. Detailed notes were also taken during each interview which provided an important reference, particularly for those interviews where transcriptions were unavailable. Not all interviewees agreed to be recorded, while the interview setting of others meant that the recordings were not of a high enough quality for transcription. One written response was also received (South Africa), where the interviewee was unavailable for interview but nonetheless wanted to feed into the evaluation. Prior to each interview, informed consent was obtained, and participants informed of their right to withdraw from the research at any time. All data is stored in accordance with the UK Data Protection Act 1998.

To inform the logframe, some further information was required. Following the interviews, stakeholders in the British Embassy/High Commission were also contacted for additional information and documentation to assess whether the indicators and milestones had been met. This included data on, for example, the number of webtool hits and whether the Government has used the tool to communicate evidence based scenarios in engagement with stakeholders. The completed logframe is set out in Appendix B.

2.1.1 Analysis

The analysis was carried out using Framework, a matrix-based method for ordering and synthesising data (Ritchie et al. 2003[6]). This involved the use of a deductive approach, wherein a predetermined thematic framework was used. This framework was derived using the interview guide, which was itself informed by the theory of change (see Figure 1) and the aims and objectives of the evaluation. Discussion amongst the evaluation team further refined the thematic framework. Ten key themes used to analyse the data were:

- Process
    - *Motivations*
    - *Challenges*
    - *Co-benefits*
    - *Peer review of inputs*

[6] Ritchie, J., Spencer, L. and O'Connor, W. (2003). Carrying out qualitative analysis. In: Ritchie, J. and Lewis, L. (Eds). Qualitative Research Practice: a guide for social science students and researchers. Sage Publications, London.

- Impact to date
    - *Use of the Calculator to date*
    - *Transparency and accessibility*
    - *Stakeholder engagement of outputs*
    - *Modelling capacity*
    - *Achievements and benefits*
- Ensuring the future

Using these themes, a matrix was developed in Excel, wherein each interviewee was allocated a row and each theme a separate column. After reading and re-reading the interview transcripts and notes, data from each interviewee was inputted into the appropriate part of the matrix. This reduced the amount of data to a more manageable level, whilst maintaining key terms, phrases and expressions. By synthesising the data in this way, the matrix enabled reading within and across the ten countries, and provided a transparent and systematic method of analysis. Quotes are used in the analysis to illustrate salient issues, and to show the range of views and experiences that emerged during interviews.

The terms of reference for this evaluation asked for value for money (vfm) of the outreach programme to be assessed. However, it was agreed with DECC that a formal 'vfm' assessment would not be possible, partly because of the early stage of the evaluation in the process of Calculator development, but also because the appropriate metrics or indicators were not available to allow such an assessment. An assessment of the efficiency of the programme was therefore carried out by qualitatively evaluating the extent to which the five vfm criteria set out in the business case were met.

2.2 Methodology - Global Calculator

The evaluation of the Global Calculator adopted a similar methodology to the 2050 Calculator country outreach. However, because it was only launched at the end of January 2015, no review documents were available; similarly, quantitative data on the uptake and use of the Global Calculator were not yet available. This component of the evaluation therefore primarily relied on qualitative information and analysis.

Three members of the project team attended the Global Calculator launch event in London on 28 January 2015, where they approached several potential interviewees. Further stakeholders were identified by DECC. In total, five semi-structured interviews were carried out with stakeholders who were specifically involved in developing or reviewing the Global Calculator. All interviews were conducted by phone between February and March 2015.

Table 2. List of interviewees: Global Calculator

Interviewee	Involvement in the Global Calculator
World Resources Institute	Co-developer
Chinese Energy Research Institute	Co-developer
Friends of the Earth	User/reviewer
Shell	User/reviewer

Mott MacDonald	User/reviewer

The evaluation questions developed here are broadly similar to those used in the national Calculator interviews. Assessing the outputs set out in the Global Calculator Theory of Change essentially involved fact-checking of whether these were met in the development and launch process (e.g. “Is there a webtool and spreadsheet? Has a launch event been held?”).

Therefore, the interview questions focussed on the four Theory of Change outcomes, rather than the outputs. See Appendix D for the list of interview questions.

The four Theory of Change outcomes, as well as themes emerging from the interviews, were used to define evaluation categories. Given that the Global Calculator’s Theory of Change differs from that of the national Calculators, the evaluation categories also differ. Evaluation categories identified for the Global Calculator aside from the four Theory of Change outcomes were:

1. interviewees’ motivations in participating,
2. stakeholder involvement in the development process (a Theory of Change output),
3. key challenges, and
4. value for money.

As with the country Calculators, a formal value for money assessment was not possible but the project team qualitatively evaluated the two vfm indicators set out in the business case for the Global Calculator work.

Interview notes and transcripts were read and re-read to capture relevant themes and information for the evaluation categories.

2.3 Limitations of the evaluation methodology

This methodology has some potential limitations which should be acknowledged:

Firstly, and as discussed above, this is an early stage evaluation. By the end of March 2015, only seven of the Calculators had been launched, with some of these launched during the evaluation period. It is therefore not yet possible to evaluate the impact of the international outreach programme, and the report therefore focuses principally on process, outputs and outcomes (see Figures 1 & 2). Future evaluations should be able to draw on a wider range of evidence to assess impact, outcomes and outputs, as well as how the Calculators are perceived and used by different stakeholder groups.

This is closely related to the second limitation, which centres on the sampling method and the resulting focus on the perspectives of the developers of the 2050 Calculators. As explained above, it was originally intended that, in addition to interviewing someone in the team responsible for the development of the Calculator, one other respondent who had not been involved would be interviewed. However, the early stage nature of the evaluation meant that in practice most interviews were with those who had been involved in commissioning and developing the Calculators. This introduces the possibility of bias; for example, dependent on DECC funding to develop the tool, respondents may have felt obliged to provide a ‘positive’ review of the programme. While it is not possible to remove this bias, we were able to conduct some interviews with the user community and this, combined with the more quantitative logframe, provides a means of triangulating the research findings.

Finally, this evaluation involved the generation of qualitative data from a small group of actors, many of whom were directly involved in the development of the 2050 Calculators and Global Calculator. In particular, the private sector is under-represented in the interview sample. The findings therefore reflect the positions and perspectives of these actors. While some of these findings will be transferable to other contexts, it should not be assumed that they are applicable to all settings or reflect the opinions of all stakeholders.

3. Results

This section sets out the analysis resulting from the application of the project methodology, structured around the key themes used to analyse the qualitative data.

3.1 Results - 2050 Calculator Country Outreach

Overview

Table 3 summarises the progress made to date on each of the eleven countries supported by DECC. The table shows that, by the end of March 2015, seven Calculators had been launched and the remainder were due for publication within a few months. In the following sub-sections we summarise the results from the evaluation, focusing on the key themes used to analyse the data. These include: motivations, challenges, co-benefits, peer review of inputs, use to date, transparency and accessibility, stakeholder engagement (with outputs), modelling capacity, achievements and benefits, and future steps. General findings from the desk research on country Calculators and energy policies are summarised in Appendix E.

Table 3. Summary of the 2050 Calculator Country Outreach programme

Country	Calculator launched	Launch date	Summary
Algeria	No	No date	Led by SONELGAS. The Algerians are now primarily working with Belgian consultants to develop the Calculator; DECC has had limited involvement so far.
Bangladesh	Yes	January 2015	Limited engagement from Government of Bangladesh in later stages. The project lead had to develop much of the data himself.
Brazil	No	Planned (2015)	Led by Empresa de Pesquisa Energetica (EPE), a public body advising the energy ministry. Intended to be launched as a communication tool alongside EPE's updated long-term energy strategy for Brazil. Consequently, the main focus is on energy. Large stakeholder consultation undertaken.
Colombia	Yes	March 2015	Four-way partnership between DECC, British Embassy Bogota, the Colombian Ministry of Environment and Sustainable Development and the United Nations Development Programme. Developed as part of the Colombian Low Carbon Development Strategy. Considers some sectors beyond energy which have not been considered in the UK 2050 Calculator, including deforestation,

			reforestation, diets, cattle farming and soil use practices.
India	Yes	February 2014. Phase 2 in process.	Led by cross-government Planning Commission and championed by a senior level civil servant. Internal team kept despite new government and political restructuring. Extensive stakeholder consultation for inputs, which was managed by engaging external Knowledge Partners to lead on different sectors and verify data with stakeholders. Main focus is on Energy Security, but LCD a co-benefit. Version 2 to include costs, but not land use
Indonesia	Yes	December 2014	Plan to launch second version in April 2015. Land use is a key sector, both for emissions and for political reasons.
Mexico	No	Planned (2015)	Developed by the Secretaría de Energía in conjunction with the Centro de Mario Molina. Initial plan was to focus on ongoing energy reforms, and the Calculator was to facilitate a numbers-based debate.
Nigeria	No	Planned (2015)	Led by the Energy Commission, stakeholder engagement limited by a lack of resources. Air quality, energy access and land use included as co-benefits
South Africa	Yes	March 2014. Phase 2 launch planned for March 2015.	Led by the Department of Environmental Affairs, but lacked a strong champion. The existing modelling expertise was high, but the priority was to make the data more transparent. Now pioneering schools' engagement and launching a my2050 tool.
Thailand	Yes	December 2014	Led by the Thai Greenhouse Gas Management Organisation, with involvement from the energy and environment ministries.
Vietnam	Yes	January 2015	Led by the Vietnamese Ministry of Industry and Trade. Focused on GHG emissions from all sectors, agriculture particularly relevant. Stakeholder engagement has mainly been across different government departments and services.

3.1.1 Motivations for participation

This section looks at the initial motivations that countries had for developing a 2050 Calculator. In short, it focuses on understanding why they are doing this. These are not necessarily the same as the eventual benefits that countries realised from the 2050 Calculators; benefits are covered in Section 3.1.7.

We start by looking at what the primary motivations were for each country. The description of one motivation as primary should not however be taken as suggesting that there were no other important motivations. Other motivations are discussed further on. The expected outputs and outcomes have been set out in Section 1.1.1 on the theory of change for the country Calculator outreach work. However, we felt it would be valuable to also ask the countries themselves as they may have had other considerations in mind when deciding to accept the support.

The most common primary motivation was **improving communication**. This could be between government ministries, or with external stakeholders including civil society organisations and the public; schools were specifically mentioned on a number of occasions. This improved communication was expected to lead to better policy making, to increased public understanding and acceptance of low carbon pathways, and to thinking long term. It was also expected to help people to understand how low carbon development fitted with, and affected, other policy objectives. "*Policy linkages*" was a phrase used often by interviewees. This motivation was mentioned by countries across the range of continents and stages of economic development.

Supporting low carbon development was another primary motivation and one mentioned by interviewees from two Asian countries. This is somewhat linked to the previous motivation, in that the way that the Calculator would support this development would be largely through communication and public engagement. There was no agreement about whether the Calculator would itself be used to determine low carbon policy or energy policy within governments. A number of interviewees stated that this, or related motivations such as policy planning, had been the primary motivation for developing a Calculator. One country said that the Calculator helped policy makers understand linkages between energy policy and their own policy area. However, for energy policy support, most countries preferred models such as MARKAL[7] and LEAP[8]. That said, at least one country took the view that these models are "*not suitable for policy makers*", for example due to the data not being disaggregated to a sufficient level of detail for decisions on policy. However, no interviewee mentioned that the primary motivation for adopting the Calculator was to increase or improve modelling capability.

For India, however, the primary driver was **energy security**, which is reflected in the name of the Indian Calculator – India Energy Security Scenarios 2047. Interviewees mentioned that greenhouse gas emissions reductions were viewed as a potential co-benefit of energy security, rather than a key driver. A number of other countries mentioned energy security as a secondary motivation or co-benefit.

To summarise, for most countries that had adopted the Calculator, the primary motivation was to have a tool that allows low carbon policy to be better communicated. Some countries wanted to use it for policy making, but by no means all.

In addition to these primary drivers, interviewees mentioned several other motivations for adopting the Calculator. There was again a strong emphasis on communication, and the related motivation of transparency and impact on public debate. Additional motivations included:

- Assessing climate vulnerability, such as "*food security affected by climate change*".

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[7] MARKAL is a numerical model used to carry out economic analysis of different energy related systems at the country level to represent its evolution over a period of usually of 40 – 50 years. Various parameters such as energy costs, plant costs, plant performances, building performance and so on, can be input and the software will choose an optimal technology mix to meet that demand at minimum cost.

[8] LEAP, the Long range Energy Alternatives Planning System, is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute.

- Demonstrating cross-sectoral links, and offering a macro perspective. This came up a number of times – the fact that the tool covers the whole energy system, and can show wider impacts and co-benefits is extremely attractive particularly where ministries or other parties operate in silos.
- Assessment of energy balancing – ensuring that there is sufficient supply to meet demand. While the Calculator only does this on an average annual basis, it is still useful for energy balancing (and so energy security, of which energy balancing is part).
- Development of a database. Some countries found it useful to have to gather all energy data for the Calculator, as this meant that they had a single repository for good quality energy data.
- Use of a user-friendly and accessible model that all can understand. This was identified as potentially valuable for international negotiations.

It is interesting to note that in some cases the original expectations of a country changed once they learnt more about the Calculator. For example, a stakeholder in Vietnam commented that the government at first thought that the Calculator would be a technical tool used by the same officials that currently use the LEAP or EFFECT models. However, after a workshop run by DECC and further training, they began to see that the primary benefits were different, particularly transparency, accessibility of data and the development of a cross-sectoral perspective.

3.1.2 Co-benefits

As set out in section 1.1.1 above, one of the expected outputs of the international outreach programme was that Calculators would not only look at energy and emissions pathways, but would also consider other potential 'co-benefits', such as land-use, air quality and costs. Interviewees were therefore asked about possible co-benefits to gauge the extent to which they were incorporated in the Calculators.

In terms of the outputs that were of most interest to the countries that had developed a Calculator, in many cases, new outputs had been added to the tool to reflect the particular interests; for example, on energy security and costs.

Costs were an output mentioned by many interviewees. It is clear why the question of costs would come up in any debate about low carbon pathways, and so easy to see why including costs would be helpful. A conference participant from Belgium cautioned that simply including the costs of the energy technologies for each pathway (that is, the capital, operating and fuel costs of each one) was misleading, since it did not reflect the wider impacts on the economy. However, calculating these would likely require a more complex model[9] which would defeat the original objective of the Calculator to be transparent. The team in India are currently working on a version of the Calculator which includes costs.

A related co-benefit was jobs. In other words, what the impact of the 2050 Calculator pathways would be on employment in the country; however, whilst some interviewees felt that this was an interesting co-benefit, they also felt that jobs belonged in a separate model.

Land use and agriculture was mentioned by several interviewees. As shown in the logframe (Appendix B), four of the countries that had published Calculators – Colombia, India, Thailand and Vietnam – had included analysis on land use. Indonesia was in the process of developing a

[9] Such as a general equilibrium model

land use module, as this sector is an important source of emissions in the country. While this was expected to be fairly rudimentary, according to one interviewee it represented an important first step in modelling emissions for land use and there had been widespread interest in the project. For other countries, specifically Brazil, despite the importance of land use and agriculture to the country's emissions, these sectors were not currently included in the Calculator, although there were plans to include these in the future.

Energy imports were mentioned by some interviewees, but exports were also important. One interviewee from India commented that being able to show that low carbon development and energy security were not at *"loggerheads*", and that energy efficiency is very important, was very helpful.

Air quality and health impacts were felt to be important but "*…too tricky to model*" (Columbia) and "*more work needed to be done*" (India). For some interviewees, the geographic nature of these impacts (that is, where the emissions happen matters) was a particular problem for the Calculator, which takes no account of location.

3.1.3 Transparency and accessibility

The business case for the international outreach programme defined the following criteria in terms of accessibility:

- Improving understanding of how the models produce their results, through:
  - Good documentation
  - Simple explanations of assumptions
  - Simplified structures that are easier for non-experts to understand
- Improving access to the tools and the underlying data

All of this helps improve the usability of the Calculators, by making them easier to understand, navigate and operate. It should be noted that the ability of the project team to evaluate the usability of the tool from a users' perspective was limited, because most tools had either not yet been released or had only recently been launched and the evaluation was necessarily focused on Calculator development rather than use. It was possible to get some insight on 'usability' for the two Calculators that have been available for longer – for example South Africa was specifically looking into the usability of their tool. In addition to this, the project team made its own assessment of the transparency, accessibility and usability of the Calculators and their associated Excel sheets. This assessment also informed the findings and was used in conjunction with the findings from interviews.

Transparency and accessibility as a driving factor

Transparency and accessibility to data was a key rationale driving the 2050 Calculator country outreach work, and was a key theme in the interviews. In all countries, the approach to transparency and accessibility of data was very different from what had been done before in those countries. One ex-FCO staff described the DECC Calculator team as being "*religious about transparency*". Long-term energy modelling work had previously been done in several countries; interviewees from South Africa, Mexico, India, Colombia and Thailand mentioned that their governments use TIMES/MARKAL or had commissioned studies using these models. Several governments also use the LEAP model; however, the underlying assumptions and input data in these cases were mostly not widely shared or made accessible to all.

Indeed, accessibility of data was one of the key reasons for adopting the approach from DECC, as opposed to other possible modelling approaches that may be more 'black box'. One of the Indian stakeholders pointed out that whilst there are many models used in India, none of these have data, assumptions and methods in the public domain. It was also pointed out by stakeholders in India that the fact the data is accessible, and the documentation is downloadable, was a key reason for choosing DECC's model. A South African stakeholder also made the same comment – that accessibility is a key differentiator with other models. This would therefore seem to be a strong unique selling point of the 2050 Calculator approach. There was limited evidence of the impacts of this transparency although one stakeholder in India did point out that they have used the model in a piece of research published in January 2015. However, some more negative comments were also received: for example, an interviewee from India said that whilst the data was transparent and the methods / assumptions were explained, the data was not high resolution enough for complex systems modelling.

Improving understanding of how the models produce their results

As explained above, this covers a range of issues, including good documentation, simple explanations of assumptions and simplified structures that are easier for non-experts to understand.

Availability and quality of excel sheets:

Of the seven countries to have published Calculators by the end of March 2015, six have publicly available Excel sheets. Vietnam is the only country that has chosen not to make it publicly available (it was initially published but is now only available on request). Of the Excel sheets that are available, all show underlying data and assumptions. However, it should be noted that this does not necessarily mean that the information is accessible and easy to understand. A review carried out by the evaluation project team shows that some of the Excel sheets were easier to understand and follow than others. This was supported by some of the interviews. For example, feedback was received from a couple of user stakeholders in South Africa that the Excel sheet was not very easy to access and navigate. This suggests that users will be assisted by (a) a clear opening tab with explanation and instructions, and (b) a system of navigation. The Excel sheet for the India Energy Security Scenarios 2047 is the only sheet so far that has both and should be seen as best practice. Other Excel sheets were somewhat harder to understand and it was felt that it would likely require discussion with one of the 2050 Calculator project team to be used properly.

In one case (Indonesia), whilst the Excel sheet is publicly available, the spreadsheet is locked, so it is not possible to change the data. For South Africa, an interviewee reported that fixing initial 'bugs' in the model required a lot of unexpected additional work. The project team also found smaller issues (e.g. missing or broken links) on some of the country Calculator websites which were fixed after DECC alerted the country teams.

Explanations and descriptions:

Another key component of transparency and accessibility is having access to clear instructions and explanations so that the user is empowered to make use of the information. Again, the review by the project team found that there was a range of outputs in this regard. Some of the 2050 Calculators take you straight to the webtool with no introduction and instructions, as in the case of South Africa and Thailand. For these two Calculators, there are links to the relevant

websites (the Department of Environmental Affairs (DEA) for South Africa and the Thailand Greenhouse Gas Management Organisation (TGO) for Thailand), but the user then has to search for the 2050 Calculator information. Other Calculators – Bangladesh, India, Vietnam and Colombia – have their own dedicated websites and these tend to have better background information and explanations. India is again a best practice example, with the evaluation team finding it to be a very clear website with a lot of useful supporting information.

Improving access to the tools and the underlying data

In some cases, the data required for the Calculator did not exist and had to be estimated. This was a particularly notable challenge in Bangladesh. However, in most countries, the 2050 Calculator work did not result in new primary data collection, but it performed an important role in accessibility. Firstly, it often resulted in the gathering of all the relevant data in one place, some of which may already have been publicly accessible. This greatly increases transparency and means that the Calculators and the underlying Excel spreadsheets are effectively acting as one-stop shops for energy and climate data. Secondly, it resulted in data that had previously not been publicly available being made available (e.g. in Brazil). In India, for example, an interviewee discussed the importance of having a government approved figure for per capita emissions in the public domain as there are different sources for politically sensitive indicators.

Feedback from interviews, mainly from Foreign and Commonwealth Office (FCO) staff, was that the accessibility of data was met with particular excitement by stakeholders who had perhaps not previously had access to the data, especially civil society and academia. For example, an interviewee in Bangladesh pointed out that civil society and academia were particularly pleased about the wealth of data that was being made publicly available. While it is not possible to draw concrete conclusions on the reasons for this positive reaction, it is worth noting that Bangladesh was the only Least Developed Country involved in the 2050 outreach work and has significant issues regarding capacity around data sharing and institutional frameworks.

Also in Bangladesh one interviewee commented that they had found that most of the users accessing the Calculator were mobile internet users. However, the Calculator webtool as currently designed is not appropriate for use on mobile phones. It would therefore be appropriate to develop a mobile version, and this will help encourage greater transparency and accessibility, by increasing the usability and meeting the demands of the users. This points to the importance of carefully considering the audience before developing a 2050 Calculator so that it can have the widest reach possible. A different example of this was in South Africa, where lack of internet access in some parts of the country was the driving factor behind the government developing a non-internet friendly version of the Calculator, particularly of the My2050 Calculator.

Even in those countries that have not yet launched their Calculators, the process of developing the tool has been transparent and open, with stakeholders actively engaged in discussions on data and assumptions. In India, this process resulted in stakeholders using the tool in their own research, suggesting that if stakeholders are involved in development they may go on to use the tool. This is discussed in more detail in the following section (3.1.4) on stakeholder engagement. Furthermore, a comment was made by a Brazilian stakeholder that not only was the Calculator transparent, but that it had also led to the government's energy planning process becoming more transparent. One interviewee from Mexico also commented on how the process of collating the data for the 2050 Calculator had been helpful in identifying where the data gaps were and where further work was needed to gather better data. Thus there can be wider, indirect, benefits for transparency and data from the 2050 Calculator work.

Of course transparency and accessibility can create some potential difficulties. One of these is around the treatment of confidential data. In Mexico, the lead technical team had to sign non-disclosure agreements when using some sensitive oil and gas data. The data appearing in the Calculator will be more aggregated and will therefore not breach confidentiality.

3.1.4 Peer review and stakeholder engagement with inputs

The Calculators were intended to be developed in consultation with stakeholders across the public and private sectors. The different pathways contain different levels of political ambition and technical feasibility making peer review an important issue, especially for data validation. In the theory of change (see Figure 1) this process was seen as a route to achieve three ends: firstly to improve the quality of the tool; secondly to enable more buy in for the tool; and thirdly, to facilitate more engagement and debate with the tool once launched. The early stage of development for the Calculators means that results are limited, however all the country Calculators included in the evaluation had implemented some form of peer review and some trends are evident in the process of stakeholder engagement that the country teams adopted. In this section we look at what has influenced these different levels of engagement, and what the implications are.

Process

Evidence of peer review has been monitored through the logframe and this shows that all country 2050 Calculators carried out stakeholder consultation (Appendix B), although a distinction is made by the DECC staff filling in the log frame between a broad range of stakeholders, meaning across government, business and NGO sectors, and a narrow range. For example Brazil's stakeholder invite list was described as 'narrow' and not inclusive. This range is also reflected in the interview data, as stakeholder engagement processes were limited to few stakeholders in some cases (Bangladesh, Nigeria, Thailand), to broad consultation and peer review of inputs across government, industry, academic and civil society organisations (India, Indonesia, Colombia, Mexico, Vietnam, South Africa). The **different levels of consultation** were attributed to two reasons; **context** and **progress**.

The engagement process reflects **the national and political context** in which the Calculators are being developed. The different degrees of stakeholder engagement reflect the institutional structures within which the teams were operating. For India and Indonesia, the Calculator was led by a government agency with a strategic planning role and these teams managed to get input from stakeholders across government departments. Others found this more challenging. This was particularly so in those countries where the tool was developed by a sector-specific ministry, and was therefore viewed by other departments as belonging to that department (e.g. in Vietnam it was seen as a Ministry of Trade and Industry tool), or developed outside government (Bangladesh, Colombia). This has so far tended to result in less comprehensive stakeholder engagement, although this has not always been the case (for example, Colombia conducted extensive stakeholder engagement despite the tool being developed outside of government).

The **engagement process progresses as the Calculators develop** and therefore is linked to the stage of development of the 2050 Calculators. For most teams, the priority was to launch the Calculator, but after launching, more opportunities to refine the data and include more sectors are recognised. This means that teams that are in advanced stages, such as India, have embarked on a new round of engagement to widen the organisations that are involved in validating inputs to the Calculator and address shortcomings or opportunities resulting from the first round of engagement. India's experience provides a useful insight into the process of peer review because the team was able to run extensive consultation. Their experience is discussed

below in order to make initial assessments of how peer review during the development phase can affect the quality of the tool and improve buy in.

Peer review – India's experience

The process of developing a Calculator requires data from multiple supply and demand sectors which can be held by different stakeholders.

The team in India was able to negotiate pro-bono support from six knowledge partners who were given responsibility for a number of sectors. These groups were able to run consultations to validate the data and debate the ambition and technical feasibility that should be included in each of the levels in the Calculator. One interviewee explained that the peer review process was:

> *"between a formal and informal process. [F]ormal in the sense that it did set up a structure, but it was informal in the sense that a lot of times you could discuss quite frankly"* (Peer Reviewer)

Another interviewee clarified:

> *"there was enough scope for the academic intellectual discussion. It was not very top-down centric, or too free[ly] academic, but they structured it well. [It was] a mutual discussion".* (Peer Reviewer)

The peer review process in India meant that some of the UK specificities of the Calculator were removed and replaced with issues more relevant to the Indian energy system. For example one peer reviewer explained that they had lobbied for the inclusion of cooking fuel in the tool, because this sector will change dramatically if India's government delivers on its vision of fast improvements in energy access. By facilitating such processes of debate and adaptation, the peer review process means the tool more accurately represents the national energy system and reflects key issues and priorities in the development of the energy system. The process has also created a sense of ownership over the tool, and it is recognised by stakeholders as an Indian-owned and developed Calculator. This sense of legitimacy can be seen in the fact that since its launch the tool has been used by some of the peer reviewing agencies. For example, one of the academic knowledge partners has cited the tool in new research, and one of the government agencies involved has asked for a new renewables policy to be included in the new version under development. This can be interpreted as showing stakeholder confidence in the quality of the tool and the data.

The peer review process was managed successfully in India, and has generated an improved Calculator, and wider buy in. This has been managed despite the political restructuring which occurred immediately after the Calculator's launch and which threatened the department in charge of the Calculator. With an uncertain political future the team spent the months following the general election working to modify the tool and include new sectors and consider how to include costs. They continued to work with their knowledge partners through this period and by the time of the evaluation, when the team's future had been secured by the new government, new plans for engagement were being made.

Peer review in other cases

Engagement in peer review has also **facilitated wider buy-in in other cases**, although the form of peer review was tailored to national contexts and specific institutional needs. For example, in Thailand the stakeholder engagement took the form of training government

employees in using the tool, because the imperative was to increase government support for the Calculator. An interviewee explained the rationale for this form of engagement:

> *"if [Government agencies] understand the model, when they use the model they can communicate with their own stakeholders". (External consultant, tool developer)*

Through this process the external consultant working on the development felt that this had helped different government agencies to become more informed users of the tool, and to critically examine the assumptions contained in energy models. This means that while the tool itself currently uses existing data, ongoing support for the Calculator could see improvements in the quality of the data if government agencies become more active participants in producing the tools, rather than passive consumers of results produced from external modelling consultancies**.**

By contrast in another national context the process of engagement was seen as being limited by a lack of funds. Nigeria's process of stakeholder engagement involved one large stakeholder meeting involving 100 participants drawn across government, industry and civil society sectors, but was constrained from extending the consultation process by a lack of funds to cover travel and subsistence. One interviewee from the government agency involved in development explained that there had been limited engagement from the private sector in peer reviewing the tool. They felt that for stakeholders to engage with the published Calculator an additional person would need to be employed to attract interest from stakeholders and specifically manage engagement.

Another point raised by the DECC team was that the outcome of the peer review process was also linked to the quality and professionalism of the civil service in countries. In cases where the civil service is under resourced, consultation may not generate the desired outcomes.

Overall the range of experiences and outcomes from the peer review process should be understood as works in progress and need to be interpreted relative to context. India's experience provides an excellent example of a well-managed process which has achieved the intended outcomes, but the successes of other countries should also be recognised.

3.1.5 Society engagement with outputs

As explained in Section 3.1.3 above, a key rationale for the 2050 Calculator country outreach work was for the 2050 Calculators to be publicly accessible sources of information that could be used to stimulate public debate about energy pathways. At the time of research, only seven Calculators had been launched (see Table 3). Due to the early stages of development even those that have been launched have seen limited engagement with the outputs by stakeholders both inside government and more widely. Even for India, which launched the Calculator in February 2014, the engagement process has been limited due to the general election and political changes mentioned above. The team's public engagement activity was restricted while their department underwent restructuring, but was gaining momentum by the time of evaluation.

Overall the priority for the countries was getting the Calculator developed and launched and only once in place (and in some cases, like India and South Africa relatively long after it was first in place) does the focus turn to engagement and awareness raising. Some stakeholders felt that the latter would be the more challenging part. This was echoed by a previous member of the DECC 2050 team, who discussed whether it may have been better to have focused on fewer countries but to have given them more assistance with awareness raising and stakeholder engagement.

However since launch, new audiences have been recognised and new outreach strategies are currently being devised. In Indonesia, for example, a relatively low-key launch was held in December 2014, but there are now plans for a bigger re-launch. The same goes in other countries that have already launched, including Bangladesh and Vietnam. Over a year after launch, the South African government is now focusing much more on engagement and has helped organise a number of stakeholder events in recent months, hosted by the organisation 'Project 90 by 2030'. What was clear from the discussions at the Taiwan conference was that those Calculators which are further behind in the process will be able to benefit from lessons learnt by earlier country experiences and they are now thinking about public engagement as they are developing their tool.

Despite limited experience, interviewees discussed their plans for engagement, and these discussions are useful to draw out some early findings on the direction that society engagement, is taking. A clear message that came through the interviews was the shift in intended audiences, as teams learnt more about the tool and the interest in the My2050 interface – the schools version of the Calculator.

Intended audiences

The rationale to develop a national 2050 Calculator varied according to country as discussed in section 3.1.1 above. Different motivations identify different audiences for the final Calculator. Through interview the following intended audiences were discussed; policymakers and government departments, industry and the energy sector specifically, civil society, academia and schools and the general public. Overwhelmingly policymakers and government agencies were recognised as the intended audience for the outputs. This was identified in six of the ten cases (Brazil, Colombia, India, Nigeria, Thailand and Vietnam). While for two cases (Bangladesh & South Africa) the public was seen as the main audience. In Mexico, the intended audience was both Government and wider society. For Indonesia the picture is less clear, the embassy identified government, industry and the public as potential audiences, while the respondent involved in developing the tool was not clear who the main audience was. This reflects the uncertainty that Indonesia had in determining the key driver; from the UK partner

perspective, the driver was to communicate LCD, while the national partner did not identify a main driver.

This indicates a relationship between the main audience intended for the tool and the engagement strategy used to reach these audiences. This relationship is an iterative one that develops as the team build their national Calculators and adapt them to their national contexts.

Interviewees from six countries discussed that as work on the Calculator progressed, new audiences were considered (Bangladesh, Colombia, India, Indonesia, Mexico, Vietnam) and there was a shift in focus from Government to include broader audiences either industry, or Civil Society Organisations or schools. Explaining the experience of developing the Calculator in China, a former DECC staff member explained that initially the intended audience had been senior policy makers, but the team realised the potential for the tool to be used for broader public engagement with civil society. This trend has been echoed in other cases as countries are now looking at the potential benefits of developing a My2050 interface, discussed below. Interviewees in Colombia discussed shifting towards academia and stakeholders in India discussed new audiences in industry, as well as academia, explaining that both audiences could use the broad top level trajectories produced by the Calculator to calibrate their own specific interests.

The change in intended audiences was discussed by some in terms of an opportunity for outreach (India, Colombia), while others saw this shift as necessary to distance official policy from the figures outputted by the tool (for example China). In other cases, for example Bangladesh, the shift from government departments to academia and civil society was not one that was planned but resulted from the government withdrawing its involvement from the project. Nonetheless, by that stage, academia and civil society had already enthusiastically embraced the Calculator and effectively took ownership of it going forward. This therefore is a good example of how the target audience can change over time for unexpected reasons. In three countries academia has engaged and shown interest in the tool (Colombia, India, Bangladesh). In India it is being used in the taught curriculum of a university. Interviewees involved in the Colombian Calculator explained that they had been surprised by the engagement with the tool. An interviewee explained:

"We asked some institutions to make some scenarios for the Calculator and a few universities and NGOs. They asked us to have scenarios and those were entities that we never expected to become involved with the climate change issues, so it's good. [Interest came from] two universities that we didn't know were working on these kinds of issues [and] two NGOs that are not related with climate change issues. So they [are] start[ing] to move and work at that." (Government interviewee)

The potential value of the 2050 Calculators has also been seen by other government bodies. In Vietnam, Indonesia and India regional authorities have expressed their interest in the Calculators and have discussed ambitions to develop regional Calculators. In Colombia, there are also plans to develop regionalised Calculators. This iterative relationship between tool and audience can be recognised as a key strength in the flexible and adaptive approach that DECC's outreach team has deployed through the process.

My2050

My2050 is a simplified version of the Calculator which has a graphic interface representing the energy system data behind it. In the UK this version is an online tool which depicts the changes a user makes to their model energy system, as they adjust it. Offshore wind turbines are animated, for example, if a user boosts this supply side technology to level 4 to meet the 2050 targets. The My2050 interface was identified by interviewees from several countries as an area

of interest. The demonstration of South Africa's version of the My2050 tool was widely discussed at the Taiwan conference. This version has bright and engaging graphics and sound effects which have been kept simple to make it compatible with low bandwidths. Representatives interviewed referred to plans to develop this engagement tool. During a breakout discussion, attendees commented on the ways in which the My2050 tool had been adapted to fit the South African context, which included a version that did not depend on continued connection to the internet. Such modifications are likely to be more appropriate to other developing world contexts, and enable improved accessibility, and suggests an important opportunity for cross-country learning. However, for the majority of countries, developing the interface remains a future ambition rather than an existing strategy. For example Colombia, and Mexico discussed their intention to run a schools engagement programme, and since being interviewed have started developing My2050 projects. India and Vietnam expressed interest in developing a My2050, but governments were a little unclear on what this would entail. The Vietnamese team were in discussions with the Ministry of Education and Training. This suggests there may still be scope for further capacity building support.

Shaping policy and public debate

The role of the 2050 Calculators in policy making and public debate has yet to be seen and was outside the scope of this evaluation, due to the very early stages of development. Even in India it was too early in the process to generate clear qualitative or quantitative evidence, however there was some discussion in interview of potential routes to influence policy and public debates. Some think tanks and consultancies had begun to quote the tool and to source data, projections and references from the Calculator and it is important to note that two of the knowledge partners who were involved in developing the tool have been using it in their own research projects. This indicates that the process of peer review can lay the seeds for future impact on broadening debate about the pathways generated with tool.

In terms of shaping policy, as has been discussed above, not all Calculator teams see this as a purpose for the tool. Rather, some see a role for the Calculator in showing integration between areas typically thought of as separate policy areas (Vietnam, India). Another area of potential application lies in the Intended Nationally Determined Contributions (INDCs) that countries will develop to publically outline their post 2020 climate actions. This was mentioned by Colombia and India interviewees, while Bangladesh and Vietnam also mentioned potential applications. These mentions cannot be considered as indicators of impact on policy or public debate for the evaluation, however they do reflect the positive experiences and evolving aspirations of the teams involved in the development of tools.

3.1.5 Challenges

During interview, respondents were also asked about the challenges they had faced in developing each 2050 Calculator. Many of these challenges were country-specific. In this section we focus on those challenges that emerged as common across multiple countries including, data availability, timing and resource, engagement and the political context.

Interviewees from most countries highlighted issues in **obtaining adequate input data**. Some stakeholders pointed to particular issues, such as costs, and particular sectors, such as transport, agriculture and Land Use, Land Use Change and Forestry (LULUCF). They also pointed to sensitive sectors such as oil, gas and nuclear, and the demand side in general. For example, one interviewee commented that they kept the UK cost estimates in their country Calculator because of time pressure. Some stakeholders found that the required data had

simply never been estimated at the required sectoral level of depth while others found it challenging to obtain existing data from the government departments and agencies responsible, or sector stakeholders. Several interviewees found disparities between different data sources. Data issues appeared to relate both to historical and current data as well as difficulties in coming up with forecasts and trajectory data.

An **ambitious time schedule** was brought up as a challenge for several countries. In most countries, the launch of the Calculator was behind schedule and a variety of factors delaying the process were identified. They felt that the project time schedule should rather be one or one and a half years. Several countries, including Mexico, Brazil and Thailand experienced delays through key staff with skills for developing the model leaving to take up jobs elsewhere. As discussed in Section 3.1.4, stakeholder consultations often took longer than expected as stakeholders found it difficult to get a grasp of the project and agree on scenario ambition levels. An interviewee commented that while initially the project appeared straightforward given the organisation's previous experience in delivering low carbon energy modelling the nine month time schedule turned out to be too tight to carry out the necessary stakeholder engagement. The lack of data availability mentioned above also contributed to delays. In Colombia, it was initially planned to include many more sector levers. Eventually, however, it was necessary to cut down the number of sectors in order to reduce further delays and complete the work.

In some countries, **government concerns about the public message** sent by the Calculator results led to delays. In one country (Bangladesh), the government lost interest in publishing the Calculator altogether without providing an explanation. In another country (Brazil) the Calculator is set to be launched alongside an updated long term national energy plan. The Calculator is viewed as a communication tool and the communication needs to be in line with the wider long term energy plan. While the technical development of the Calculator has been completed largely according to schedule, it appears as though approval for publication is pending on further refinements on elements of communication including pop-ups and one-pagers as well as scenario assumptions.

Wider political challenges associated with the development and subsequent launch of the 2050 Calculator was also mentioned. Several interviewees from different countries felt that pathways tend to be interpreted by stakeholders as government-supported solutions. In another country, this interpretation from the side of government is likely to have led to less ambitious trajectories after the involvement of senior government officials. This also relates to issues of communication and defining Level 4 scenario trajectories (addressed as a separate challenge further below). In India, a government agency was concerned about including emissions data in the tool as this could be picked up by lobbyists and be used to promote their own agendas. Despite these concerns the Calculator was eventually made public including emissions data. In another country, the organisation tasked with development of the tool stated that they consulted with the government over trajectories in sensitive areas such as nuclear or coal:

> "*the idea was not to create a 100% academic view of the future of [the country] but somehow have this view with some boundaries from the view of the government"* (Brazil).

Concerns about a **lack of government interest or support** was also raised by a number of interviewees. For example, one stakeholder recalled that persuading government officials that the tool was worth pursuing was a key challenge. Another interviewee highlighted tendencies towards short-termism within government, and highlighted how interest in energy policy rose and fell with the oil price. The opportunity to have a structured discussion on very long-term energy planning was often seen as a benefit of the Calculator (see Section 3.1.7.). Nevertheless, some interviewees found it challenging to get the stakeholders involved in the

workshops more generally to engage with the time horizons of the Calculator and to think long-term. Co-operation between different government ministries was found to be a key challenge for the project in Thailand.

Defining scenario trajectories with the input from stakeholder workshops was generally perceived as challenging. Most countries sought to base their scenario trajectories (Levels 1-4) for each sector heavily on the judgement of expert stakeholders consulted in workshops. Quantifying and reaching agreement on the specific trajectories amongst a number of stakeholder was difficult. In particular:

- DECC suggests that a Level 4 trajectory (i.e. the most ambitious trajectory) should be one that approaches physical or technical limits. Some interviewees felt that explaining a Level 4 effort to stakeholders and developing a Level 4 trajectory was difficult in practice. Defining it as a technical or physical limit raised question marks and several countries appear to have defined Level 4 trajectories which are substantially below true technical potential. In Colombia, a country with three times the land mass and more than half the population of Germany, Level 4 on-shore wind is set at 2 GW installed capacity for 2050 whereas Germany at present already has over 30 GW installed onshore capacity.
- Defining technical limits becomes especially difficult around intermittent renewable electricity sources. Should it be defined in terms of conceivable land area available for development? Or in terms of maximum levels of variable generation the current grid structure can support? Or in terms of maximum levels which a presumed future grid structure with better storage and demand side management could support?
- At least one of the organisations involved with the model development drew on previous work in dispatch modelling to assess the quantity of variable renewables the country's electricity grid could support in order to inform the upper bounds for wind and solar electricity generation.

One interviewee judged their country's Level 4 results to be quite conservative as a result of the stakeholder consultation. On the one hand, they felt this was because they had:

> *"mostly convened NGOs and stakeholders with a minimum technical depth. So it wasn't an open call for just any NGOs"* (Government official).

There was a feeling that within this community of technically literate stakeholders the outlook tends to be conservative. On the other hand, the interviewee felt that Calculator trajectories can never be purely technical and will tend to be culture-specific: in their country, which has been economically stagnant for 30 years, people tend to be cynical about change and careful not to set out overly optimistic scenarios. Another interviewee pointed out that defining scenario levers in terms which the general public or policy makers can relate to by setting illustrative references such as 'the average home' can be more difficult than in the UK given diversity in socio-economic living situations, as well as geography and climate.

In two countries, UK government **funding requirements** were raised as a challenge. For instance, the fact that government officials were already paid for their regular work and could not receive further direct support led to some reluctance to be involved because the Calculator was perceived as additional work. In another country an interviewee mentioned that the need to follow British accounting standards were perceived as a challenge by those involved in developing the model. This included the need to get quotes, issue purchase orders and provide receipts. Not being able to pay honorary fees to stakeholders for attending workshops was also challenging as, in the country, this is how stakeholders are usually brought to engage in workshops.

Several interviewees also identified **future uptake** as a key challenge ahead. Specific challenges mentioned include communicating the tool's outputs, ensuring a lasting impact, establishing the tool in the NGO community, and ensuring it is used by stakeholders. To date, levels of use in the outreach countries and strategies to increase these had not yet been explored at large. Experience from the UK, on which some interviewees commented, suggested that ensuring the Calculator is used requires ongoing outreach and promotional activity.

There are further key challenges which have only been raised by single interviewees but may be relevant to several country contexts.

- For example, one interviewee noted low public awareness of climate change issues.
- Similarly, in another country the agency managing the project felt that mitigation actions, as opposed to climate adaptation, were difficult to sell to the public, given that the country is highly climate vulnerable but only accounts for a small share of global emissions. These challenges are likely to apply to several of the reviewed countries. Consequently, the focus of some country Calculators has shifted towards energy security (India) or energy access (Nigeria); emission reduction then only features as a co-benefit of a desired energy pathway.
- In Bangladesh there was a challenge around the government being initially supportive of the Calculator but later apparently seeking to abandon the project. The Calculator was eventually launched between the other stakeholders involved in its development and without the government.

3.1.6 Modelling capability

Assessment of existing modelling capability

In determining whether the 2050 Calculator has improved Government modelling capability, it is helpful to understand the current state of energy modelling in each country. Our approach here has been to start by looking at the use within country of the energy modelling model MARKAL (including its variants and successors such as TIMES), and where this is not apparent, looking for evidence of the use of other energy models. MARKAL is a standard tool used by the UK Government and other countries to consider long term energy and emissions pathways. In technical terms it is a bottom-up, technology-driven, optimisation model, which considers the energy system in more detail than the 2050 Calculator. This detail leads inevitably to the model being complex and only usable by specialists – indeed, overcoming these issues was one of the key benefits of the 2050 Calculator.

A review of licensees for MARKAL shows that the following countries have acquired licences for named government officials, and so can be considered to have existing sophisticated energy modelling capability in Government:

- Brazil (Ministry of Mines and Energy)
- Indonesia (Agency for Assessment and Application of Technology)
- Thailand (Energy Planning and Policy Office)
- Vietnam (Institute of Energy, Electricity of Vietnam, Ministry of Energy)

Many of the other countries have used MARKAL through academic or other research institutes, including:

- Bangladesh (Bangladesh Atomic Energy Commission study)
- South Africa (where MARKAL is licensed to the University of Cape Town)
- India (The Energy and Resources Institute has a licence for MARKAL)

This is similar to the situation in the UK, where academic institutions – particularly UCL – have the

capability in MARKAL and provide this expertise to Government when needed.

We are not aware of an existing MARKAL model for Mexico although our interviews indicated that this option may have been explored in the past. Mexico is shown as a separate region in the global TIMES Integrated Assessment Model (TIAM). Another well-known energy model, LEAP, has been used for Mexico before. However, this was by the Stockholm Environment Institute on behalf of the Government rather than the Government itself. LEAP has many similarities to the 2050 Calculator, in that it is an accounting model that looks at activity levels within sectors, and matches supply and demand. It is somewhat more complex to operate, however, and because the calculations are not shown to the user, less transparent than an Excel file.

For Nigeria, there are existing MARKAL and LEAP studies but we are not aware of MARKAL modelling capability in Government. However, we understand that Nigeria has used MESSAGE (Model for Energy Supply System Alternatives and their General Environmental Impacts) and similar models, which would have a similar degree of complexity and detail to MARKAL.

In short, most of the countries considered have sophisticated existing energy modelling capabilities. Interviewees from Mexico and Nigeria did not consider that the Calculator had improved modelling capability in their countries.

One of the intended outputs of the 2050 Calculator country outreach work was improved modelling capability out to 2050 (see Figure 1). As set out in the business case for the outreach work:

> "Given that it is national governments who will be looking to lead the debate on what low carbon development looks like in their country, it follows that modelling capability should be easily accessible for them, and ideally within national ministries. By improving the modelling capability within developing countries we improve their ability to present viable low-carbon development pathways. Improving it within national governments themselves increases the likelihood that the results will be viewed as legitimate, and will ultimately be used to inform policy and planning" (DECC, 2012: 8).

This points to the multiple ways in which 'modelling capability' may be defined. For example, modelling capability can be defined relatively simply by considering the inputs. Output 1 of the logframe addresses modelling capability, specifically improved modelling capability out to 2050 (see Appendix B). This is measured by indicator 1.1 (national government and stakeholders attend a one week workshop), and by the end of 2014 all of the ICF-funded countries had met this indicator. Many interviewees mentioned the very beneficial impact of attendance at these workshops, which enabled them to deepen their understanding of the Calculator and provided the opportunity to discuss issues with the team at DECC. The logframe also notes that training has been provided to at least nine other countries over the two years of the International Outreach work. The ten countries had also developed a one pager (indicator 1.2), although only four countries had published theirs as part of their model by the end of 2014. Finally, indicator 1.3 (development of an Excel model suiting the requirements of the 2050 Calculator approach) had been met since all countries had working Excel models, even though not all had published.

A broad definition of modelling capability is that the introduction of the 2050 Calculator would improve the country's ability to develop long term low carbon development scenarios. It is difficult within this evaluation to draw definitive conclusions on this. On the one hand, as shown in the review of existing modelling capability in the ten countries, most of the countries already had sophisticated modelling capabilities in the form of MARKAL and LEAP. That said, the introduction of the 2050 Calculator in itself will have added to and improved the capability of the

host governments to develop low carbon development scenarios, especially considering the specific benefits of the Calculator over other models (namely the high level of peer review and stakeholder engagement, and the level of transparency and accessibility of data). In this sense, the output can be considered to have been met.

Modelling capability may also refer to the development of specific modelling skills, to improve capacity to understand model outputs, and/or to facilitate long-term futures thinking. The ideal output is that modelling capability within government is improved by the outreach work. However, improving the capability in an organisation outside of government, whilst ensuring the model, data and outputs are accessible by government actors, is also an acceptable output. In some countries, the tool was not developed in-house but rather by service providers, due to a lack of modelling resource within government (Bangladesh, South Africa, Mexico). One interviewee spoke of his hope that the model would be assimilated by government, leading to improved modelling capability in the longer-term (Mexico). In a couple of cases (Brazil, Nigeria), modelling capability was enhanced by exposing greater numbers of people to this kind of modelling work and thus increasing the pool of people with relevant modelling experience in the country, for example academia or other non-government institutions.

Stakeholders were asked whether they felt that modelling capability had been improved as a result of the international outreach programme. This was interpreted by some interviewees as whether new technical skills had been developed, and these individuals were largely ambivalent about whether the Calculators had led to improved modelling skills amongst the team developing the tool. Indeed, most of those directly involved in developing the Calculator, already had existing modelling expertise. Stakeholders described how they already had energy systems models, such as MARKAL and LEAP, but explained that the approach taken by the 2050 Calculators was more accessible to those who did not have technical modelling skills. One stakeholder also commented that the 2050 Calculator had changed the approach to modelling within that country, particularly in enabling the exploration of the linkages between energy demand and economic development (Nigeria). This was echoed by another interviewee who argued that while the Calculator had not improved technical modelling skills within government, it had introduced models to a wider range of stakeholders (Brazil).

While improved modelling capability had not been a primary or even secondary motivation for countries for the development of the tool, the broader benefits, particularly in terms of a country's ability to model long term energy scenarios, were recognised. This illustrates how a broader interpretation of capability is required, one that goes beyond the development of specific technical skills to incorporate the outcomes in terms of the promotion of cross-sectoral and strategic long term thinking and planning within an energy system.

3.1.7 Achievements and benefits

Interviewees were also asked whether their original expectations for the Calculator had been met. The responses were extremely positive, and most of our interviewees felt that their expectations, aims and objectives had been met and in some instances surpassed. The achievements of the Calculator may be grouped into three categories, although there is some overlap between them. These were: engagement and communication, long-term thinking and data development.

For many interviewees, one of the key achievements in the process of developing the Calculator was that of stakeholder **engagement and communication**. As discussed in Section 3.1.4 above, for many countries the process of bringing together different stakeholders had been entirely new (India, South Africa), and one which had enabled links to be built across government, and with wider stakeholder groups (South Africa). For some, this had proved to be

a challenging process, but ultimately a beneficial one. For example, one interviewee explained that even getting government stakeholders to participate in the process had been an achievement (Indonesia).

Interviewees felt that the collaborative and often participatory approach to developing the Calculator was innovative, and an important benefit of the process. Related to this was the development of a user-friendly tool for non-experts, which some participants felt would facilitate discussion amongst stakeholders about the interlinkages between energy and climate change targets, and potential unexpected impacts (Mexico, South Africa). One participant felt that the Calculator would also help the public to focus on the sectors and technologies that were more significant in influencing greenhouse gas emissions (South Africa). Another participant argued that, while there had been concern prior to the launch about the lack of interest, this had proven to be unfounded; in the event, there had been an 'overwhelming' positive response from civil society and academia to the Calculator (Bangladesh). A key factor underlining the use of the Calculator as a communication tool was also its transparency and accessibility. On this issue, one interviewee highlighted the creation of an interactive and visual tool as an important outcome of the project (Colombia).

A related benefit for several countries was that it facilitated **long-term thinking**, something that was not routinely done by government prior to the development of the Calculator (Brazil, Colombia, Nigeria, Thailand). Encouraging both project teams and wider stakeholders to think about the longer term was often a challenge. Some interviewees commented on how the Calculator had enabled them to go beyond five or ten-year development plans, to create longer-term energy scenarios (Brazil, Thailand). Interviewees also spoke of how the Calculator had enabled more coherent storylines to be created for different energy sources, as well as for less well developed technologies (Brazil).

For some interviewees, one of the key benefits was **data development**. Interviewees felt that this process was beneficial, either because it generated new data (Bangladesh) or because it collated existing data and presented it in a more useable format (Brazil, India). This again points to the importance of transparency and accessibility.

Finally, for interviewees of one country (Vietnam), a notable achievement had been the speed of the development of the Calculator. For one interviewee, this was due to the strength of the team that had developed the Calculator and the appointment of a 'very good' coordinator.

3.1.8 Use of the Calculator to date

As shown in Table 3, by the end of March 2015, seven Calculators had been launched, and three of these had been launched since December 2014. Therefore, when interviewees were asked how the Calculator had been used, many answered that it was too early to tell. Several participants mentioned their hopes that the tool would lead to more robust policymaking, particularly because it was the first model to capture the energy sector comprehensively (Nigeria, Vietnam).

In India however, the Calculator had been used both within Niti Aayog (what used to be the Planning Commission, and the department that had developed the tool), as well as by other stakeholders. Internally, the Calculator had been used to demonstrate the possible impacts and outcomes of an ambitious renewable energy target. It had also been used by another ministry who were using it to explore emissions in different land use change scenarios. Another example of how the Calculator was expected to feed into policy was provided by Colombia, where interviewees explained that the Calculator would be used to inform the country's

Intended Nationally Determined Contribution (INDC). The team developing the Calculator discussed their plans to hold sector-specific training sessions, which they argued would show potential users how to change assumptions and input data so that "*it would be as flexible as possible for their work in defining their INDC*". The recent launch of the 2050 Calculator in many of the countries meant that it had not yet been used to inform policy making.

3.1.9 Ensuring the future

With regard to the continuation of the tool once DECC support ceased, the countries varied in their views of how the continued development of the project would be ensured.

For some teams, this was expected to involve a continuation of the current situation and resource had been allocated to ensure that this would be the case.

For others, particularly those where the Calculator had been developed by a service provider, there were plans to transfer the tool to a relevant government ministry. In an interview with one service provider, the importance of demonstrating to government officials that the Calculator would work for them was emphasised. This respondent was confident that by showing government how it worked, the Calculator would help to inform policy and to show the impacts of those policies that they would use it (Thailand). When asked if there was specific resource allocated to maintaining the tool, he explained that:

> *"It's not necessary because if we can complete the model, they don't have to modify it. If they would like to modify it, they can do it themselves".*

In one instance, the Calculator was expected to remain with the non-governmental developer, although it was hoped that it would be taken up by academics and civil society. Other interviewees were uncertain about how the tool would be sustained financially, technically and politically over the longer-term (Mexico, India). Several interviewees mentioned the importance of having a committed champion, particularly one who was in a senior position within government (India, Indonesia). One interviewee spoke of the difficulties of gaining this senior support for the tool, but also expressed concern that changes in government meant that this hard won support could easily be lost (India). Finally, many participants discussed plans to develop the Calculator further; for example, to account for different spatial scales such as the city, province or region (Indonesia, Vietnam) or to develop a My2050 version which could be used by schools and other educational purposes (see Section 3.1.4).

3.1.10 Cost effectiveness

The terms of reference for this evaluation asked that the project team consider value for money (vfm) of the international 2050 Calculator support. However in discussion with DECC, it was agreed that a true vfm assessment which, for example, follows National Audit Office rules on vfm assessments, would not be possible for this project. This is partly because the project is at an early stage and the full benefits have not yet been felt, but also because clear and robust vfm criteria were not set out in the business case for the international outreach programme.

Instead, the approach taken is two-fold. First, we looked at the criteria proposed in the original ICF business case and considered qualitatively the extent to which they had been met. Second, we looked at more general process questions about how DECC worked and whether its support to countries developing the 2050 Calculator was effective.

The ICF business case for the international 2050 pathways partnerships has proposed several evaluation criteria for assessing the programme's vfm, based on the Theory of Change:

1. It builds developing country government capacity (note that the business case defined this quite broadly, as government capacity to demonstrate the viability of low-carbon pathways)
2. It facilitates low-carbon dialogue
3. It uses existing resources
4. It does not use consultants
5. It enhances UK reputation as leader on low carbon development

Our assessment is as follows:

- Criterion 1 has broadly been achieved in those countries that had launched 2050 Calculators, when taking a broad definition of improved modelling capability as an improved ability to develop low carbon development scenarios. However, specific modelling capability, for example in the form of skills and expertise, was not really affected.
- As most of the ICF funded Calculators have only been launched over the past few months, or are yet to be launched, it is too early to evaluate Criterion 2.
- Criterion 3 has been fulfilled. From the UK side, the Calculator draws largely on existing resources, drawing on members of the 2050 Calculator team, as well as DECC's modelling integrity team, for technical input, and the FCO for wider networking and relationship building. In terms of the countries, the work was done using existing institutions and staff and did not require new posts or resources.
- Criterion 4 was only partly fulfilled. The vfm goal was to minimise the use of consultants and have most of the work done through government employees. However, the interviews and country information available to us show that consultants (including research institutes) were sometimes used in the development of the Calculators. One interviewee suggested that this may have been partly because government employees already receive fixed salaries and have fixed, project-independent duties whereas consultants can be paid directly through the available programme funds.
- The interviews showed some evidence for the achievement of Criterion 5. An interviewee from a UK Embassy/High Commission felt that the increased leverage to work with the country government on energy and climate change issues had been one of the project's greatest benefits from their perspective. Similarly, an interviewee from Brazil argued that the UK energy sector has long been the model the country looked to follow and that, since the 2050 Calculator had originated in the UK, it had carried more weight in Brazil.

Moving beyond these criteria to look at the process more broadly, we asked interviewees about whether DECC resources were available as needed to promote development of the 2050 Calculator in countries. This considered both financial resources and technical support from the DECC team, and interviewees mainly focused on the latter. The DECC team's willingness to try to address any problem that the countries encountered, and to be available at short notice to do so, was cited by almost everyone as absolutely crucial in the process of delivering the 2050 Calculators. The ability to maintain momentum, which might otherwise be lost while an issue remained unresolved, was very important. This made good use of the teams in each country. This would be a useful area to focus on for the future, rather than simply offering financial support.

A related point was the value of the International Conference on the 2050 Calculator, held in Taiwan in February 2015. This allowed countries to make connections with one another, and to share good practice on how common problems had been overcome. This should, if well managed by DECC, form the foundation of a self-sustaining community of practice which should reduce the overall technical support burden on DECC in future. It is hard to see how this could have happened without face-to-face meetings between country representatives. This event also included countries that had not received ICF funding, but had chosen to develop a 2050 Calculator anyway (or start the process of doing so), such as Australia, Taiwan, New Zealand and a group of countries in South East Europe. By including such countries, and connecting them with others who had already gone through the process of Calculator development, those countries were supported in a way that puts little resource burden on DECC.

3.2 Results – the Global Calculator

The key themes emerging from the interviews with co-developers and reviewers of the Global Calculator are summarised here. As noted earlier, a key limitation with the evaluation of the impact of the global Calculator is that it was only launched in January and we were only able to interview 5 stakeholders. The findings should therefore be read with these caveats in mind.

3.2.1 Aims

When asked about the aims of the Global Calculator, several interviewees mentioned they felt that it was a tool for improving the global climate and energy debate by providing clarity on the areas of agreement and disagreement between parties. Another purpose one interviewee identified was educating and engaging the public, making them aware of the breadth of the issue and challenging single 'pet-solutions'. Related to that is the perception that the Global Calculator allows stakeholders to outline their visions of a low carbon future and put climate issues in a broader perspective as it makes it possible to concretely discuss trade-offs between technology and aspects of quality of life. This view was articulated by one interviewee. In general, it was felt that the target audiences were policy makers and individuals or organisations involved in policy debates, such as academics, NGOs and businesses.

3.2.2 Stakeholder involvement in the development process

Several of the organisations interviewed who were involved in reviewing the Global Calculator had been involved from an early stage in the development of the tool, giving them the opportunity to comment on what they felt would be important in the design of the tool (e.g. framing of the objective as meeting a global cumulative emissions 'carbon budget') as well as to provide feedback on the operation of the tool and the scenario levels. An interviewee felt that DECC got the engagement 'about right' and doubted that deeper input into the numbers used in the scenarios would have yielded a better result.

3.2.3 Interviewees' view on outcomes

This section summarises the thoughts which the interviewees expressed around the outcomes as set out in the Global Calculator's Theory of Change.

Use of the tool by businesses, NGOs, governments in developing and developed countries (Outcome 2a)

Given the early stage of the Global Calculator little evidence for or against the tool becoming popular with relevant stakeholders could be gathered. Asked for their views on how the Calculator was being received and used among stakeholders and the general public,

interviewees consistently felt it was too early to say. One organisation interviewed indicated that when giving presentations on the Calculator at a transport conference and the Lima climate summit meeting participants seemed very interested in the Global Calculator.

Improved understanding of the trade-offs and scenarios for low carbon development pathways (Outcome 2b)

While not being able to comment on the general use within stakeholder communities, reviewers did report learning effects within their own organisations. One organisation found the tool useful for communicating internally the significance of the need to address various different sectors simultaneously, including non-energy land use. Another organisation found the tool to be generally helpful for clarifying their strategy around climate change. The experience of creating a pathway with a group of people and the discussions involved in that process helped learning and strategic thinking. Several stakeholders found that the tool was helpful for comparing the results from Global Calculator pathways to the results of their own models. A company found that the Global Calculator allowed taking more account of factors which were not focussed on by their in-house scenarios while in-house scenario results could be used to critique some of the Global Calculator's results.

More engagement of stakeholders in the energy and climate change debate (Outcome 2c)

Interviewees again felt that it was too early to comment on the extent to which different stakeholders were engaging with the tool. One of the reviewers interviewed commented that the tool takes time to engage with and therefore requires interest in the subject matter. They argued that it would not appeal to those who were not interested in climate change.

A reviewing organisation mentioned that they were not yet using the Calculator but intended to do so, given its advantages over developing energy scenarios with other models (see Section 3.2.5). Overall, interviewees felt the tool was likely to resonate well with those already involved in the climate change debate but felt less certain that the tool would necessarily result in more, or broader engagement.

Several stakeholders viewed ongoing outreach and promotion of the Calculator as critical to its success in getting stakeholders involved. An interviewee with experience in public engagement on climate change described the Global Calculator as a strong tool for countering the "*propaganda of vested interest groups*". However, such groups devoted substantial resources to influencing public opinion. Therefore, continued promotion of the Global Calculator as an evidence-based tool for enlightening public debate should be important.

Global Calculator increases the robustness of national Calculators (Outcome 2d)

Generally, interviewees had little to say about the potential of the Global Calculator for improving national Calculators' robustness, partly because most had not been involved in the development of country Calculators. However, several interviewees did comment on the Global Calculator's appealing webtool user interface which they felt was a big improvement over those of the national Calculators.

3.2.4 Key challenges in the Calculator development process and looking forward

In terms of challenges, most interviewees felt the project itself, namely building an evidence-based tool that is accepted and found helpful by diverse stakeholders with often conflicting interests and different ideological persuasions, was inherently very challenging. However, they felt that these challenges had been dealt with well. For example, one stakeholder commented that the Calculator had struck the right balance in terms of complexity, being transparent and

user-friendly, but not simplistic. A stakeholder involved in the development of a sector of the Calculator found the development of a cost model to be 'very tricky', especially given time constraints. As such, there could be scope for improvement on costs for future Calculator versions. One of the reviewing organisations interviewed also emphasised the difficulty of getting cost estimates right.

An interviewee involved in the development of the Global Calculator articulated their vision of a global Calculator integrated in national or regional Calculators which would consequently allow further analysis of regionalised impacts and co-benefits. This appeared to be an important goal for the interviewee as air quality and impacts on local ecosystems were viewed as more immediate issues in their country.

3.2.5 Value for Money

It has not been possible to undertake a full value for money assessment based on the interviewees' comments on the issue. This was partly because the interviews took place very shortly after the Global Calculator's public launch, meaning that assessing the Calculator's added value in terms of uptake and impact could not be known. However, interviewees were asked to estimate the amount of time they had spent dealing with the Global Calculator.

The Global Calculator ICF business case sets out two indicators of value for money which it argues the Calculator would achieve:

- far cheaper per use cost compared to those of other energy models
- leveraging impact of the ICF money through attracting voluntary contributions from other organisations, thus helping to limit development costs.

Related to the former indicator, one interviewee for the Global Calculator commented that they felt it was extremely good value for money for their organisation. The Global Calculator addresses questions for which the organisation would have otherwise had to commission consultancies or academics to develop scenarios based on other proprietary models that are less transparent. Therefore, the interviewee felt that using the Global Calculator could save money while also impacting positively on credibility, as all data and assumptions are clearly laid out.

Related to the latter indicator, the interviewees from the organisations who reviewed earlier versions of the Calculator and built their own example pathways generally felt that they had spent substantial amounts of time, perhaps more than originally anticipated. Their estimates in terms of senior staff time spent ranged between 4 and 15 days. This suggests that some leveraging of ICF funds has been achieved. This is in addition to the funding that Climate-KIC[10] provided for the development of the global calculator and the in-kind contributions from the more than 100 experts that provided their own time for development and review of the calculator.

[10] http://www.climate-kic.org/

4. Discussion

This section collectively interprets the individual experiences of developing and, to a lesser extent, using the 2050 Calculators. It highlights the trends that have emerged in relation to the project objectives and the evaluation criteria set out in the Theory of Change. This is done to gauge how successful the programme has been so far in achieving its objectives and to identify key contributing factors and lessons that can be taken forward.

The rationale driving this project is the reality of climate change and the UK's ambition to limit rising global temperatures through international co-operation and long-term strategic planning in the service of a shared low carbon future. This rationale has been translated by DECC into three core areas of impact that can be achieved through the international outreach work; Low Carbon Development (LCD) Pathways, Government Capacity, and a Strengthened Mandate. Although it is too early to evaluate the impact of the project, it is possible to comment on the groundwork that has been laid through the co-operation and to make suggestions for ways to support the project in the next stages on its way to achieving impact.

4.1 Low Carbon Development Pathways

Although the demonstration of feasibility of LCD pathways is a critical rationale for the project, for the majority of countries this is seen as a co-benefit of producing an integrated energy system Calculator, rather than the focus of the project. Like many countries in the Global South, those included in the project are focused on upscaling supply, rather than constraining demand. Extending access to energy and improving the quality and reliability of supply are key political priorities. Reflecting these different priorities, countries have developed Calculators that do not include key emissions-producing sectors, for example, or have scaled down Level 4 ambitions in line with political agendas or to avoid controversial numbers appearing in the public domain. In the case of Bangladesh, the project was developed outside government and remains on the margins. In this case it seems that the focus on LCD has been achieved, at the expense of stakeholder engagement and government support for the Calculator.

Reducing the emphasis on LCD needs to be balanced with the level of government and stakeholder support for the Calculators. Overall, DECC has managed to achieve widespread buy-in from the countries, which can be interpreted as a strategic approach that has enabled the delivery of the Calculators. This approach has meant that in the majority of cases, the teams have been able to launch a Calculator within tight timeframes and to exceed stakeholders' expectations for the Calculator's development in terms of the speed and the level of support achieved.

Allowing countries to develop Calculators tailored to their national objectives and political environments appears to be a key factor in achieving government buy-in and stakeholder engagement. Through this strategy the DECC team has managed to build good working relationships, and has opened up the potential for ongoing collaboration. All countries were very positive about the Calculator itself, as well as the process of developing the tool, and this good relationship may be capitalised on if future support is provided. DECC may be able to influence further development of the Calculator to be used to look at LCD pathways.

4.2 Government capacity

The second key area of impact is to build government capacity to: 1) Build evidence-based scenarios' that 2) are shared with stakeholders and 3) incorporated into planning.

Comparing experiences across the different contexts shows the range of capacities that exist either within the government, or within the institutes and agencies that carry out energy system modelling.

Demystifying energy systems models was one of DECC's aims, and one which was mentioned by some interviewees as a driver. Although Governments are likely to continue to rely on using external experts to run energy systems models such as MARKAL and LEAP, there has been some capacity building, both for internal/government teams and those engaged to work with government for the Calculator's development. This has been in: incorporating many different sectors into the development of the tool; facilitating long term thinking; understanding cross sectoral links and demonstrating the implications of growth policies on Low Carbon Development plans. As noted above, developing the tool facilitates more active and critical understanding of energy systems planning and the evidence this type of strategic thinking is based on.

Another key benefit of developing the Calculators has been the process of bringing together the stakeholders. The achievement of managing such different agencies and institutions was celebrated in contexts where cross-sectoral thinking is not supported institutionally.

Another critical achievement is the data itself that has been compiled through the process of developing the Calculators. Despite the challenges of collecting and verifying the data, the newly compiled datasets can be interpreted as adding to government capacity for strategic energy system planning.

4.3 Strengthened mandate

The third key area of the project was to strengthen the mandate of LCD through enabling stakeholder engagement and generating debate about the inputs to the Calculator and to encourage broader understanding of the outputs – the variety of future pathways that are based on transparent and credible data. As has been discussed above, this area was challenging and recognised by DECC as one which could have benefited from greater resourcing and support.

The range of experiences shown by the national teams demonstrates that the level of engagement with inputs is linked to which institution takes ownership of the tool and how this ownership influences perceptions of the Calculators' content and purpose by other stakeholders. A common theme was that the environment ministry had limited political power. In other cases where a more powerful department led (e.g. industry and trade) this affected the sectors and the levels of ambition in the tool.

Stakeholders are more likely to feed into the peer review process if they can see political advantage in being involved, or if they can recognise the relevance of the tool to their own priority areas, and can see that it will have some function within government. A key factor in achieving this is the fit to the government structure. For example, the political restructuring that followed India's new government involved more attention to cross-sectoral thinking. The Calculator supported this strategic government aim, and as result, an in-house team has been retained to continue developing the Calculator. In cases where such top level linkages are not a political reality a different strategy is required. Lessons learnt include the fact there needs to be a high ranking political champion, who can push forward the project and overcome scepticism and institutional siloes.

During the Taiwan Conference, a speaker offered the following advice from their experience.

> *"It takes time to explain the Calculator's rationale and philosophy to stakeholders. Don't commit to over-ambitious timetables. Discuss the pros and cons of the Calculator compared to other models – make sure you understand what they are. Set out how simple the Calculator can be. Explain how the numbers from it will be used. Engage with stakeholders early on other issues too – like data." (*Source: Confessions of an Energy Modeller)

There was also some evidence of expected use of the Calculator in international fora. Two countries – India and Colombia – mentioned the opportunity to use the Calculator in the INDC process, suggesting that using a tool based on shared protocols and running on publically accessible data would be beneficial in international debates. They suggested that UK government support for this would bring credibility and weight to the Calculator as a government tool.

Generating engagement with the Calculators once launched is also an area which needs additional support. The different experiences have shown how the national context, such as the institutional lead or level of internet access for example affects the likely impact of the tool, and support is needed to design new interfaces and applications that fit the way that the internet is accessed in each country.

5. Conclusions

In this final section, we set out the conclusions based on the research and analysis carried out for the evaluation. These conclusions fall into two categories: Firstly, on the process of developing and launching country Calculators and secondly on impact, outcomes and outputs (as set out in the ICF business case). Conclusions are also presented on the recently launched Global Calculator.

5.1 The 2050 Calculator country outreach

5.1.1 The process of development

Support from DECC

Feedback from stakeholders was overwhelmingly positive about the 2050 international outreach programme. In particular, the support from DECC was very positively received; this support was financial, technical and political, and was both responsive and practical. The flexibility of the support also meant that it was possible to adapt the 2050 Calculator to match each country's specific interests and priorities. This flexibility has translated into a strong sense of ownership by teams that have developed the Calculator which has helped drive the development process forward and without which the process may have foundered.

An iterative process

For most countries, the priority was to develop and launch the Calculator. This in itself is an important achievement and should not be underestimated. It is a considerable logistical exercise which in most cases entailed a new way of working (i.e. more open and collaborative) and involved overcoming considerable barriers including, obtaining adequate data, delays from changes of staff, lack of government support and technical difficulties in defining scenario trajectories. In some instances, leading the project to completion required compromising on the depth and quality of some elements of the development process, such as the level of consultation on the inputs, the level of communication and engagement on the finished Calculator and the availability of clear guidance documentation for users. The development of the 2050 Calculator is an iterative process, which means that these issues can be mitigated over time. In addition to support from DECC, this iterative process is likely to increasingly be assisted via the emerging global 2050 Calculator community, which we have already seen started through the conference in Taiwan in February 2015.

Identifying a 'champion'

A number of factors were seen to be important for developing the 2050 Calculator and ensuring its use. Important factors were ensuring that senior figures in government are supportive of the tool and identifying a 'champion' who was able to drive the process forward. Care also needs to be taken in considering which government department is best placed to lead the work. Our evaluation found that it can help to have a more cross-cutting organisation (for example a prime minister's office or a planning commission) lead the work rather than a line ministry. Such a

body may be better placed to draw the resources and data required from across government and to resolve specific issues between ministries.

The FCO played a key role in realising the outreach programme, particularly by facilitating contacts with government officials and other stakeholders. This 'on the ground' knowledge was clearly crucial in gaining support for the international outreach programme, and facilitating one of the 'softer' benefits of the outreach work, namely improved engagement and relationships with the countries.

Tailoring the Calculator to the audience

The process of developing the 2050 Calculators led many country teams to rethink which audiences they could engage with. There is a benefit to identifying expected audiences early on and designing an engagement strategy so that the Calculator can be tailored to this audience, especially regarding the design of the web interface.

Stakeholder engagement with inputs

Stakeholder engagement with inputs requires resources for the developer. In addition it may require some diplomatic skill. In India, peer review has contributed to a sense of ownership of the tool, and has led to the use of Calculator outputs by academic, policy makers and civil society organisations.

5.1.2 Achievements

Use to date

To date, there is only limited evidence of Calculators having been used by stakeholders (although stakeholders were generally involved in the development of the Calculators). This is not surprising given the stage at which this evaluation took place. The experiences of India and South Africa have shown it may take time to facilitate stakeholder use of the Calculator and its outputs, and this may be delayed by external factors such as elections and subsequent political changes. There is some evidence of stakeholder uptake in India, as mentioned above, and also some indications that other countries are planning to use the tool in international fora, and to develop their INDCs.

Communication and engagement

A range of expected benefits were cited by stakeholders, and communication was the primary motivation for many of the countries taking part in the outreach programme. This could be between different stakeholders or within institutions such as government, businesses and NGOs. The communication and engagement was expected to lead to various outcomes, including longer term thinking, better policy making, and increased public understanding of low carbon issues.

Momentum and leverage

The interviews found that there was early evidence of momentum being generated by the outreach work. Some countries were actively taking forward communications and engagement themselves, others discussed the development of regional Calculators, and most countries expressed interest in a My2050 Calculator. In some cases, funding for this follow-up work was coming from the UK government but in other cases it was not, showing that there was some evidence of leverage of additional resources from the outreach work. This subsequent work may bring new stakeholders into that country's 2050 Calculator community. For example, in one country the FCO was now talking actively to the Ministry of Education and Training about using the Calculator in schools.

Transparency and accessibility

Maintaining transparency and accessibility of data was a key objective for DECC, and this was mentioned by stakeholders as something that distinguishes the 2050 Calculator from other energy models. The level of accessibility constituted a significant innovation and brought numerous benefits, including ensuring otherwise fragmented data is in one place, and encouraging data sharing.

Of the countries to have published Calculators, all but one had made underlying data accessible. Nonetheless, it is important to remember that accessibility is about more than just making data available, and also extends to having a clear guidance and simple structures. There is a range in quality in this regard, with some Calculators being criticised by stakeholders for being difficult to understand.

Modelling capability

Whether or not the outreach work has achieved its objectives of improving modelling capability depends heavily on how we define the term. If we define it in its broadest sense – as improving capacity for developing low carbon development pathways – then this has been achieved simply through the process of helping countries build their own 2050 Calculators. However, it is less clear whether the outreach work has helped improve modelling skills within or outside government, although in some instances it has led to greater exposure to this type of modelling work. The theory of change was clear that the priority was for developing modelling capability within government, and in some cases this had not been achieved due to the Calculator being developed by organisations outside of government. Evidence of whether or not this can lead to or inhibit that modelling capability being transferred to government in the future is limited.

Co-benefits

Many of the countries which had developed a 2050 Calculator had included co-benefits. Indeed, as suggested above, in some cases the greenhouse gas reductions were themselves seen as the co-benefit, while another driver – typically energy security – was the main issue of interest. There was also a trade-off between co-benefits and transparency, as including more functionalities (e.g. costs, air quality) increases complexity and risks making the Calculators less transparent. Whilst there was a clear interest in co-benefits, there was a concern from some countries that including them would be quite time-consuming and difficult. The reluctance in some countries to include co-benefits may be problematic as the inclusion of country-relevant factors has in other cases been crucial for achieving buy-in and ownership for the Calculators.

Ambition in low carbon development pathways

A possible limitation of some of the Calculators was that some scenarios appear unambitious and do not capture a sufficiently broad range of conceivable developments. Indeed, some level 4 trajectories were below physical and technical limits. This highlights a possible trade-off between comparability of ambition across countries, and ownership of the Calculator by national institutions and processes. However, a seemingly 'unambitious' Level 4 trajectory could be interpreted as indicating country-specific institutional or socio-economic barriers towards low carbon development.

5.2 The Global Calculator

Finally, with regard to the Global Calculator, this report highlights the very positive view that stakeholders had of the Global Calculator. They felt that its development was very challenging, but that this challenge had been met well in terms of being a credible tool, striking the right balance by being transparent and user-friendly, but not simplistic. User-friendliness has also been improved compared to the national Calculators in terms of the design of its web-based interface. The inclusion of sectors beyond energy, such as land use and diet, as well as the option to select different population scenarios were also viewed as valuable improvements. The outputs set out in the Theory of Change have been met, and there is evidence that those involved as reviewers have committed their own resources to provide feedback to help improve the tool and create sample pathways, thus indicating leveraging of the ICF funds. The tool also helped reviewers gain new insights around low carbon development. However, it is too early to tell whether the outcomes will be met in terms of stakeholders more widely improving their understanding of low carbon development and becoming more involved in the debate. Moreover, it is not clear whether the Global Calculator will make national Calculators more robust. Stakeholders felt that the likelihood of achieving the outcomes would be increased by continued promotion of the tool.

5.3 Future evaluation

As highlighted in Section 2.3, this is an early stage evaluation of the 2050 Calculator international outreach programme. By the end of March 2015, seven countries had launched their Calculators; four had launched before the end of December 2014 (India, South Africa, Thailand and Indonesia), and three between January and March (Bangladesh, Vietnam and Colombia). As a result, the evaluation necessarily focused on the process of developing the tools, with some discussion of the expected outcomes in the near future. For the same reasons, the majority of the interviews were with stakeholders involved in the development of the Calculators as in many cases, audiences and users had yet to be established.

It was not possible to carry out a value for money assessment, partly because it is too early to tell whether some of the outputs and outcomes are being delivered and partly because of the lack of indicators and data to perform such an analysis. However, it has been noted above that there are promising signs of momentum, in terms of additional work being carried out to update, improve and disseminate the Calculators, and leverage, in terms of governments and other stakeholders putting in their own resources to doing this.

5.4 Summary

This section considers how the outreach work has performed against the theory of change and the outputs, outcomes and impact that were foreseen. Whilst it is too early to draw firm conclusions on whether the 2050 Calculator outreach will have the expected impact, it has already been highly successful in a number of ways.

Outputs

The process of developing the 2050 Calculators had been a significant achievement, especially considering the variety of barriers and challenges that their development had presented.

- Modelling capability – met. The ability of these countries to present viable low-carbon development pathways has been improved by the very presence of the 2050 Calculators. In most cases the Calculators have led to this capability being improved within government and where the Calculators were developed by organisations external to government, actions are being taken to transfer ownership to government. Technical capacity on energy modelling in central government has in most cases already existed in one form or another. However, the Calculators have helped non-technical government staff better understand trade-offs inherent in decisions on the design of an energy system.
- Accessibility – met. Data has, in nearly all cases, been made publicly available. This represents a paradigm shift for many of these countries and has also shown evidence of leading to wider benefits. However there is a diversity in the quality of accessibility with some calculators showing scope for improved transparency.
- Peer review – partially met. Stakeholders have generally been involved in the development of the Calculators and in reviewing the inputs. However, different levels of consultation were observed, depending on the national and political context in which the Calculators are being developed and on the stage of development of the 2050 Calculators.
- Society engagement – not yet met. Communications and engagement have been a central driving factor for many of the countries who have or are developing 2050 Calculators. However, due to the early stages of development even those that have been launched have seen limited engagement with the outputs by stakeholders both inside government and more widely. The priority has been for countries to get the Calculators developed and launched and only once in place does the focus turn to engagement and awareness raising.
- LCD co-benefits – met. Many of the countries have included co-benefits in their calculators.

Outcomes

- Government capacity – met. There was evidence that Governments' ability to build evidence-based scenarios was enhanced by having 2050 Calculators available to them and the focus on transparency has led to the evidence-based scenarios being shared with stakeholders. There were early suggestions (although little hard evidence at this stage) that these may be incorporated into planning.
- Low carbon development viability – partially met. This was not achieved in all cases due, in part, to a desire to ensure engagement and uptake of the tool meaning that DECC had less control over the level of ambition. The result of this decision is that some of the 2050 Calculator pathways are not very ambitious.
- Strengthened mandate – not yet met. There were clearly expectations that the Calculators would lead to a more informed debate. However at this stage there was

relatively little evidence that civil society has become more supportive of low-carbon development as a result of the Calculators. There are a number of reasons for this, not least that the evaluation took place at an early stage in the lifetime of the Calculators. Other factors include the relative lack of focus from DECC on stakeholder engagement alongside the development process, the fact that the peer review process in some instances was quite narrow, and that engaging in the 2050 Calculator discussion does not necessarily mean that low carbon options will be advocated or chosen.

There are also other positive outcomes:

- Through the outreach programme, the 2050 Calculator has shown itself to be adaptable to a range of different countries and local situations.
- There is evidence of momentum being generated by the outreach programme, with a number of countries looking to improve existing Calculators, develop My2050 versions and to roll-out regional Calculators.
- The development of the 2050 Calculator is an iterative process, allowing for improvements to be made both to the tool and to supporting processes (such as stakeholder engagement) once it is launched.

Impact

The 2050 Pathways Calculator has provided a new, unique tool to country governments and societies, requiring them to take a fundamentally different approach to policy development and helping them to think long term (e.g. over 10 year period or longer), to make links across policy areas and sectors and to understand the implications on growth. Capacity on energy modelling was already present in most countries but the 2050 Calculator has provided important additional benefits over and above other energy modelling approaches and its focus on transparency and engagement means that it is arguably more likely to have an impact on the climate and energy debate in these countries. So in terms of building general capacity in the energy sector this seems to have been a real success of the programme.

On the other hand, there were limitations that could affect the extent to which viable low carbon development pathways that lead to emissions reductions were developed and discussed. A key success of the outreach work was its adaptability to local circumstances and contexts and without this the process may have been less successful in delivering functioning 2050 Calculators. However, a result of this was a certain loss of control from DECC over the levels of ambition set in the Calculators. Therefore achieving ambitious low carbon pathways and integrating this into government policy would seem to depend on their already being a certain level of support for low carbon pathways in the country. Without such drivers, that are external to the DECC support, there is a limit to the extent that the final impact can be achieved.

Furthermore, the lack of focus on stakeholder engagement and dissemination plans means that even where Calculators have been published there has been limited stakeholder engagement with the outputs so far. That said, there was clear evidence that countries were focusing their limited resources on getting Calculators developed and launched, and would only then turn their attention to stakeholder engagement and dissemination. This points to the benefit of a later evaluation to assess whether this lack of initial focus on engagement has hindered or simply delayed the delivery of the expected impacts.

Appendix A. Stakeholders contacted

Country	Organisation name	Type of involvement	Date of interview	Format*
Bangladesh	Cardiff University	Developer	Taiwan	F2F
	International Center for Climate Change and Development (ICCCAD)	Developer	Taiwan	F2F
	British High Commission Dhaka	Support & Liaison with DECC	04 Feb 2015	Phone
Brazil	Empresa de Pesquisa Energética	Government agency in charge	29 Jan 2015	Phone
	Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering (COPPE)	Developer	13 Feb 2015	Phone
	British Embassy Brasilia	Support & Liaison with DECC	22 Jan 2015	Phone
Colombia	Ministry of Environment and Sustainable Development	Government agency in charge	Taiwan	F2F
	Colombian Low Carbon Development Strategy	Developer	26 Jan 2015	Phone
	United Nations Development Programme	Implementing agency	Taiwan	F2F
India	Niti Aaoyog (ex-Planning Commission)	Government agency in charge	21 Jan 2015	F2F
	C-Step	Developer/user	20 Jan 2015	F2F
	British High Commission and DfID	Support & Liaison with DECC	20 Jan 2015	F2F
	Confederation of Indian Industries	Reviewer/user	20 Jan 2015	F2F
	TERI	Developer	21 Jan 2015	F2F
	India Smart Grid Forum	Developer/user	21 Jan 2015	F2F
	Prayas	Developer/user	22 Jan 2015	F2F
Indonesia	Ministry of Energy and Mineral Resources	Government agency in charge	Not interviewed	
	Energy Economics Institute	Developer	Taiwan	F2F
	British Embassy Jakarta	Support & Liaison with DECC	Taiwan	F2F
	Pelangi Indonesia	Developer	Taiwan	F2F
Mexico	Secretaría de Energía de México	Government agency in charge	Taiwan	F2F
	Centro Mario Molina	Developer	Taiwan	F2F
	British Embassy Mexico City	Support & Liaison with DECC	03 Feb 2015	Phone
Nigeria	Energy Commission	Government agency in charge	Taiwan	F2F
	British High Commission	Support & Liaison with DECC	05 Feb 2015	Phone

	Birmingham City University	Developer	25 Feb 2015	Phone
South Africa	Department of Environmental Affairs	Government agency in charge	Taiwan	F2F
	Project 90 by 2030	Developer	11 Feb 2015	Phone
	South African National Energy Development Institute	User	26 Feb 2015	Phone
	Energy Research Centre, University of Cape Town	Developer	Not interviewed	
	British High Commission	Support & Liaison with DECC	Not interviewed	
	Promethium	Observer	Not interviewed	
	Department of Energy	Observer	Not interviewed	
	City Press	Observer	Not interviewed	
Thailand	Thai Greenhouse Gas Organization	Government agency in charge	Taiwan	F2F
	Consultant	Developer	Taiwan	F2F
	British Embassy Bangkok	Support & Liaison with DECC	29 Jan 2015	Phone
Vietnam	Ministry of Industry and Trade	Government agency in charge	Taiwan	F2F
	National Target Program to Response to Climate Change (NTP-RCC)	Developer	03 Mar 2015	Phone
	Consultant	Developer	26 Jan 2015	Phone
	British Embassy	Support & Liaison with DECC	02 Mar 2015	Phone
Global Calculator	World Resources Institute	Co-developer	11 Feb 2015	Phone
	Chinese Energy Research Institute	Co-developer	12 Feb 2015	Phone
	Shell	User/reviewer	24 Feb 2015	Phone
	Mott MacDonald	User/reviewer	2 Mar 2015	Phone
	Friends of the Earth	User/reviewer	23 Mar 2015	Phone
	Climate-KIC	*Co-developer*	*Not interviewed*	
	Imperial College London	*Co-developer*	*Not interviewed*	
	International Energy Agency	*User/reviewer*	*Not interviewed*	
Other	DECC QA team	Reviewer	19 Feb 2015	Phone
	DECC Modelling Integrity team	Reviewer	09 Feb 2015	Phone
	ex-DECC	Observer	11 Feb 2015	Phone
	ex-FCO	Observer	06 Feb 2015	Phone

* F2F = face-to-face

Appendix B. Logical Framework

International 2050 Pathways Partnerships

PROJECT NAME	International 2050 Pathways Partnerships						
IMPACT	**Impact Indicator 1**		**Baseline**	**Milestone 1 - 2014**	**Milestone 2 - 2015**	**Target (date)**	
A range of developing country societies have published viable low carbon development pathways, that are credible for investors and lead to emissions reductions. These examples are transparently shared internationally.	Calculator used to inform policy and strategy documents on low carbon pathways (e.g. NAMAS, public spending, international low carbon funding)	**Planned**	Belgium and South Korea have copied the UK methodology with minimal support from DECC	8 countries published 2050 Calculators by end of 2014	Calculators are being used to inform policy in around 5 countries	2016	
		Achieved		By end of 2014, only 4 countries had published 2050 calculators (South Africa, India, Thailand, Indonesia). By end of March 2015, 3 further countries had published their 2050 calculators (Vietnam, Bangladesh, Colombia).	Milestone target date not yet reached. Of the 7 published calculators by end Mar 2015, there is only evidence of one being used to inform policy (Colombia have said they are using it to develop their INDC). However there were expectations in [most] countries that they would eventually be used in this way.		
			Source				
			FCO network, testimony from teams themselves, websites of national governments				
	Impact Indicator 2		**Baseline**	**Milestone 1 - 2015**	**Milestone 2 - 2016**	**Target (date)**	
	Countries involved in the intervention use their Calculator	**Planned**	Only the UK does this at the moment	3 Countries participating have achieved Indicator 2	5 countries participating in this project have achieved Indicator 2.	Milestone 1 - 2015 Milestone 2 - 2016	

	as a tool for communicating low carbon development plans in international fora.	**Achieved**		Milestone target date not yet reached. However Colombia has already communicated its 2050 calculator to the UNFCCC Conference of the Parties in Lima in Dec 2012. Mexico is planning to give a presentation on its calculator to the Clean Energy Ministerial in May 2015. India has presented their work at the Delhi Sustainable Development Summit (whch is international), and has presented their tool in UK, Taiwan, Australia, New Zealand and Mauritius. Thailand has plans to use the tool in domestic energy planning and present the results in international fora.			
			Source				
			Testimony from teams themselves, press releases, FCO climate network				
	Impact Indicator 3			**Milestone 1 - 2015**	**Milestone 2 - 2016**	**Target (date)**	
	Countries not included in this intervention look to adopt the Calculator methodology.	**Planned**	Some countries pursue the work	International 2050 Community conference.	Regional dynamics develop.	Milestone 1 - 2015 Milestone 2 - 2016	
		Achieved		International 2050 Community Conference held in Feb 2015 in Taiwan. Representatives of 30 countries attended.	Early signs of this happening. Colombia is giving technical support to the new Ecuadorian team. We have linked up the Mauritian team with the South African and Indian team. New Zealand and Australia are sharing information.		
			Source				
			Reporting from FCO climate network, independent evaluation, websearch, testimony from team's themselves				

OUTCOME1	**Outcome 1 Indicator 1**		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end March 2015**	**Target (date)**	**Assumptions**
Low-Carbon Development Viability: Demonstration of feasible and credible low carbon pathways to 2050	Analysis undertaken and published which demonstrates visible and low carbon pathway to 2050	**Planned**	none	3 countries participating in the project have achieved Indicator 1.	5 countries participating in this project have achieved Indicator 1.	Milestone 1 - 2014 Milestone 2 - 2015	This assumes that the partner government is committed to a credible low carbon pathway.

		Achieved		Of the 4 countries that published their calculators by end 2014, only India has example pathways on its website. South Africa, Indonesia and Thailand do not so far.	Of the 7 countries that have published their calculators by end Mar 2015, 4 (India, Bangladesh, Vietnam and Colombia) have example pathways on their websites.		
			Source				
			2050 Calculators themselves - do they contain preprogrammed low carbon pathways, reports and presentations from national teams based on numbers from the Calculator, FCO network				
OUTCOME 2	**Outcome 2 Indicator 1**		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end March 2015**	**Target (date)**	**Assumptions**
Government capacity. Enhanced ability to build evidence-based scenarios to share these with stakeholders and to incorporate into planning.	Government officials use tool for evidence based analysis to inform policy planning and negotiations	**Planned**	Lack of public debate and consensus on future energy and emissions pathways	3 countries participating in the project have achieved Indicator 1.	5 countries participating in this project have achieved Indicator 1.	Milestone 1 - 2014 Milestone 2 - 2015	This assumes that the partner government team is capable, committed and influential.
		Achieved		Not met, as not all of the 4 countries that had published calculators by end 2014 had used it to inform policy planning and negotiations.	Only Colombia has confirmed it will use it for their INDC. We have confirmation from India that senior figures have used the tool, e.g. Mr Arving Panigariha (Vice Chair to NITI Aayog) has been presented it, as well as key policymakers in Ministries of Power, Oil and Gas, Renewable Energy. And also to chief secretaries to various states in India (like Gujarat, Orrisa etc). Thailand plans to use the tool to analyse policy planning after 2015.		
			Source				
			Independent evaluation, FCO network, testimony from teams				
	Outcome 2 Indicator 2		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end March 2015**	**Target (date)**	
	Government use tool to communicate evidence based scenarios in engagement with stakeholders	**Planned**	Developing countries lack robust public facing tools that can be used to communicate energy and emissions pathways	3 countries participating in the project have achieved Indicator 2.	5 countries participating in this project have achieved Indicator 2.	Milestone 1 - 2014 Milestone 2 - 2015	

		Achieved		Not formally met as not all of the 4 countries that had published their calculators by end 2014 had used the tool to engage with stakeholders. However India had done so (?) and South Africa has been doing so in 2015	Those countries that have published their calculators are actively engaging with stakeholders to communicate the tool more widely, so it is expected that this milestone will be met. South Africa doing that now.		
			Source				
			Independent evaluation, FCO network, testimony from teams				
OUTCOME 3	**Outcome 3 Indicator 1**		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end March 2015**	**Target (date)**	**Assumptions**
Strengthened mandate: Key players and civil society become more supportive of low carbon development, convinced it is desirable and feasible resulting from an informed debate.	Statements by key individuals (Government and stakeholders) referring to calculator analysis made in five countries	**Planned**	Lack of public debate and consensus on future energy and emissions pathways	3 countries show statements	5 countries make statements	Milestone 1 - 2014 Milestone 2 - 2015	This assumes that a capable and committed civil society exists in the partner country interested in energy and climate matter.
		Achieved		4 - India launch 28/02/14, BK Chaturvedi, Member Energy Planning Commission, spoke about need to roll out solar and wind capacity. Previously Montek Singh presented about the tool at the Delhi Sustainable Development Summit. Thai launch 27/11/14, Dr Twarath Sutabutr, Deputy Permanent Secretary of the Thai Ministry of Energy, spoke. Minister pulled out of South African launch but speech read by Deputy Director-General Judy Beaumont and published online. Colombians referred to how they would use the Calculator to develop their INDC at the Lima COP in December.	6 in total - In Vietnam, Mr Luong (senior at the Ministry of Trade and Industry) spoke at the launch. In Colombia, their Environment Minister and their Director of Climate Change spoke at the launch.		
			Source				
			Web research of press releases and government websites, FCO network				
	Outcome 3 Indicator 2		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end March 2015**	**Target (date)**	

	Evidence of strengthened government coordination in energy and emissions policy in at least three countries	**Planned**	Developing countries lack robust linking of emission and energy	1 country fullfils objective	3 countries fulfill objective	Milestone 1 - 2014 Milestone 2 - 2015	
		Achieved		Vietnam confirmed that the process of developing the 2050 calculator has led to strengthened cooperation between ministries	No further evidence at this stage, though more than three teams did involve a range of ministries in the work.		
			Source				
			Web research of press releases and government websites, FCO network				
INPUTS (£)			**Govt (£)**	**Other (£)**	**Total (£)**	**DECC SHARE (%)**	
	2		**1.94**		**1.94**	**100%**	
INPUTS (HR)	**DECC (FTEs)**						
	4						

OUTPUT 1	**Output Indicator 1.1**		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	**Assumption**
Modelling capability: Improved long-term modelling capability out to 2050	National government and stakeholders attended one week workshops	**Planned**	None have	3 countries participating in the project have achieved Indicator 1.1	10 Countries have achieved Indicator 1.1	Milestone 1 - 2013 Milestone 2 - 2014	This assumes that the information the DECC team transferred is being taken on by ther partnering team. It also assumes that personal consistancy exists in the partnering organisation.
		Achieved		Training in the 8 ICF-funded countries took place in 2012 and 2013 (Bangladesh, South Africa, Brazil, Mexico, Colombia, Thailand, Nigeria, India)	Rest of ICF countries received training in 2014 (Indonesia, Vietnam and Brazil). Additional training was given to at least 9 other projects over the two years (Taiwan, Uzbekistan, Hungary, Japan, Czech Republic, Slovenia, Austria, Bulgaria, New Zealand, Australia and Mauritius)		
			Source				
			DECC 2050 team - who will have run the workshops				
	Output Indicator 1.2		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	
	Ten national teams developed one	**Planned**	None have	3 countries participating in the project have achieved Indicator	10 Countries have achieved Indicator 1.2		

	pagers (between 30 and 50)			1.2			
		Achieved		Delays in developing national calculators meant this milestone was not met.	Met - 11 countries had developed a set of one pagers, though Vietnam, Bangladesh, Nigeria, Mexico, Colombia, Brazil and Algeria hadn't published yet.		
		Source					**RISK RATING**
		2050 Calculators themselves - or email exchanges with teams in the case that Calculators are not published					
		DECC Research					
	Output Indicator 1.3		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	
	Ten national team developed excel model suiting the requirements of the 2050 Calculator approach	**Planned**	None have	3 countries participating in the project have achieved Indicator 1.2	10 Countries have achieved Indicator 1.2		
		Achieved		Not met. No countries had fully working models by the end of 2013.	Met - 11 countries had working excel models, though Vietnam, Bangladesh, Nigeria, Mexico, Colombia, Algeria and Brazil hadn't published yet.		
		Source					**RISK RATING**
		2050 Calculators themselves - or exchanges with DECC 2050 team					
INPUTS (£)	**DECC (£)**		**Govt (£)**	**Other (£)**	**Total (£)**	**DECC SHARE (%)**	
IMPACT WEIGHTING (%)							

OUTPUT 2	**Output Indicator 2.1**		**Baseline**	**Milestone 1 - end of 2014**		**Target (date)**	**Assumptions**
Accessibility: Energy and emisison options publicly available in an easy to use format. Data in public domain	Ten national teams publish on a website an Excel version of the 2050 Calculator for their country	**Planned**	None have	10 countries have		Milestone- 2014	This assumes that the partner government is willing and able to publish its energy and emissions data.
		Achieved		4 by the end of 2014. As of end March 2015, 6 of the 7 countries that have published calculators have the excel model available online (India, South Africa, Thailand, Bangladesh, Indonesia and Colombia). Vietnam's was initially published but is now available on request.			
		Source					

		Websites in each country					
	Output Indicator 2.2		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2**	**Target (date)**	
	Ten national teams publish a web interface for their 2050 Calculator, that enables users who are not comfortable with Excel to run the model.	**Planned**	None have	10 countries have		Milestone- 2014	
		Achieved		Not met - only 4 countries had published web interfaces by end 2014. By end Mar 2015, this had risen to 7.			
		Source					**RISK RATING**
		Websites in each country					
	Output Indicator 2.3		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2**	**Target (date)**	
	Ten national teams accompany indicators 2.1 and 2.2 - with additional documentation to explain assumptions (these could be included within the Excel and web page versions)	**Planned**	None have	10 countries have		Milestone- 2014	
		Achieved		Not met - only 4 countries had published web interfaces by end 2014. Only India's web interface had access to additional documentation. By end of March 2015, Vietnam also has. Colombia plan to.			
		Source					**RISK RATING**
		Webtools and Excel sheets themselves - or additional documentation published alongside this e.g, driver trees or technical manuals					
INPUTS (£)	**DECC (£)**		**Govt (£)**	**Other (£)**	**Total (£)**	**DECC SHARE (%)**	
IMPACT WEIGHTING (%)							

OUTPUT 3	**Output Indicator 3.1**		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - 2014**	**Target (date)**	**Assumption**

Peer Review: Stakeholders involved in reviewing data to improve assumptions	Broad range of relevant stakeholders of government, business and ngo involved (indication of seniority)	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved	Milestone 1 - 2013 Milestone 2 - 2014	This assumes that stakeholders are capable and interested in participating in the process.
		Achieved		2 - India had begun to use a range of "knowledge partners" in 2013. Bangladesh held workshops/steering group meetings in 2012 and 2013.	9 Brazil's workshops had a narrow invite list and Algeria did not hold wide stakeholder consultation.		
		Source					
		FCO network, national teams themselves, DECC 2050 team, independent evaluation					
	Output Indicator 3.2		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - 2014**	**Target (date)**	
	Input provided by stakeholders (examples)	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved	Milestone 1 - 2013 Milestone 2 - end 2014	
		Achieved		India used five different organisations as formal "knowledge partners" to work on different sectors, as well as involving many ministries and organisations like Society of Indian Automobile Manufacturers (SIAM) and the Association of Oil and Gas Operators (AOGO).	10 of the 11 countries developing calculators had received input from stakeholders by end 2014 (not Algeria).		
		Source					**RISK RATING**
		FCO network, national teams themselves, DECC 2050 team, independent evaluation					
	Output Indicator 3.3		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - 2014**	**Target (date)**	
	Input utilised by national team (examples)	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved	Milestone 1 - 2013 Milestone 2 - end 2014	
		Achieved		Not met due to delays in developing calculators.	In all cases, national teams had utilised input from stakeholders. For example, Colombia has used a lot of information from other studies and revised down a lot of their assumptions for Level 4 on the basis of their workshops.		

		Source					**RISK RATING**
		national teams themselves, DECC 2050 team,					
IMPACT WEIGHTING (%)							

OUTPUT 4	**Output Indicator 4.1**		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	**Assumption**
Society engagement: Key actors and wider socity debate pathway options using Calculator	Launch events; breadth of invitations and attendance	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved	Milestone 1 - 2013 Milestone 2 - 2014	This assumes that the stakeholders in the partnering country are capable and interested in national energy and climate matters.
		Achieved		Not met due to delays in launching calculators - no countries had launched a calculator by end 2013.	Not met due to delays in launching calculators - only 4 launched by end 2014. By end of March 2015, 7 have launched holding launch events with a wide invitation list.		
		Source					
		2050 Calculators themselves - are there stakeholder pathways					
	Output Indicator 4.2		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	
	Access to webtool (numbers of hits; feedback by users)	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved		
		Achieved		No calculators webtools launched in 2013.	Only 4 webtools published by end of 2014. Only data available to date is that the Indian website had received 15,624 hits up to mid-January 2015.		
		Source					**RISK RATING**
		FCO network, independent evaluation + web research					
		DECC Research					
	Output Indicator 4.3		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	
	Press mentions (number of articles)	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved	Milestone 1 - 2013 Milestone 2 - end 2014	

		Achieved		3 - Mexico - 11 online articles about the start of the project. Colombia - 5 online articles about the start of the project. India - 1 online article about the start of the project.	By end of 2014, 7 countries in total had press mentions: India - 11 online articles, 1 TV. South Africa - at least 2 online. Thailand - on TV news. Vietnam - 1 web article and 1 TV news piece in 2014 about kick-off event (pre-launch). Indonesia - the calculator was covered in the ministry's Mineral and Energy journal in December to mark its soft launch, filling the whole issue. By end of March 2015, number had risen to 8: Bangladesh - 15 online articles, Colombia - 3 newspapers, 15 websites, radio.		
		Source					**RISK RATING**
		FCO network, webresearch					
	Output Indicator 4.4		**Baseline**	**Milestone 1 - 2013**	**Milestone 2 - end 2014**	**Target (date)**	
	Used by third parties (who and how?)	**Planned**	None have	3 countries participating in the project have achieved	10 Countries have achieved	Milestone 1 - 2013 Milestone 2 - end 2014	
		Achieved		Not met due to delays in launching calculators. No calculators launched in 2013 (India's was launched in Feb 2014).	Not met due to delays in launching calculators - only 4 launched by end 2014. However, in India NGOs, think tanks and consultancies have started quoting the Indian tool and sourcing data/projections/ references from the work. Thai calculator will be used by a university for analysis.		
		Source					**RISK RATING**
		FCO nework, national teams, webresearch					
INPUTS (£)	**DECC (£)**		**Govt (£)**	**Other (£)**	**Total (£)**	**DECC SHARE (%)**	
IMPACT WEIGHTING (%)							

OUTPUT 5	Output Indicator 5.1		Baseline	Milestone 1 - 2013	Milestone 2 - 2014	Target (date)	Assumption
LCD co-benefits - Low-carbon development shown to deliver more than emissions cuts e.g. air quality, fossil fuel imports etc	Analysis and webtool include consideration of relevant developmental co-benefits	**Planned**	None have	3 countries participating in the project have achieved	5 countries have achieved	Milestone 1 - 2013 Milestone 2 - 2014	This assumes that interest in co-fbenefits exists in partnering team country as well as reliable data.
		Achieved		Not met as no countries had published webtools in 2013	2 of the countries publishing in 2014 (India and Thailand) included analysis of the impacts on land use. By March 2014, this had risen to 4 (Vietnam and Colombia consider land use).		
		Source					
		DECC Research					

INPUTS (£)	DECC (£)		Govt (£)	Other (£)	Total (£)	DECC SHARE (%)
IMPACT WEIGHTING (%)						

Global Calculator

PROJECT NAME	Global Calculator						
IMPACT	**Impact Indicator 1**		**Baseline**	**Milestone 1 - end 2015**	**Milestone 2- end 2016**	**Target (date)**	**Assumptions**
Politicians in developed and developing countries feel more **empowered** to take action to tackle climate change because businesses and NGOs are willing to give their **political consent** to action. **National plans are based on more robust evidence.**	Number of busineses, NGOs and government officials that have presented the Global Calculator in international fora.	**Planned**	n/a. None as the Global Calculator does not exist.	4 businesses, NGOs or governments officials have used the Global Calculator in international forums by end 2015.	6 businesses, NGOs or government officials have used the Global Calculator in international forums by end 2016.	Milestone 1 - end 2015 Milestone 2 - end 2016	Officials, NGOs and businesses that use the Global Calculator are in a position to influence leaders and these leaders are willing to listen.
		Achieved		At least 2 so far - Mott MacDonald have been presenting it internally and externally, including at an event in Japan. The ERI (part of the Chinese Government's National Development and Reform Commission) hosted a launch event in Beijing.			
			Source				
			Helped organise the Bejing launch. Had email confirmation from Mott MacDonald.				
	Impact Indicator 2		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end 2015**	**Target (date)**	**Assumptions**

Globally: number of businesses, NGOs and government officials who agree that the Global Calculator has helped persuade them of the need to take more urgent action to tackle climate change.	**Planned**	n/a. None as the Global Calculator does not exist.	10 businesses, NGOs or governments officials agree that the Global Calculator has helped to persuade them of the need to take more urgent action to tackle climate change. (By survey.)	15 businesses, NGOs or governments officials agree that the Global Calculator has helped to persuade them of the need to take more urgent action to tackle climate change. (By survey.)	Milestone 1 - end 2014 Milestone 2 - end 2015	
	Achieved		N/A - the tool was launched at the end of January 2015.			
		Source				
Impact Indicator 3		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end 2015**	**Target (date)**	**Assumptions**
Target countries: number of businesses, NGOs and government officials in Brazil, India, China and S'Africa who agree that the Global Calculator has helped persuade them of the need to take more urgent action to tackle climate change.	**Planned**	n/a. None as the Global Calculator does not exist.	4 businesses, NGOs or governments officials in Brazil, India, China and S'Africa agree that the Global Calculator has helped to persuade them of the need to take more urgent action to tackle climate change. (By survey.)	6 businesses, NGOs or governments officials in Brazil, India, China and S'Africa agree that the Global Calculator has helped to persuade them of the need to take more urgent action to tackle climate change. (By survey.)	Milestone 1 - end 2014 Milestone 2 - end 2015	
	Achieved		N/A - the tool was launched at the end of January 2015.			
		Source				

OUTCOME 2a and 2b	**Outcome Indicator 1**		**Baseline**	**Milestone 1 - Autumn 2014**	**Milestone 2 - end 2014**	**Target (date)**	**Assumptions**
Businesses, NGOs and governments use the Global Calculator. Also, they better understand the trade offs and scenarios for low carbon development pathways.	Globally: number of businesses, NGOs and government officials that are aware of the Global Calculator.	**Planned**	n/a. Businesses, NGOs and government officials are not aware of the Global Calculator because it does not exist.	Globally, 60 businesses, NGOs and government officials have seen a presentation on the Global Calculator (e.g. at the public launch event, 1:1 meetings, webinars etc).	Globally, 80 businesses, NGOs and government officials have seen a presentation on the Global Calculator (e.g. at the public launch event, 1:1 meetings, webinars etc).	Milestone 1 - Autumn 2014 Milestone 2 - End 2014	Officials, NGOs and businesses know about the Calculator, see it and use it.
		Achieved		111 experts attended our workshops where they saw an early version of the tool - 62 of them were from businesses, NGOs and governments (24 from businesses, 23 from NGOs and 15 from governments). Held a cross-Whitehall presentation attended by c.60 in September. Various other meetings held.	Additionally held two events in Peru in December - one for Peruvian government, NGOs and businesses attended by c.30, and a side event at the COP attended by c.50. The tool actually launched 28/01/15 with 149 people attending event in London, and others from government, business, NGOs and the media in Beijing. Since then we have also presented it at international events in India and Taiwan, and a series of events are planned for Brazil in April.		

		Source			
		Attendance lists and Global Calculator team records.			
Outcome Indicator 2		**Baseline**	**Milestone 1 - Autumn 2014**	**Milestone 2 - end 2014**	**Target (date)**
Target countries: number of businesses, NGOs and government officials in Brazil, India, China and S'Africa that are aware of the Global Calculator.	**Planned**	n/a. Businesses, NGOs and government officials in Brazil, India, China and S'Africa are not aware of the Global Calculator because it does not exist.	Globally, 30 businesses, NGOs and government officials have seen a presentation on the Global Calculator (e.g. at the public launch event, 1:1 meetings, webinars etc).	Globally, 40 businesses, NGOs and government officials have seen a presentation on the Global Calculator (e.g. at the public launch event, 1:1 meetings, webinars etc).	Milestone 1 - Autumn 2014 Milestone 2 - End 2014
	Achieved		At least 22 experts from these countries attended our workshops (5 from businesses, 7 from NGOs and 10 from governments), and 1 responded to our call for evidence (a government organisation from South Africa). We have no figures for 1:1 meetings, but for example 2050 calculator teams in India, Brazil, China and South Africa are aware of it.	Hard to find out how many people from these countries attended events by the end of 2014. The tool actually launched 28/01/15 and events have taken place in Beijing and India in 2015 so far with more than 40 attendees.	
		Source			
		Attendance lists and Global Calculator team records.			
Outcome Indicator 3		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - mid 2015**	**Target (date)**

Number of people who have used the Global Calculator, as measured by the number of unique users of the web tool.	**Planned**	n/a. None because the Global Calculator does not exist.	1000 unique users of the Global Calculator web tool by end 2014.	1200 unique users of the Global Calculator web tool by mid 2015.	Milestone 1 - end 2014 Milestone 2 - mid 2015	
	Achieved		3,169 users from 01/06/14 to end of 31/12/14.	15,691 users from 01/06/14 to 10/03/15. 28% of sessions have been from the UK, 22% from France, 11% from the USA, 6% from Germany and 5% from Canada.		
		Source				
		Google Analytics of the web tool.				

Outcome Indicator 4		**Baseline**	**Milestone 1 - end 2014**	**Milestone 2 - end 2015**	**Target (date)**	
Number of businesses, NGOs and government officials who have commented on the assumptions in the Global Calculator.	**Planned**	n/a. None because the Global Calculator does not exist.	30 businesses, NGOs and government officials have commented (e.g. via the Call for Evidence) on the assumptions or messages from the tool.	40 businesses, NGOs and government officials have commented (e.g. via feedback to the IEA) on the assumptions or messages from the tool.	Milestone 1 - end 2014 Milestone 2 - end 2015	
	Achieved		At least 80. 62 of the participants in our sector workshops were from businesses, NGOs and governments (24 from businesses, 23 from NGOs and 15 from governments). Also			

				received 44 comments through call for evidence, and 18 identified themselves as being in these groups (12 business, 1 NGO, 5 government bodies).			
			Source				
			Attendance lists and call for evidence tool.				
OUTCOME 2d	**Outcome Indicator 5**		**Baseline**	**Milestone 1 - mid 2015**	**Milestone 2 - mid 2016**	**Target (date)**	
Where national Calculators already exist, the Global Calculator helps make them more robust.	Number of Country Calculators that the Global Calculator has helped to sanity check.	**Planned**	n/a. None because the Global Calculator does not exist.	The Global Calculator has been used to sanity check the results from 4 Country Calculators. (By survey of Country Calculator teams and expert stakeholders.)	The Global Calculator has been used to sanity check the results from 8 Country Calculators. (By survey of Country Calculator teams and expert stakeholders.)	Milestone 1 - mid 2015 Milestone 2 - mid 2016	The country Calculator work proceeds as planned. The countries that adopt their own Calculators are aware of the Global Calculator and use it.
		Achieved					
			Source				
	Outcome Indicator 6		**Baseline**	**Milestone 1 - End 2015**	**Milestone 2 - End 2016**	**Target (date)**	
	Number of countries to report that the Global Calculator helped persuade them to develop a Country Calculator.	**Planned**	n/a. None because the Global Calculator does not exist.	2 Calculator teams report that the Global Calculator helped persuade them to develop a Country Calculator. (By survey of Country Calculator teams.)	4 Calculator teams report that the Global Calculator helped persuade them to develop a Country Calculator. (By survey of	Milestone 1 - end 2015 Milestone 2 - end 2016	The country Calculator work proceeds as planned. The countries that adopt their own Calculators are aware of the Global Calculator and

					Country Calculator teams.)		use it.
		Achieved					
			Source				
OUTCOME 2a and 2b	**Outcome Indicator 7**		**Baseline**	**Milestone 1 - end 2015**	**Milestone 2 - end 2016**	**Target (date)**	
Businesses, NGOs and governments use the Global Calculator. Also, they better understand the trade offs and scenarios for low carbon development pathways.	Number of businesses, NGOs and government organisations that provide example pathways we can publish in the webtool.	**Planned**	At the launch on 28/01/15,we had pathways from 6 of these organisations not directly involved in making the tool - Shell, Friends of the Earth, Mott MacDonald, The Vegan Society, Chatham House and the World Energy Council.	Pathways from 5 additional organisations.	Pathways from 10 additional organisations.	Milestone 1 - end 2015 Milestone 2 - end 2016	Note - this indicator was added in March 2015 to give additional data on engagment in the tool, and because we are using this as an internal marker of success.
		Achieved		So far 2 - World Nuclear Association has submitted a pathway, and working on one from WWF.			
			Source				**Assumptions**

			The Global Calculator webtool.				
	Outcome Indicator 8		**Baseline**	**Milestone 1 - End 2015**	**Milestone 2 - End 2016**	**Target (date)**	
	Number of times the Global Calculator is presented at international forums/forums in key countries for businesses/NGOs/governments in total (including by Global Calculator team members).	**Planned**	n/a. None because the Global Calculator does not exist.	Global Calculator presented at 15 international forums/forums in key countries.	Global Calculator presented at 25 international forums/forums in key countries.	Milestone 1 - end 2015 Milestone 2 - end 2016	Note - this indicator was added in March 2015 because this is work by the GC team that is not covered otherwise in the log frame and we are using this as an internal marker of success.
		Achieved		So far 9 - COP in Lima, launch in London, launch in Beijing, Mott MacDonald have been presenting it, Delhi Sustainable Development Summit, Calculator conference in Taiwan, Moscow New Climate Economy event, Alexandre in Brazil, Climate-KIC conference in Valencia.			
			Source				
			Global Calculator team records.				

OUTPUTS	**Output Indicator 1.1**		**Baseline**	**Milestone 1 - early 2014**	**Milestone 2 - mid 2014**	**Target (date)**	**Assumption**
Global Calculator tools: web tool and spreadsheet.	Adherence to project plan set out in annex 2.	**Planned**	N/a (there is no Global Calculator).	We share the first version of the Global Calculator spreadsheet and web tool as a selected CfE.	We release the Global Calculator spreadsheet and web tool as a public CfE in Summer 2014.	Milestone 1 - early 2014 Milestone 2 - Summer 2014.	Global Calculator project delivers as according to the project plan

Expert stakeholder engagement during build phase. Documentation setting out how the Calculator works. Launch event and presentation materials.		**Achieved**		Achieved - series of sector workshops held in January, April and May where an early version was shown.	Achieved - call for evidence launched on 17/07/14. Spreadsheet and webtool made available online.		
		Source					
		Global Calculator team records					
	Output Indicator 1.2		**Baseline**	**Milestone 1 - mid 2014**	**Milestone 2 - end 2014**	**Target (date)**	
	Target countries: number of stakeholders (businesses, NGOs and govt officials) from Brazil, India, China and S'Africa attending workshops or meetings to help develop the Global Calculator.	**Planned**	None. (No stakeholders attend Global Calc workshops because there is no Global Calculator.)	10 stakeholders from Brazil, India, China and S'Africa help develop the Global Calculator by attending workshops or meetings on it.	20 stakeholders from Brazil, India, China and S'Africa help develop the Global Calculator by attending workshops or meetings on it.	Milestone 1 - mid 2014 Milestone 2 - end 2014	
		Achieved		23. At least 22 experts from these countries attended our workshops (5 from businesses, 7 from NGOs and 10 from governments), and 1 responded to our call for evidence (a government organisation from South Africa).			
		Source					**RISK RATING**

		Attendance lists and the CfE tool.					
	Output Indicator 1.3		**Baseline**	**Milestone 1 - mid 2014**	**Milestone 2 - end 2014**	**Target (date)**	
	Globally: total number of stakeholders (businesses, NGOs and govt officials) attending workshops or meetings to help develop the Global Calculator.	**Planned**	None. (No stakeholders attend Global Calc workshops because there is no Global Calculator.)	20 stakeholders globally help develop the Global Calculator by attending workshops or meetings on it.	40 stakeholders globally help develop the Global Calculator by attending workshops or meetings on it.	Milestone 1 - mid 2014 Milestone 2 - end 2014	
		Achieved		111 experts attended our workshops where they saw an early version of the tool. Call for evidence received 44 respones.	Held a cross-Whitehall presentation attended by c.60 in September. Various other meetings held.		
		Source					**RISK RATING**
INPUTS (£)	**DECC (£)**		**Govt (£)**	**Other (£)**	**Total (£)**	**DECC SHARE (%)**	
			£0.55m	We have leveraged additional support from external organisations, as summarised in business case section 2.3.	Difficult to quantify the total monetary value.	Majority (although difficult to quantify this).	
INPUTS (HR)	**DECC (FTEs)**						
	2 FTE (for 18 months) and 1 FTE for 6 months.						

Appendix C. Interview questions: 2050 Calculator international outreach

Questions	Category	Rationale for question
Background		
What's your role in [organisation]?	C	
In what ways has your organisation been involved with the Calculator?	P	Clarifies role of interviewee in the Calculator development process and will help put their answers into context. Need to be mindful of possible bias/vested interests.
Awareness of the Calculator		
How and when did [organisation] first find out about the Calculator?	C/P	
When was the decision made to develop your own Calculator? By whom?	P/R	
What were the main reasons for pursuing the opportunity? (prompt, what other approaches or tools are used?)	R	Check consistency with DECC's theory of change.
Description of process of developing the tool		
Has your organisation been involved in developing the tool?	C	To know what extent to ask questions about the development of the Calculator. If not very involved, can potentially skip most of the following questions.
We're interested in a number of different areas in the design and development of the Calculators. Could you give us tell us more about the following areas: (tailor to role of organisation]		
What type of funding did you receive? What was if for? How did you use it?	P / E1	
How much support did you get from UK government? Was it sufficient? (if no, prompt did you ask for more?) What could have been improved?	P / E2	
What's the goal that the Calculator is designed to reach? How was this established?	P/R	Check consistency with DECC's theory of change.
Are there other targets / goals? What is the relationship between these in the calculator?	P/R	Output 5 (LCD co-benefits) – allows interviewee to identify which co-

(prompt GHG reductions vs. energy security, prompt does this reflect key policy priorities?)		benefits are relevant to the country and whether these were reflected in the calculator.
Which sectors were included and why? Was there debate? Were sectors / technologies dropped? Why?	R/ P / E1	Output 3 (peer review) – how much debate was there on the scope of the Calculator?
How was the technical maximum established? (prompt process of developing levels 1-4 cases for each technology)	R / E1	Output 3 (peer review) – how much debate was there on the levels?
What was the process for collecting data? Where there challenges?	P / E1	Output 2 (accessibility) Output 3 (peer review)
Is the data accessible? (prompt for evidence of use or ambitions to promote transparency)	R / E1	Output 2 (accessibility)
How were stakeholders involved in the development of the Calculator? (prompts: recruitment, form of participation, scenario development, feedback, ongoing engagement?)	P / E1	Output 2 (accessibility) – to what extent were stakeholders involved?
Did you have train up your staff? Or support other organisations? (build capacity within / between organisations) (Which types of skills? Who attended?)	P / E1	Output 1 (modelling capability)
Has the calculator been released? When? Has it been promoted? How?	P	Might give ideas for recommendations on how to maximise participation in the Calculator.
Experience of using the Calculator		
How has the tool been used by your organisation?	P / E1	Output 2 (accessibility) – was data accessible enough to mean they were they able to use it? Output 4 (society engagement)
By the policy making community?	P / E1	Output 2 (accessibility) – was data accessible enough to mean they were they able to use it? Output 4 (society engagement)
By other organisations?	P / E1	Output 2 (accessibility) – was data accessible enough to mean they were they able to use it? Output 4 (society engagement)
Is the Calculator designed to teach people about energy systems and the decisions that have to be made to reach the intended goal? (if yes, how have you tried to make this possible? Prompt: is it easy to use? Have you had to make changes? Or planning to?)	R / E1	Output 2 (accessibility) – was the calculator easy to use? Output 4 (society engagement)
Are you monitoring its use? Have you had feedback	E1	Output 4 (society engagement)
Has the tool been used in political debates on energy & climate? In what ways? (Prompt have ambitions changed? Have co-benefits been highlighted?)	E1	Output 4 (society engagement) Output 5 (co-benefits)

How? (name specific policies or implementation)	E1	Output 4 (society engagement)
Modelling capability (if level of modelling capacity has not been raised as either a challenge or a benefit of this process and this tool then we will need to specifically ask the interviewee about this)		
Are there any challenges in developing these types of models in [country]? If so, how did you overcome them?	R / E1	Useful for coming up with future recommendations on how best to develop such calculators.
Are there any challenges in using the results from these types of models to design and implement? If so, how did you overcome them?	R / E1	Useful for coming up with future recommendations on how best to ensure that the calculator does influence policy development.
Has the Calculator helped build these types of skills (technical modelling capacity and interpretation of systems models' results) How? (prompt, what other approaches or tools are used?)	E1 / E2	Output 1 (modelling capability)
Is this Calculator different to other tools used in climate change mitigation policy making in your country (prompt, how? What are the strengths and weaknesses?)	R / E2	Helps understand the demand for such a tool but also indirectly indicates value for money by showing what additional benefits stem from spending money on the calculator rather than other models.
Future developments in climate change mitigation strategies		
Can you give me an overview of the status and ambition of policies addressing climate change in [country]?	C /R	
Will this tool (types of tools) contribute to these strategies? How? Why not?	E1	Output 4 (society engagement)
What is (or could be) happening to increase the use/ impact of the Calculator? (need to prompt to find out if there's scepticism about climate change mitigation, about the tool specifically, this type of policy making more broadly?)	P / E1	Output 4 (society engagement)
Evaluation of the process & the Calculator. *Finally, we have a few questions to evaluate the process overall, the Calculator specifically and its future:*		
What were your aims and objectives at the start of the project?	R	
Have these been achieved? (prompt: why? Why not? was it mis-sold?)	P / E1 / E2	
Have they been changed (if so why? Increased or decreased expectations)	R / E1 / E2	
What worked well?	P / E1 /E2	
What were the key challenges? (Prompts for main challenges – political buy in, organisational capacity, inclusion of different sectors, data access / quality, modelling capacity)	P / E1 /E2	
How does the Calculator compare to other tools? (Did data exist already? Is it already used? Will it now be used by other institutions?)	E1 / E2	

How much has been invested in this (resources / people / enthusiasm)?	E2	
Do you feel it's been a valuable process? Do you feel it was represented appropriately by UK government?	E1/ E2	
Would you do anything differently? If so what & why?	R / E1 / E2	
Is there anything else you'd like to mention / key messages back to FCO & DECC?	R/ P / E1 /E2	

Appendix D. Interview questions: Global Calculator

Question	Rationale for question
Background	
What's your role in organisation?	
Why did your organisation decide to get involved? Did they apply or were they approached by DECC?	Context. Be aware of possible bias/vested interests.
What were the main reasons for pursuing the opportunity? (prompt, what other models / approaches are used to plan for LCD or Energy futures? Are there unique benefits of 2050 CALCULATOR?)	Check consistency with DECC's theory of change. Also establishes what type of stakeholder and what key rationales are.
Description of process of developing the tool (if applicable)	
Which sectors were included and why? Was there debate? Were sectors / technologies dropped? Why?	
How was the technical maximum established? (prompt process of developing the 1-4 cases for each technology)	
Objectives	
What do you think the calculator was/ is intended to do?	
Has it achieved that (recognising that it is at an early stage)?	
Why (not), in your view?	
Has any lack of achievement been because of factors beyond the programme's control?	
Have there been any unforeseen impacts?	
Learning	
Has the process improved your understanding of the options to reduce GHG emissions and mitigate climate change?	Outcome 2b (improved understanding)
Are you aware of anyone using the Global Calculator?	Outcome 2a (tool is used)
Have you ever had a conversation with anyone in which it has come up as part of their evidence/ thought process?	Outcome 2b (improved understanding)
Do you see other organisations becoming more involved with climate change thanks to the Global Calculator?	Outcome 2c (more engagement in the climate change debate)
Are there insights to be drawn from the Global Calculator for the development/refinement of national calculators?	Outcome 2d (GC makes national calculators more robust)

Value for money	
Roughly how much effort and resources have you put into the calculator?	
Overall evaluation	
What do you see as the key benefits of being involved?	
What were the key challenges?	
What could have been better?	

Appendix E. Literature review summary and documentation

Bangladesh

Summary of literature findings:

Bangladeshi CO_2 emissions are expected to grow drastically due to population increases and economic growth. DECC's documents indicate that Bangladesh is concerned about climate change and resource scarcity as a threat to national security. On this basis an initial dialogue on climate change between the UK and Bangladeshi governments was established.

Publically available literature identified:

First and Second National Communications to the UNFCCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

Bangladesh Climate Change Strategy and Action Plan 2008, 2009
http://www.moef.gov.bd/climate_change_strategy2009.pdf, http://www.sdnbd.org/moef.pdf

Bangladesh National Adaptation Programme of Action
http://unfccc.int/resource/docs/napa/ban01.pdf

Brazil

Summary of literature findings:

Brazil is Latin America's largest economy. The reviewed documents indicate that there has been a surge in interest in energy sector emissions as deforestation rates fall while Brazil continues on the path to industrialisation. However, CO_2 emissions per capita are fairly low at just over 2 tonnes per capita.

Publically available literature identified:

First and Second National Communications to the UNFCCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Plan on Climate Change
http://www.project-catalyst.info/images/publications/brazil_national.pdf

Climate Change in Brazil: Economic, Social and Regulatory Aspects
http://www.ipea.gov.br/agencia/images/stories/PDFs/livros/livros/livro_climatechange.pdf

GHG Mitigation in Land Use Sector: Introduction to National Policy Landscape
http://www.wri.org/sites/default/files/ghg-mitigation-brazil-land-use-sector.pdf

Brazil GHG Protocol Programme
http://www.climate-policy-watcher.org/?q=Brazil

Colombia

Summary of literature findings:

While Colombian low per-capita emissions are low, the Colombian government aims to constrain the growth in CO_2 emissions induced by rapid economic development through a series of mitigation measures. A Low Carbon Development Strategy as joint undertaking between the government ministry in charge and the United Nations Development Programme is underway. DECC documentation states that the Calculator Team was approached by the Colombian ministry to complement the Strategy.

Press articles/releases:
http://www.elcolombiano.com/en_un_ano_colombia_tendra_calculadora_de_carbono-NYEC_267183

http://procurement-notices.undp.org/view_notice.cfm?notice_id=18042

First and Second National Communications to the UNFCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Plan for Adaptation for Climate Change
https://www.minambiente.gov.co/index.php/component/content/article/476-plantilla-cambio-climatico-32#documentos

Colombian Strategy for Low Carbon Development
https://www.minambiente.gov.co/index.php/component/content/article/469-plantilla-cambio-climatico-25#documentos

Sectoral Abatement Cost Studies
https://www.minambiente.gov.co/index.php/component/content/article/1347-plantilla-cambio-climatico-44#generalidades-y-resumen-ejecutivo

Colombia: Integrated National Adaptation Project http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/07/11/000333037_20120711003513/Rendered/PDF/ICR22980P083070LIC0dislosed07090120.pdf

India

Summary of literature findings:

Documentation for India suggests that the government was looking into several options for energy and emissions modelling and decided on the 2050 Calculator. Moreover, the documentation performs an initial assessment on the achievement of outputs and outcomes, providing some information on the stakeholders involved in the consultation process and the feedback they provided.

Publically available literature identified:

CleanTechnica. (2014, 11 03). India To Formulate A “Renewable Energy Act” To Attract More Capital. By Anand Upadhyay . Retrieved from http://cleantechnica.com/2014/11/03/india-formulate-renewable-energy-act-attract-capital/

Economic Times. (2014, 08 12). Government aims to add 10,000 MW per year to lift wind energy sector. By Mitul Thakkar. Retrieved from http://economictimes.indiatimes.com/industry/energy/power/government-aims-to-add-10000-mw-per-year-to-lift-wind-energy-sector/articleshow/40079023.cms

IEA. (2012). Understanding Energy Challenges in India: Policies, Players and Issues. By Sun-Joo Ahn and Dagmar Graczyk. Retrieved from http://www.iea.org/publications/freepublications/publication/India_study_FINAL_WEB.pdf

Live Mint. (2014, 07 10). Budget stresses on clean energy sources. By Utpal Bhaskar. Retrieved from http://www.livemint.com/Politics/fUzkHkQ5VKZ73v6KeoJpAM/Arun-Jaitley-allocates-Rs-1000-crore-for-renewable-sector-s.html

National Geographic. (2014, 09 19). India's Push for Renewable Energy: Is It Enough? By Shruti Ravindran. Retrieved from http://news.nationalgeographic.com/news/energy/2014/09/140919-india-modi-renewable-energy-science-world-wind-solar

NBR. (2011, 26 10). India’s Energy Policy and Electricity Production. An Interview with Charles Ebinger. National Bureau of Asian Research. Retrieved from http://www.nbr.org/research/activity.aspx?id=181

Planning Commission. (2013). India Energy Security Scenarios 2047. Retrieved from http://indiaenergy.gov.in/index.php

Planning Commission. (2014, 04). The final report of the expert group on low carbon strategies for inclusive growth. Retrieved from http://www.indiaenvironmentportal.org.in/files/file/low%20carbon%20final%20report.pdf

ZeeNews. (2014, 11 14). Reconstituted climate panel reviews progress by national missions. Retrieved from http://zeenews.india.com/news/eco-news/reconstituted-climate-panel-reviews-progress-by-national-missions_1499197.html

Indonesia

Summary of literature findings:

Indonesia has significant reserves of coal, oil and gas, some of which is exported. When taking into account deforestation and land use change, Indonesia is one of the world’s largest net emitters of GHG emissions. However, little documentation from DECC or the public domain was available on Indonesia’s motivations for taking up the calculator. Financial support for the calculator development was channelled via the Asian Development Bank’s Southeast Asia climate network funded by the FCO.

Publically available literature identified:

Ministry of Finance Green Paper: Economic and fiscal policy strategies for climate change mitigation in Indonesia
http://www.fiskal.depkeu.go.id/webbkf/siaranpers/siaranpdf%5CGreen%20Paper%20Final.pdf

Indonesia First and Second National Communications Under the UNFCCC
http://unfccc.int/files/national_reports/non-annex_i_natcom/submitted_natcom/application/pdf/indonesia_snc.pdf (second communication)

Presidential Regulation on: The National Action Plan for GHG Emissions Reduction
http://forestclimatecenter.org/files/2011-09-20%20Presidential%20Regulation%20No%2061%20on%20The%20National%20Action%20Plan%20for%20Greenhouse%20Gas%20Emission%20Reduction.pdf

National Action Plan for Climate Change Adaptation Synthesis Report
https://gc21.giz.de/ibt/var/app/wp342deP/1443/wp-content/uploads/filebase/programme-info/RAN-API_Synthesis_Report_2013.pdf

Guideline for Implementing GHG Emission Reduction Plan
http://www.paklim.org/wp-content/uploads/downloads/2012/05/Guideline-for-the-implementation-of-GHG-emission-reduction-action-plan.pdf

Guideline for Developing Local Plan for GHG Emission Reduction
http://www.paklim.org/wp-content/uploads/downloads/2012/03/Guideline-for-developing-local-action-plan-for-greenhouse-gas-emission-reduction-RAD-GRK.pdf

Indonesia Adaptation Strategy: Improving Capacity to Adapt
http://climatechange-asiapac.com/resource/indonesia-adaptation-strategy

Indonesia Climate Change Sectoral Roadmap
http://climatechange-asiapac.com/resource/indonesia-climate-change-sectoral-roadmap

Mexico

Summary of literature findings:

Mexico is a net exporter of oil. Its GHG emissions have been gradually increasing along with moderate population and economic growth. Mexico has committed to unconditionally reduce its GHG emissions over a business-as-usual growth scenario by 25% by 2030, and various policies for promoting energy efficiency and renewable energy generation are in place. However, motivations and background information on the calculator project's uptake in Mexico have not been highlighted in the DECC documentation.

Publically available literature identified:

Press articles/releases:
http://www.sener.gob.mx/portal/Default.aspx?id=2511

http://centromariomolina.org/calculadora-2050/

First, Second and Third National Communications to the UNFCCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Climate Change Strategy
http://mitigationpartnership.net/sites/default/files/encc_englishversion.pdf

Special Climate Change Programme 2009-2012
http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/Libros2011/CD001024.pdf

Mexico's Vision on REDD+: Towards a National Strategy
http://theredddesk.org/countries/plans/mexicos-vision-redd-towards-national-strategy

Nigeria

Summary of literature findings:

In the case of Nigeria, the fast population growth, resource wealth and low current energy access (the electricity grid only reaches half the population) were described as reasons for DECC to provide support in the development of a calculator. Aside from DECC's press release on signing the MoU with Nigeria, no further public domain analysis on the Nigeria Calculator was identified.

Publically available literature identified:

First and Second National Communications to UNFCC http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Policy on the Environment http://www.environment.gov.ng/index.php/downloads/6-national-policy-on-environment

National Council of the Environment Reports, Environmental Policies documents
http://www.environment.gov.ng/index.php/downloads

Nigeria's Path to Sustainable Development Through Green Economy: Country Report to Rio+20 Summit
http://www.ng.undp.org/content/dam/nigeria/docs/Sustainable%20Development/UNDP_NG_SustDev_NigeriaCountryReport_RIO_2013.pdf

Nigeria and Climate Change: Road to COP15
http://www.mrl.uk.com/casestudies/sites/nigeriaatcancun/pdf/Nigeria%20Cop%2015%20Dec%2009.pdf

National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN)
http://nigeriaclimatechange.org/docs/naspaAug2012.pdf

Climate Change Scenarios for Nigeria: Understanding Biophysical Impacts
http://nigeriaclimatechange.org/BNRCCScenariosFINALJan30.pdf

BNRCC Publications http://www.nigeriaclimatechange.org/projectpublications.php

South Africa

Summary of literature findings:

South Africa is the second largest economy in Africa behind Nigeria. At over 9 tonnes per year, per capita GHG emissions are very high compared to other middle income countries, partly due to its large domestic coal reserves and the important role for coal in electricity generation. Economic and population growth are expected to further increase GHG emissions. There has been some policy interest in low carbon development, with the South African government having a conditional commitment to reduce CO_2 emissions by 42% below the business-as-usual forecast for 2025. The 2050 Calculator is intended to play a role in communicating the policy choices around this area. A carbon tax and a carbon budget have been foreseen by government for several years but are delayed in their implementation.

Publically available literature identified:

Long-term mitigation scenarios
http://www.erc.uct.ac.za/Research/publications/07Scenario_team-LTMS_Scenarios.pdf

National Climate Change Response White Paper
http://www.sanbi.org/sites/default/files/documents/documents/national-climate-change-response-white-paper.pdf

Key flagship programme documents
http://www.sanbi.org/biodiversity-science/state-biodiversity/climate-change-and-bioadaptation-division/ltas

First and Second National Communications to the UNFCCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

Thailand

Summary of literature findings:

In Thailand, per capita GHG emissions have increased along with strong economic growth over the past decades. Thailand is the second largest economy in Southeast Asia after Indonesia, thus providing a rationale for funding of the calculator project. DECC documentation on Thailand already assesses project performance against intended outputs, finding that the figures used in the Calculator are available in the public domain, and some stakeholder engagement is taking place for the development of trajectories, as intended. The funding is also channelled through FCO's South East Asia Climate network.

Publically available literature identified:

First and Second National Communications to the UNFCCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Strategic Plan on Climate Change Management B.E. 2551-2555 (2008-2012), Thailand
http://siteresources.worldbank.org/INTTHAILAND/Resources/333200-1089943634036/475256-1232532308749/thailand-strategy-onep.ppt

Thailand: Environmental Quality Management Plan 2012-2016
http://accad.sean-cc.org/index.php?option=com_msearch&c=content&id=2584

Thailand Power Development Plan
http://www.iaea.org/INPRO/8th_Dialogue_Forum/Breakout_Economics_05_Wongla.pdf

11th National, Social and Economic Development Plan
http://www.nesdb.go.th/Portals/0/news/plan/p11/Plan11_eng.pdf

Vietnam

Summary of literature findings:

Vietnam's per capita GDP and emissions are fairly low compared to Indonesia and Thailand; yet it is expected to experience continued high rates of economic growth. Vietnam is also involved with the ADB's Southeast Asia climate network. However, the calculator project was finally set up as a bilateral cooperation between Vietnam's Ministry of Industry and Trade and the UK government, as delays were experienced in the ADB schedule.

Publically available literature identified:

Viet Nam Assessment Report on Climate Change
http://www.unep.org/pdf/dtie/VTN_ASS_REP_CC.pdf

First and Second National Communication to UNFCCC
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Strategies on Climate Change, Environmental Protection, Sustainable Development and Cleaner Industry
http://chinhphu.vn/portal/page/portal/English/strategies

National Strategy for Environmental Protection Until 2010 and Vision to 2020
http://theredddesk.org/sites/default/files/national_env_strategy_1.pdf

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.gov.uk/decc
URN 15D/482