

# An Early Evaluation of the 2050 Calculator International Outreach Programme

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## ABSTRACT

This paper presents the findings of an early evaluation of the UK Department of Energy and Climate Change's 2050 Calculator International Outreach Programme. The programme supported eleven countries to develop their own versions of the 2050 Calculator. Drawing on interviews with stakeholders who were involved directly and indirectly in the development of the 2050 Calculators, this paper evaluates the process of developing these tools in different national contexts and discusses the lessons learnt so far. The findings discussed include the original motivations for involvement and how these evolved through the project, and the process of stakeholder engagement. The latter was expected to be a key benefit of the Calculator, and one which would open up debate about long term energy futures. While the teams developing the Calculators faced challenges, including data availability, political buy-in, and defining scenario trajectories, a flexible approach enabled countries to develop Calculators that were tailored to their national objectives and political environments. Overall, the 2050 Calculators have led to a wide range of benefits and there is ongoing commitment to develop new iterations and applications to use these Calculators to support planning of, and debate on, future energy and emissions trajectories.

**Keywords:** 2050 Calculator, evaluation, energy, low carbon development, modelling

## 1. Introduction

The transition to a low carbon future requires substantial changes to current development paths and existing infrastructures of energy supply and demand. International commitment and co-operation between national governments are recognised as key to an equitable global transition (Lange *et al.*, 2007; Lange *et al.*, 2010). Deliberative democracy and public participation in the process of imagining and implementing

the future scenarios for individual states is also recognised as critical (Dryzek and Stevenson, 2011). The UK government has committed to reduce national greenhouse gas (GHG) emissions by 80% by 2050 (HM Government, 2008). To achieve this transformation, the UK government has outlined a number of scenarios, and has developed tools that can stimulate debate and help the public understand the choices involved and the pathways ahead (DECC, 2010; Allen and Chatterton, 2013).

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The 2050 Calculator is one of these tools. The UK Government launched the 2050 Calculator in July 2010, 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 (DECC 2010). The Calculator presents a system-wide approach to considering the choices and trade-offs about national 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 different energy supply and demand sectors. The Calculator sets out four trajectories, or levels, for the types of changes that might be seen in each sector. The trajectories are designed to cover a broad range of possibilities and to demonstrate feasible and credible low carbon development (LCD) pathways to 2050.

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.”*<sup>1</sup>

Since the launch, 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 web game; and the full Excel version of the Calculator for experts who want to look at the underlying model.

The Calculator has received interest from

a number of other governments, such as Taiwan and China, who went on to develop their own 2050 calculators, using the same model structure, tailored to their national contexts. Building on this international interest, the UK Government took the decision to carry out an international outreach programme based on the 2050 Calculator, supported by the UK Government’s International Climate Fund (ICF)<sup>2</sup>. This outreach work involved supporting eleven countries to build their own 2050 Calculators, as well as a global calculator project. The rationale driving the outreach work was to build national capacity in integrated and transparent energy system planning. The objective was to support a number of developing countries – which would together account for over a third of global emissions – in the development of their own open-source 2050 Calculators. Supported by the UK Department for Energy and Climate Change (DECC), the tool would be used to stimulate public debate in those countries on how to combine economic development with low carbon emission pathways.

In this paper, we discuss the results of an early evaluation of the outreach programme commissioned by DECC. The evaluation aimed to collect experiences from national teams involved in the outreach programme and to take on board lessons for the programme’s next steps. The evaluation was designed to address a range of evaluation areas, in this paper we discuss the following two key questions:

- How, where, why and to what extent has the 2050 Calculator strengthened capacity and supported transition to low carbon development pathways in developing countries?

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<sup>1</sup> <https://www.gov.uk/2050-pathways-analysis>

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

- Did the 2050 Calculator country outreach achieve intended outputs and outcomes, and why?

The rest of the paper is structured as follows. In Section 2 we describe the evaluation methodology, while Section 3 presents the findings. Section 4 discusses the use and future impact of the 2050 Calculators, while Section 5 draws some conclusions.

## 2. 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. 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 scope of the evaluation included ten of the eleven national Calculators supported by DECC;

it was agreed that Algeria should be left out of the evaluation as DECC’s immediate involvement had been more limited. The evaluation took place between December 2014 and March 2015.

A purposive sampling 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). 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 (see Table 1 below). Wherever possible interviews were also sought with other organisations that had been involved either in the development of the Calculator or

Table 1. Qualitative sample structure for country Calculator interviews

Country	No. of interviews	Developer	User community					
			National govt	User	Facilitator	Observer	Reviewer	UK govt
Target	20	10	10					
Bangladesh	3	2						1
Brazil	3	1	1					1
Colombia	3	1	1		1			
India	8	4	2		1			1
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	4					2	2	
<b>Total</b>	<b>40</b>	<b>16</b>	<b>24</b>					

who had used the outputs of the tool. A total of 40 interviews were undertaken, of which 36 were with national Calculator stakeholders, two were with current DECC staff, two were with former DECC and Foreign and Commonwealth Office staff. Fourteen of these interviews were carried out at the International Calculator Conference held in Taiwan in February 2015. The conference offered a valuable opportunity to generate individual evaluations of the Calculator through interview, but also provided a forum for collective reflection on shared experiences and lessons learnt between countries. This provided more qualitative data for the evaluation team to analyse.

The analysis was carried out using Framework, a matrix-based method for ordering and synthesising data (Ritchie *et al.*, 2003). This involved the use of a deductive approach, wherein a predetermined thematic framework was used. Ten key themes were used to analyse the data, and in this paper we focus on the five themes most relevant to the special issue:

- Motivations and co-benefits
- Transparency and accessibility
- Stakeholder engagement and peer review
- Achievements and benefits
- Challenges

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 then input 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. In the following

sections we summarise the results from the evaluation.

## 3. Results

The ten Calculators selected for evaluation were at varying stages of development. While some were published during the evaluation, others had been publicly available for far longer. Table 2 summarises the progress made to date on each of the ten countries supported by DECC. The table shows that, at the end of March 2015, seven Calculators had been launched and the remainder were due for publication within a few months.

### 3.1. Motivations and co-benefits

National teams joined the outreach programme for a range of different reasons. Three primary drivers were identified: improved communication, low carbon development, and energy security. The most commonly cited of these was the ambition to improve communication. This encompassed communication between government ministries, as well as with external stakeholders including civil society organisations, and the public. The Calculator was expected to lead to better policy making and to facilitate long term thinking. It was also expected to help people to understand how low carbon development fitted with, and affected, other policy objectives. This motivation was mentioned by countries across the range of continents and stages of economic development.

Supporting low carbon development was another primary motivation. There was a range of views on 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

Table 2. Summary of the 2050 Calculator Country Outreach programme for the 10 cases

Country	Calculator launched?	Launch date	Summary
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 Low Carbon Development (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 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	No	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.

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<sup>3</sup> and LEAP<sup>4</sup>. 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, and due to the lack of transparency to non-experts.

For one country, the primary driver was energy security. Interviewees mentioned that GHG 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.

In addition to these primary drivers, interviewees mentioned several other motivations for adopting the Calculator, which showed that communication, and the related motivation of transparency and impact on public debate were important.

One of the expected outputs of the international outreach programme was that the 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. In many cases, this had enabled new outputs to be added to the tool to reflect the particular interests; for example, on energy security, employment, land use and agriculture, and costs.

### 3.2. Transparency and accessibility

Transparency and accessibility to data was a key rationale driving the 2050 Calculator country outreach work, and was a key theme to emerge from the interviews. In all countries, the approach to transparency and accessibility of data for the 2050 Calculators was very different from what had previously been done in those countries. While several countries had experience with long-term energy models, in many instances the underlying assumptions and input data were not widely shared or made accessible to all. Indeed, accessibility of data was one of the key reasons for adopting the Calculators, as opposed to other possible modelling approaches that may be more ‘black box’ and several respondents made the point 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.

In some cases, the data required for the Calculator did not exist and had to be estimated. However, in most countries, the 2050 Calculator work did not result in new primary data collection, but nonetheless 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

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<sup>3</sup>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.

<sup>4</sup>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.

publicly available being made available.

Feedback from interviews 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. Even in those countries that had not yet launched their Calculators, the process of developing the tool had generally been transparent and open, with stakeholders actively engaged in discussions on data and assumptions. Furthermore, a comment was made by one participant that not only was the Calculator transparent, but that it had also led to the government's wider energy planning process becoming more transparent. Another interviewee 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.

### **3.3. Stakeholder engagement and peer review**

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. This process was seen as a route to achieve three ends: first to improve the quality of the tool; second to enable buy-in; and third, to facilitate engagement with and debate about the tool and its outputs once launched.

All country 2050 Calculator teams carried out stakeholder consultation at the start of the project. The engagement processes varied from one that

involved a few stakeholders to a broad consultation and peer review of inputs across government, industry, academic, and civil society organisations. Two reasons emerged to explain the different levels of consultation: context and stage of development. First, the engagement process reflects the national context in which the Calculators are developed, and the institutional structures within which the teams operated. Some Calculators were developed 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, or developed outside government. This had tended to result in less comprehensive stakeholder engagement, although this had not always been the case. And second, the stage at which the teams were in terms of developing the tool had affected the process of engagement. Where some had only done initial consultations, other teams at later stages of development had run multiple consultations and had changed the organisations and stakeholders they were engaging with.

In terms of engagement with civil society and other users, interviews revealed that this process only began with the launch of the Calculator. Overall, the priority had been to develop and launch the Calculator and only once in place had the focus turned to engagement and awareness raising. This means that teams that are in advanced stages had embarked on a new round of engagement to widen the breadth of organisations that are involved in validating inputs to the Calculator and address shortcomings or opportunities resulting from the first round of engagement. It is clear that those

Calculators which are further behind in the process will be able to benefit from lessons learnt by earlier country experiences and all are now thinking about public engagement as they develop the 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.

### **3.4. Achievements and benefits**

Interviewees were also asked whether their original expectations for the Calculator had been met. The responses were extremely positive, and most 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 above, the process of bringing together different stakeholders had in many instances been new. This process had enabled links to be built across government, and with wider stakeholder groups. For some, this had proved to be a challenging process, but ultimately a beneficial one. Many 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 had or

would facilitate discussion amongst stakeholders about the interlinkages between energy and climate change targets, and potential (un)expected impacts. One participant felt that the Calculator would also help the public to focus on the sectors and technologies that were more significant in influencing GHG emissions. 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. A key factor underlining the use of the Calculator as a communication tool was also its transparency and accessibility.

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. 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. 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.

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

### **3.5. Challenges**

Respondents were also asked about the challenges they had faced in developing each

2050 Calculator. As might be anticipated, many of these challenges were country-specific, but this section focuses on those challenges that emerged as common across multiple countries.

Interviewees from most countries highlighted issues in obtaining adequate input data. Some stakeholders pointed to particular issues, such as costs and demand, and particular sectors, such as transport, agriculture, and Land Use, Land Use Change, and Forestry. 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.

In some countries, government concerns about the public message sent by the Calculator results led to delays. In one country, without explanation the government had lost interest in publishing the Calculator, leaving those developing the project to find new collaborators. In another country, the Calculator was due to be launched alongside an updated long term national energy plan; viewed as a communication tool, participants described how the Calculator needed to be in line with the updated energy plan. This requirement led to additional delays and, while the technical development of this specific Calculator had been completed largely according to schedule, approval for publication had been delayed pending further refinements. Wider political challenges associated with the development and subsequent launch of the 2050 Calculators were also mentioned. Several interviewees from different countries felt that

pathways tend to be interpreted by stakeholders as government-supported solutions. In one country, this interpretation by government was likely to lead to less ambitious trajectories after the involvement of senior government officials.

Defining scenario trajectories with the input from stakeholder workshops was generally perceived as challenging. Most countries sought to base their scenario trajectories for each sector on the judgement of expert stakeholders consulted in workshops. Quantifying and reaching agreement on the specific trajectories amongst a number of stakeholders was difficult. There was a feeling that within this community of technically literate stakeholders the outlook tends to be conservative. Overall, the Calculators supported in the outreach programme appear more conservative than the UK Calculator in terms of the scale of potential change and technology deployment. In some cases this may also be reflective of cultural aspects. As one interviewee emphasised, the Calculator trajectories can never be purely technical and will tend to be culture-specific: in this country, which has seen limited economic growth over the last 30 years, people tend to be cynical about change and therefore tend to be careful to not set out overly optimistic scenarios. Another interviewee pointed to a practical challenge affecting countries with very high levels of socioeconomic inequalities (or even diverse geographies and climate): it becomes more difficult than in the UK to define illustrative references such as ‘the average home’ for scenario levers which the general public or policy makers can relate to.

Several interviewees also identified future uptake as a key challenge. Specific challenges mentioned include communicating the tool’s outputs, ensuring a lasting impact, establishing the tool in the NGO community, and ensuring that 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. The UK experience suggests that ensuring the Calculator is used requires ongoing outreach and promotional activity.

## 4. Discussion

The demonstration of feasibility of LCD pathways was a critical rationale for the UK government's outreach programme. For the majority of countries, LCD was seen as a co-benefit of producing an integrated energy system tool, rather than the focus of their involvement. In common with 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.

However, a reduced emphasis on LCD was balanced with the need to obtain government and stakeholder support for the Calculators. This meant that the countries engaged with the UK government's outreach programme have developed their own Calculators. Enabling countries to develop Calculators tailored to their national objectives and political environments was a key factor in achieving government buy-in and stakeholder engagement. This pragmatic approach has enabled the delivery of these tools, and countries are managing to build wider support. It has also meant that in the majority of cases, the

project 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 level of support achieved.

At the end of the evaluation, many of the Calculators had only recently been launched. As a result, they were not yet or had only recently reached the stage where they could be used either by government or wider stakeholder communities. This means the role of the 2050 Calculators in policy making and public debate has yet to be seen. Nonetheless, potential routes to influence policy and public debates had been identified by the project team on one of the more established Calculators. Some think tanks and consultancies in this country had begun to quote the tool and to source data, projections, and references from the Calculator. Indeed, two of the stakeholder groups involved in developing the tool in this country had been using it in their own research projects. This indicates that getting stakeholders to review inputs can plant the seeds for future impact on broadening debate about the pathways generated with tool.

In terms of shaping policy, not all Calculator teams viewed this as a purpose for the tool. Rather, some saw a role for the Calculator in showing integration between areas typically thought of as separate policy areas. For example, policies aimed at industry would have a knock-on effect on efforts to extend access to electricity. Some teams discussed another area of potential application, the development of Intended Nationally Determined Contributions (INDCs). The INDCs will publically outline a country's post-2020 climate actions. Interviewees argued that if the Calculator outputs could be used in this process there would be a mechanism for comparing contributions across countries. Such aspirations are in line with the ideals of the 2050 Calculator outreach programme

as a process of creating a culture of transparency and international cooperation around pathways for low carbon development.

## 5. Conclusions

The Calculators continue to evolve: new audiences have been recognised, new outreach strategies are being devised, and new versions of the tool developed. The My2050 interface, which is aimed at non-experts, provides a key example of this. For example, the South African team has developed an offline My2050 tool which will be used in schools, many of which do not have access to the internet. The international conference in Taiwan provided a forum to establish a community of Calculator users and enabled national groups to share experiences and innovations. This has facilitated the sharing of country-specific additions and adaptations amongst this nascent Calculator community. Such developments show the unanticipated and dynamic directions that this form of participation in planning for low carbon development can take. The momentum generated by the Calculator community promises to be something to watch in future climate negotiations.

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## 2050能源供需模擬器國際推廣方案先期評估

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### 摘 要

本文針對英國能源暨氣候變遷部所發展的2050能源供需模擬器的國際延伸方案進行先期評估。此方案協助11個國家發展該國的2050能源供需模擬器，本文評估不同國家發展這項工具的過程，並對目前獲得的結果加以討論。討論的部分包括原來參與本計畫的動機以及利益相關者參與的過程。後者預期將是本工具的最大效益，也是打開未來長期能源辯論的關鍵。本工具在發展的過程中，各團隊雖然面臨許多的挑戰，包括資料的可及性、政治的介入、及情境的界定等，然此具彈性的方法仍使各國在發展能源供需模擬器的同時，能將其國家的目標及政治環境融入。總體而言，2050能源供需模擬器的發展已獲致了廣泛的益處，並且承諾將持續發展新的迭代及應用，以支持未來能源以及碳排放相關的規劃及辯論。

**關鍵詞：**2050能源供需模擬器、評估、能源、低碳發展、模型

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