Designing Energy Policy through the Indian Energy Game

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Abstract: Planning and Design of Energy Policy in India is a wicked problem, and the lack of awareness about its complexity, among the public and even among those with a working knowledge about the domain is an associated issue. In this paper we describe the Indian Energy Game which is designed to address the above issues through game based experiential learning.

Introduction

India is the world's sixth largest energy consumer with the demand growing at an average of 3.6% per annum over the past 30 years. India uses the Five-Year Planning model, where an overall framework for development is created[1] with the main focus on improving one sector each plan. With the 12th Five-Year Plan[2] being from 2012 - 2017, it is important to understand what the constraints faced by India are when creating the energy policy. An ideal energy policy would account for the decreasing coal reserves, emission constraints, environmental issues, security issues and technical challenges coupled with the geographic size and population of India. The huge energy shortfall makes energy one of the most pressing needs, making it all the more important to understand how these constraints are taken into account while creating the energy policy.

The problem of energy policy design can be categorised as a wicked problem [14] as there are multiple stakeholders, each with their own objectives and preferences. These objectives are often conflicting. An associated problem is that of raising awareness about the complexity of energy policy design, as there is a risk that the process can be misconstrued as that of only resource allocation.

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[1] The Five-Year plans are created by the Planning Commission of India.. http://planningcommission.nic.in/. *Last Accessed on 29 April 2013.*

[2] Draft 12th Five-Year plan released by the Planning Commission. http://planningcommission.gov.in/plans/planrel/12thplan/welcome.html. *Last Accessed on 29 April 2013.*

Serious Games have proved useful as tools for policy making processes and for policy advocacy and awareness. Hofstede [8] argues that over the past 40 years, serious games have become a powerful way to learn about complex organisational situations within a realistic context. Over the last forty years, games have proved a very useful and powerful tool to explore solutions for complex multi-actor problems, with conflicting objectives [1, 4, 5, 6, 9, 11 and 12].

In the next section we will present in more detail the energy policy design in India, the challenges faced by the stakeholders involved, and the lack of awareness about the complexity. We then describe the Indian Energy Game and how the game has been designed to address some of the challenges relating to the awareness of energy policy design in India. In the last section, we describe results from a few gameplay sessions.

Energy Policy Design in India

Considering the geographic size of India, its population and its increasingly growing energy needs, energy policy in India is complex in nature can be explained due to the following factors:

1. Institutional Structure – The Indian Energy Policy sector has multiple key players, both at the centre and the state government levels. At the centre, there are the Planning Commission and Empowered Group of Ministers (EGOM), that decide on the overall plan. The Planning Commission sets an energy target for five years after recommendations from these ministries. There are six ministries under the Government of India which are responsible for energy policy design and implementation. Each institution involved has its own mandate and objectives. For instance, DAE's objective is to increase the nuclear power generation capacity and MoP's objective to add coal generation capacity. Each ministry is interested in promoting the generation technologies they are responsible for [3]. Furthermore, there are private sector industries involved in electricity generation and research & development (refer Figure 1 in TERI Energy Data Directory [16]).
2. Geopolitical factors - Though one of the policy objectives in the energy policy framework is energy security and independence, India is still highly dependent on fuel imports for generation of electricity. India imports 61% crude oil and about 21% natural gas for its energy usage [13]. Geopolitical factors play a key role in some of the energy choices. For example, increasing natural gas plants would mean increased dependence on imports, which would leave the country vulnerable to international price shock [13].
3. Environmental factors - Though India's greenhouse gas emissions (GHG) are less than the global average, the sustainable development policy direction makes it important to contain emissions [13]. Given the relationship between economic growth and sustainable development, there are both internal and international

pressure to keep the GHG emissions under a certain level. This increases the pressure to use cleaner fuels and invest in research & development.

4. Technical factors - Some generation technologies have associated technical issues that limit their capacity; such as unstable grids resulting from varying wind speeds [2]. Technical failures could also arise due to lack of maintenance leading to massive shortfall in energy.
5. Social factors – One of the primary objectives in energy policy is Universal Energy Access [3]. However, this has been difficult to realise due to capacity shortage and affordability issues. This makes producing electricity at very low costs one of the key constraints. Additionally, some of the generation technologies have high societal costs. For instance, large hydroelectric projects displace millions of people, and having an effect on the surrounding ecosystem as well[3].
6. Monetary factors - India's economy is growing and this needs a matching growth in energy capacity. Ministries have a limited budget to work with, making it hard to achieve desired energy targets [16].

In the following section, we will describe the Indian Energy Game and how we have addressed these factors in the game.

Indian Energy Game

Experiential learning [10] is a cyclic process, where learning can begin at any of the stages (concrete experience, observation and reflection, the formation of abstract concepts and testing in new situations).

The Indian Energy Game was designed as a learning tool to help participants learn about the complexity involved in designing the energy policy in India, by allowing them to experience the policy making process. In the previous section, we described the various factors that make the energy policy design in India a complex problem. The game was targeted at the public at large, and to people with a working knowledge of the energy sector.

Tensions Designed in the Game

Fullerton [7] defines formal elements as those elements that form the structure of the game. She describes Players, Objectives, Procedures, Rules, Resources, Conflict, Boundaries and Outcome as formal game elements. We adopted this approach in designing the game.

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[3] For example, refer case of the Narmada Bachao Andolan (NBA), http://narmada.org. *Last accessed on 29 April 2013.*

The game has three roles modelled after the institutional structure for energy policy in India:

1. Ministry of Power (MoP)[4]: In the game, MoP controls the decisions about Coal based thermal plants, Hydroelectric Power plants and Natural Gas based thermal plants.
2. Department of Atomic Energy (DAE)[5]: In the game, DAE controls the decisions about Nuclear Energy.
3. Ministry of New and Renewable Energy (MNRE)[6]: In the game, MNRE controls decisions about Solar and Wind Energy.

Table 1 gives an overview of the elements designed in the game.

Table 1. The Tensions designed in the game

		Constraints					
		I	G	E	S	T	M
Roles	MoP	Y					
	DAE	Y					
	MNRE	Y					
Objectives	Emission limit		Y	Y			
	Capacity Addition		Y	Y			
	Avg. cost of generation				Y		Y
Boundaries	Five Year Plans	Y					
	O&M and R&D costs						Y
Resources	Messages	Y	Y	Y	Y	Y	Y
	Budgets						Y

I= Institutional structure, G= Geo-political factors, E= Environmental factors, S= Social factors, T= Technical factors, M= Monetary factors

Together, the participants' objective is to design an energy mixture for additional capacity to be added in the 12th and 13th Five-Year Plans.

In the first round the participants play the 12th Five-Year plan and in the second round they play the 13th Five-Year plan. Throughout the course of the game, the participants are provided with *messages*, which describe various constraints that the participants experience. For example, the message "90% of Natural Gas is imported" is provided to the MoP to inform them about that the availability of natural gas is dependent on political calm in the region. The message "Hydro projects will

[4] Ministry of Power, http://powermin.nic.in/. *Last Accessed on 29 April 2013.*

[5] Department of Atomic Energy, http://www.dae.gov.in/. *Last Accessed on 29 April 2013.*

[6] Ministry of New and Renewable Energy, http://www.mnre.gov.in/. *Last Accessed on 29 April 2013.*

displace people, for which the rehabilitation costs are high" is provided to the MoP to describe the social cost of building large hydroelectric projects. Technical factors such as unstable networks due to wind energy generation are also introduced through messages.

The participants have three objectives[7] they need to satisfy as a group. They need to

- add a capacity of 76,000 MW in the first round,
- maintain the price of generation per kWh at Rs. 3,
- and maintain CO_2 emission levels at 395 Million Tonnes of CO_2.

Each of the ministries have a pre-defined budget to meet these targets. The objectives for the second round are dependent on the players' performance in the first round.

The game begins with a briefing session, where the facilitator describes the roles and objectives of the participants. This is followed by the game session. The first round of the game is typically played for around 45 minutes. This is followed by a debrief session for that round. The second round of the game is played for 20 minutes. The final debrief session is after the second round of the game where the participants provide feedback about their experiences in the game.

Analysis of the results

In each game session, we documented the background of the participants, captured interactions between the players throughout the course of the game, their responses to the messages provided to them and the debrief sessions. We have 9 game sessions and 6 play-tests [8] of the Indian Energy Game. These nine sessions had the following mix of participants:

1. Session 1 and 7: The participants had little or no knowledge about energy policy design in India.
2. Sessions 2 and 3: The team was a mixture of people who had a working knowledge of energy policy design and its complexity in India, people who worked in the energy sector and people who had little or no knowledge about energy policy design. Session 3 had a member from the Planning Commission as a participant.
3. Sessions 4, 5 and 6: The participants had a working knowledge of energy policy design and its complexity in India. Furthermore, they had a bias towards clean energy and were staunchly against the use of nuclear power.

[7] The calculations are either done manually, or preferably using a spreadsheet based calculator. We used a web-based application to help the participants with the calculations.

[8] We used the iterative game design method [15] with multiple play-tests to design the game.

4. Sessions 8 and 9: The participants had a working knowledge of energy policy design in India and were from the Indian Administrative Services (IAS).

Analysis of play: the tensions experienced in the game

In order to understand whether the game helped the participants learn by experience, we will use data from the participants' feedback and the game-play data collected throughout the course of the game. We will corroborate them to analyse whether the participants' learnings translated into actions during the course of the game.

In Table 2 we present the feedback from the participants that was common across all nine sessions of the game, and the observations from the game-play.

Table 2. Experiences and feedback from the participants, common to the 9 game sessions

Participants' learning and experiences	**Observations from game-play data**
High lifecycle cost of solar energy	Refer Fig 4. The teams reduce the amount of solar capacity added over the course of the game.
High reliance on coal based energy	Refer Fig 2, 3 and 4. The teams begin the game with a mixture that results in a high cost of generation. They gradually reduce the mean cost of generation by relying on coal based energy sources.
Non-availability of inexpensive hydroelectricity	Refer Fig 4. The teams begin with an average of 25% hydroelectricity. As constraints about hydroelectricity are introduced in the course of the game, the average share of inexpensive hydroelectricity decreases.

Fig. 2, 3 and 4 show the mean costs of generation, mean emissions and mean composition of energy mixtures across all the nine sessions of the game, respectively. The duration of the game was divided into 20 bins of equal size.

For each of the observations in Table 2, it is seen that the teams begin with a premise based on their experience, experience the process of energy policy design and face the constraints themselves, resulting in the conceptualisation of a different composition of the energy mixture.

Fig. 2. Mean of the cost of generation across 9 game sessions

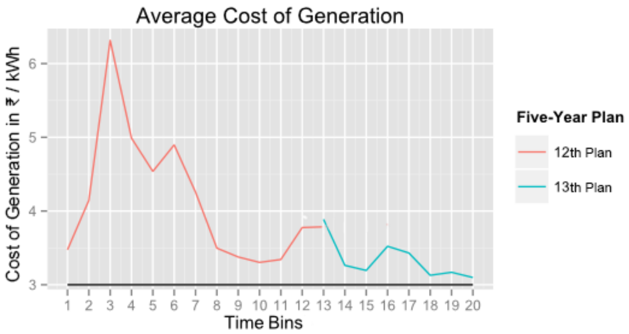


Fig. 3. Mean emissions across 9 game sessions

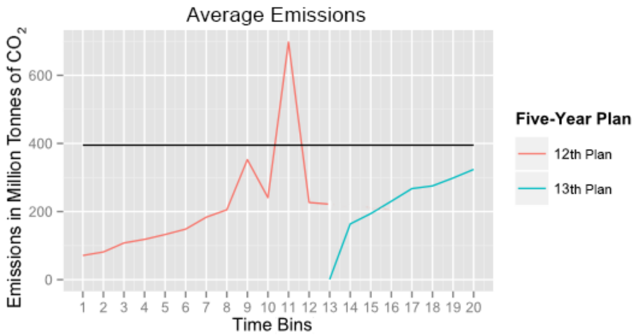
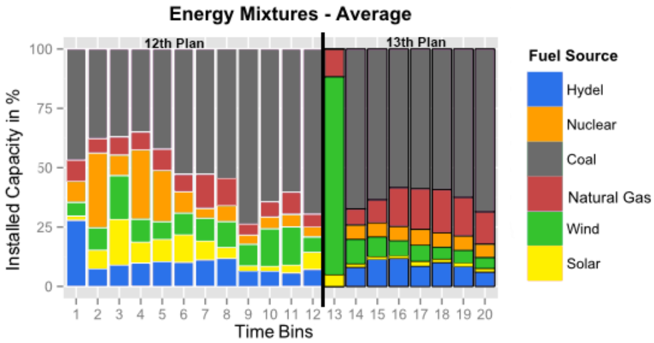


Fig. 4. Mean Composition of energy mixtures across 9 sessions



In Table 3 we present the participants' learnings from game sessions 4, 5 and 6. Refer the previous section for the participants' background.

Table 3. Experiences and feedback from the participants from game sessions 4, 5 and 6.

Game Play details.	Participants' learning and experiences	Observations from the gameplay data
Session 4	Tried a strategy of developing an energy mixture without coal Game helped them understand better the consequences of the same.	Refer Fig 5. The team did not use coal based power, and eventually failed to meet the energy requirements of the country in the game.
Session 5	The high financial and lifecycle emission consequences of installing solar power became evident during the course of the game.	Refer Fig 6. The team began with a high percentage of solar power, which reduced the available budget due to its cost.
Session 6.	The game helped understand environmental, social, monetary, institutional and technical factors determining the energy policy cannot be isolated The game helped them understand the environmental and societal costs of an energy mixture without nuclear energy.	Refer Fig. 7. The graphs show that the teams used no nuclear power but generated 75% of the power through coal, thereby potentially increasing emissions and decreasing coal reserves

Fig. 5 Energy Mixture of Team 1 throughout the course of the game.

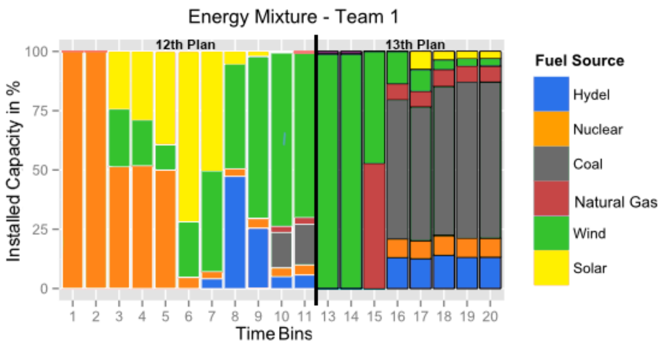


Fig. 6 Energy Mixture of Team 2 throughout the course of the game.

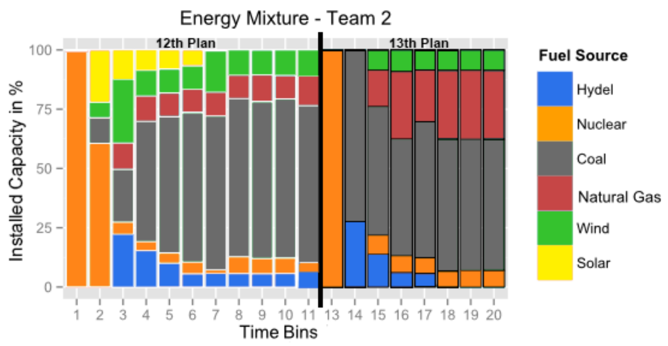
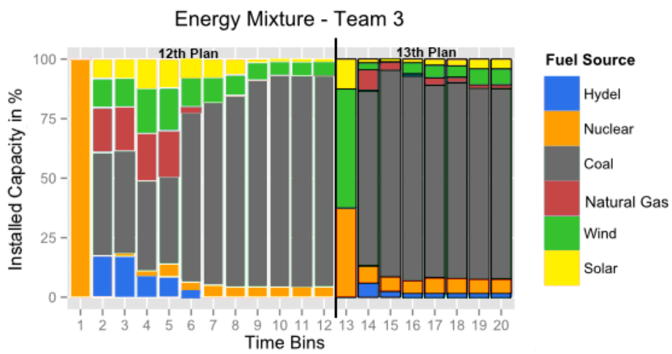


Fig. 7 Energy Mixture of Team 3 throughout the course of the game



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Participants from session 4 decided not use coal based energy in the first round of the game. They experienced the consequences of the same; they failed to meet the capacity generation objective in the game. In order to meet the energy requirements, in the second round of the game their energy mixture had 55% coal based energy.

Participants from team 5 began the game with a 25% share of solar energy[9] in the mixture. They experienced the constraints of their strategy when the high cost of adding solar energy resulted in overshooting of the budget. The team gradually reduced the solar generation capacity, finishing the first round with no solar capacity installed. The team did not use solar generation capacity in the second round of the game.

[9] Currently, the total share of all renewable energy in India is 19% [16].

Participants from team 6 decided not to use nuclear power. They experimented with various combinations of the energy mixture, as is evident from Fig. 7. They experienced the constraints of not using nuclear power, and finished the game with over 75% capacity generated by coal based energy.

For each of these sessions, the feedback provided by the participants has reflected their experiences in the game (as described in Table 3).

In these game sessions described above, the participants began the game with a certain set of preferences based on their concrete experiences. Thus, it is seen that the participants conceptualised and experimented with new strategies and learned experientially through the game about the consequences of their actions; thus helping them go through the learning cycle.

Conclusion and Future Work

In this paper, we have described the Indian Energy Game; a multi-player game designed to sensitise the participants about the complexity of the energy policy design process in India. We have then described how the game presents this complexity to the players during the course of the game, followed by results from different sessions which show that the participants did indeed experience the tensions involved in the energy policy design process.

While we have nine runs of the game and multiple play-tests, the detailed analysis of results is subject for future work. Future plans to the game also include building a framework to measure the learning through the game and to measure its translation to real world, and additional layers of complexity by introducing the supply and distribution networks.

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