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The "right to develop" vs. the need to "protect the climate": Can the growing energy needs of developing countries be reconciled with international CO_2 emission reduction objectives? – The case of India

Mémoire de Fin d'Etudes présenté par
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En vue de l'obtention du grade académique de
Master en Sciences et Gestion de l'Environnement
Finalité Gestion de l'Environnement Ma120ECTS ENVI5G-M
Année académique 2014-2015

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“Energy is the golden thread that connects economic growth, increased social equity and an environment that allows the world to thrive.”

– Sustainable Energy for All Initiative, “Global Action Agenda”

“Saving our planet, lifting people out of poverty, advancing economic growth – these are one and the same fight.”

– United Nations Secretary-General Ban Ki-moon

Résumé

L'accès à l'électricité des ménages est un problème qui concerne plus d'un milliard de personnes (1.1 milliard), ce qui équivaut à une personne sur sept sur la planète. De plus, 2.9 milliards de personnes n'ont pas accès à des combustibles non-solides utilisé pour la cuisson. Un quart de ces personnes habite en Inde. De plus, l'Inde, qui présente de bonnes perspectives de croissance économique et de réduction du niveau de pauvreté, est le troisième émetteur mondial de gaz à effet de serre.

Son rôle dans la politique mondiale du climat est par conséquent capital. L'accès à l'électricité et aux combustibles non polluants pour la cuisson est principalement un problème rural. En effet, 93% de la population indienne vivant en ville a accès à l'électricité, contre 67% de la population rurale. Concernant les combustibles non-polluants pour la cuisson, seulement 12% de la population rurale y ont accès contre 72% de la population urbaine.

L'éclairage dans les zones rurales et urbaines provient principalement de deux sources: l'électricité (produit majoritairement par le charbon en Inde) et le kérosène. Les combustibles destinés à la cuisson dans les ménages urbains sont avant tout composées de GPL, de biomasse et de kérosène, alors que les ménages ruraux utilisent principalement la biomasse (le bois de feu et bouse) et, dans une moindre mesure, le GPL.

Toutes ces sources d'énergie ont une forte teneur en carbone et par conséquent de grandes émissions en CO_2, ce qui a un impact sur le changement climatique. Cependant, les politiques énergétiques de l'Inde soutiennent leur utilisation, à l'exception de la biomasse, soit par le bais de subventions (kérosène et GPL), soit par le développement d'infrastructures (comme par exemple à travers la Politique d'Electrification Rurale).

L'analyse montre que le développement de l'accès à l'énergie moderne peut aider à réduire les émissions de GES grâce à une plus forte efficacité de la combustion de certains combustibles au stade de l'utilisation finale (comme le kérosène et le GPL) et grâce aussi à des émissions de carbone plus faibles (comme le biogaz ou le gaz naturel en remplacement de charbon pour la production d'énergie).

Cependant, ce papier montre également que certains combustibles, communément appelés « moderne », n'ont pas nécessairement un impact positif sur le climat si l'on considère leur émissions en GES. En revanche, elles ont des émissions de particules plus réduites (GPL et kérosène) et par conséquent un impact plus faible sur la pollution de l'air local. Uniquement le biogaz a l'avantage d'être faible en émissions de particules et de GES. Son développement devrait donc être prioritaire. L'utilisation durable de la biomasse devrait également recevoir plus d'attention au niveau politique.

Ainsi, en vue de faire avancer les objectifs d'accès à l'énergie propre pour tous et de la lutte contre le changement climatique, la politique climatique devrait être liée à la politique énergétique. Maximiser les avantages comparatifs spécifique de chaque région au profit d'un bouquet énergétique régional durable est d'une importance stratégique, pas seulement pour le secteur énergétique national mais aussi pour le climat mondial.

Summary

Electricity access for households is a problem which today still concerns over 1.1 billion people; that is an equivalent of one in seven persons in the world. In addition, 2.9 billion people do not have access to non-solid fuels for cooking purposes. A quarter of these people live in India. India is also the third largest greenhouse gas emitter of the world, with optimistic perspectives for further economic growth and therefore increasing alleviation of poverty of its population. Its role in international climate policy is therefore critical.

Access to electricity and to clean, low-emission cooking fuels is a predominantly rural problem, with 93% of the urban population and 67% of the rural population being electrified. Regarding clean cooking fuels, only 12% of rural households have access to clean cooking fuels, versus 72% of their urban peers.

The main sources of lighting in urban and rural areas are dominated by two sources: electricity (which is produced mainly by coal in India) and kerosene. Cooking fuels in urban households are primarily composed of LPG, biomass and kerosene, whereas in rural households mainly biomass (firewood and dung cake) and some LPG are used.

All of these sources of energy are very carbon intensive and therefore have high CO_2 emissions that have an impact on climate change. Despite this, Indian energy policies support the use of all of them with the exception of biomass, either through subsidies (kerosene and LPG) or through generalised infrastructure development (e.g. through the Rural Electrification Policy).

The analysis shows that the development of modern energy access can help to reduce GHG emissions thanks to the higher end-use efficiency at combustion of certain fuels (notably kerosene and LPG) and partially lower carbon emissions (e.g. biogas or natural gas as replacement of coal for electricity production). Nevertheless, it has also emerged from the present study that certain fuels which are commonly cited as “modern” are not necessarily climate-friendly in terms of GHG emissions, but only have lower PM emissions and therefore a lower impact on local (often indoor) air pollution (LPG and kerosene). Only biogas has the benefits of being low in both particulate matter and GHG emissions and its use should hence be developed as a priority. The sustainable use of biomass should also receive further policy attention.

Hence, in order to advance the objectives of clean energy access for all and the fight against climate change, climate policy should be linked to energy policy. Taking advantage of comparative advantages in the development of region-specific sustainable energy mixes is of strategic importance, not only for the national energy sector but also for the global climate.

Keywords: energy access, India, climate change, energy policy, climate policy, energy mix

Remerciements

Tout d'abord, j'aimerais exprimer ma sincère gratitude envers M Etienne Hannon pour tout le soutien qu'il m'a apporté pendant la phase de préparation du mémoire, depuis la définition du sujet jusqu'aux dernières retouches. Je serai aussi toujours reconnaissante qu'il m'a donné la possibilité précieuse d'assister à la COP 20 à Lima, Pérou en décembre 2014, ce qui m'a permis de suivre en direct et de mieux comprendre le monde complexe des négociations climatiques internationales.

Je tiens également à remercier M Samuele Furfari pour renforcer mon intérêt pour le sujet de l'énergie grâce à son cours passionnant de Géopolitique de l'Energie et pendant lequel il puise dans son expérience riche de la politique énergétique. Merci aussi pour le feedback apporté concernant ce mémoire.

Je suis reconnaissante pour la relecture du document par ma collègue Ksenija qui a été très utile pour améliorer le papier davantage, et pour la version française du résumé que mon amie Claire m'a préparé.

Je ne voudrais pas oublier ma famille et les amis qui, de loin ou de près, m'ont donné chacun à sa façon l'énergie nécessaire pour terminer ce papier ainsi que les études à côté de mon travail.

Ceci a été une expérience enrichissante, non seulement au niveau d'apprentissage intellectuel mais également au niveau personnel. Pour arriver au bout, il faut apprendre à cultiver des éléments comme la patience et la persévérance; et ceci est beaucoup plus facile avec l'aide d'amis – merci à mon collègue Guy.

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I. Introduction

Energy is the fuel of life.

It is also the single most important ingredient for economic development and growth – and the biggest contributor to climate change. It comes as no surprise then that developing countries claim for themselves access to energy as a key aspect of their "right to develop". The newly formulated Sustainable Development Goals (SDGs), to be officially adopted in September 2015, testify to this desire: Goal number 7 aims to "ensure access to affordable, reliable, sustainable, and modern energy for all".[1]

At the same time, goal number 13 of the SDGs calls for the world to "take urgent action to combat climate change and its impacts". On a planet where "one in seven people are still without electricity" (World Bank, 2015c) and 81% of the global energy demand is sourced from carbon-emitting fossil fuels[2] the parallel pursuing of these two goals appear at first glance to create frictions with each other.

While for developed countries the challenge is to transform their existing industrialised or post-industrial economies into low-carbon societies in order to avoid any major climatic turmoil in the future, for developing countries the hurdle to take is to "leapfrog" the polluting steps of economic development of developed nations in order not to repeat the same mistakes as developed countries. The objectives for developing and developed countries are hence evidently very different.

But what is actually understood by the concept of "development"?

While the notions of the First and Third World (i.e. industrialised countries and the "rest of the world" respectively) have become somewhat out of fashion after the fall of the Iron Curtain and the dissolution of the Soviet bloc (the Second World) in the 1990s, there remains nevertheless a large dividing line between the so-called "developed" and "developing" countries up until today.

Typically, global development financial institutions such as the World Bank or IMF consider developed countries or "high-income economies" to be those countries that accumulate a certain minimum estimate of the gross national income (GNI) per capita[3]. Any country below that threshold[4] is considered to be a developing country, sub-classified as either a "middle-income

[1] United Nations, 2015, pp. 13-14
[2] IEA, 2014b, p. 6
[3] A good discussion of the different classification systems for developmental stages used by international organisations is given in Nielsen, 2011
[4] which for the fiscal year 2015 is defined by the World Bank as a GNI per capita of US$ 12,746 or more (World Bank, 2015), equivalent to roughly 12 times the "low-income" threshold of US$1,046

economy" or a "low-income economy". This in turn has consequences for these countries' negotiating power on the international political scene regarding topics such as free trade agreements. It also impacts their financial situation, as a country's classification as a "poor" country can have substantial impacts on its international lending terms and its eligibility for (other forms of) development aid such as grant financing, debt relief or technical assistance.

Clearly then, the World Bank and IMF approach views the concept of development as based on economic considerations. It is not by coincidence that this is then also the dominating approach that defines the roles of states in international politics today.

Nevertheless, a second commonly used approach to development exists. It is an approach which puts the human dimension instead of the economic one at the centre of its attention[5] and it is notably advocated by the UN and its specialised Development Programme UNDP. The most commonly used indicator under this notion is the Human Development Index (HDI) which defines whether a country has reached "developed" status or not. It is calculated as a "summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and […] a decent standard of living."[6]

It is important to note the different purposes or goals of "development" as they form the basis for policymaking, trickling down eventually to the local level as the implementation of these policies and defining citizens' daily challenges and opportunities.

Choosing one or the other as development pathway can thus have very different implications, as the prioritisation on industrial development does not have the same energy needs as a focus on a healthy and educated population. Yet, for both of these a certain minimum amount of energy is necessary in order to ensure that basic human needs such as cooking food for eating are met. Due to its large population and geographical size, India is the one country in the world that is most affected by energy poverty in absolute terms, hence making the topic very relevant for this nation.

A. Research Questions

In the framework of the UN's Sustainable Energy for All initiative India pledged in 2011 to contribute to "ensuring universal access to modern energy

[5] The HDI emphasises that "people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone" (UNDP, n.d.)
[6] UNDP, n.d.

services", "doubling the global rate of improvement of energy efficiency" and "doubling the share of renewable energy" by the year 2030[7].

The adherence to these objectives appears to epitomise the Indian ambition to step out of its role as a "developing country" and to improve the welfare of its citizens, in a limited timeframe. The question that poses itself though is: At what cost for the climate can this be done in a country which is the second largest country of the world in terms of population? How sustainable is Indian policymaking with regards to energy access for its population? And what role does India as a country take on internationally for its impact on the climate it creates with the provision of energy access – the role of a victim or rather the role of a leader?

Expressed differently, the following questions will guide the structure of the present paper:

What is the climate impact of providing energy access to the entire Indian population?

What implications does this have for Indian policymaking and, vice versa, what are the implications of the international climate policy objectives for Indian energy policy?

The following sub-questions that will help to answer the above questions will be posed:

i) What are the links between energy access and climate change?

ii) What are the interactions between energy policy and climate policy?

iii) What are the climate change mitigation objectives that are included in Indian energy access policy?

As one of the world's top five economies as well as the world's third largest emitter of CO_2 after China and the USA, India is an ideal case study to analyse these questions. India is also one of the top ten countries responsible for roughly two-thirds of the global energy consumption[8]. More specifically, from an energy policy and climate policy point of view, the case of India is relevant and useful for the three following reasons:

- The first one is that India is one of the four BASIC countries (Brazil, South Africa, India and China), i.e. a group of the largest emerging economies that formed a bloc for the Copenhagen Climate Summit in 2010 in order to defend the right of developing countries for "equitable

[7] United Nations, April 2012, p. 2
[8] The other ones are: USA, China, Russia, Japan, Canada, Germany, Brazil, South Korea and Iran (for energy consumption)/ Indonesia (for CO_2 emissions) (Source: Statista.com)

space for development". They also requested developed countries to provide them with finance, technology and capacity-building support, based on the developed nations' "historical responsibility for climate change"[9]. While the BASIC country alliance has since somewhat fallen apart, at least in public, the demands by these and other developing countries have remained the same, repeating in essence what was already advocated for in the first Rio Earth Summit in 1992, over 20 years ago. Hence, the Rio Declaration of 1992 stated that "[t]he right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations" (Principle 3) and that "[s]tates should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies" (Principle 9).

- Secondly, even if the unified strength of the BASIC bloc has not been maintained in international climate policymaking since Copenhagen, the mere adoption and implementation of climate policies at the national level as well as, by consequence, those internationally supported by India could be a game changer for the climate since India is the second, soon biggest country in the world in terms of population. India is thus of critical importance to international climate negotiations.

- Thirdly, from an energy point of view, too, "India is at a similar stage to many other developing countries in terms of energy access"[10] and the results can therefore, even if not directly transferred, but at least be paralleled to other countries at a similar level of economic development and purchasing power.

B. Methodology

In order to analyse the above questions first of all the extent of the problem of universal energy access for households is presented, first on a global level, and then in the Indian context. This includes an analysis of existing solutions proposed by Indian energy policy, as well as the implementation challenges (chapter II). Next, the state of play of global climate mitigation objectives and the Indian contribution to climate change mitigation is presented (chapter III). Chapter IV then goes on to put the issue of energy access into the context of global climate change, by analysing existing calculations of the climate

[9] "BASIC group wants global deal on climate change by 2011", The Hindu, 26 April 2010

[10] "Climate Change; Improved electricity access has little impact on climate change". 2014. Global Warming Focus, pp. 25.

impact of providing universal energy access for their accuracy. Eventually, following the observed interlinkages between climate and energy-related issues, chapter V suggests that in order to have maximum effectiveness, climate policy should in fact be dealt with as a subset of energy policy rather than as a separate policy.

For the purposes of this analysis, a literature review including grey literature and notably policy documents has been undertaken in order to juxtapose energy and climate policy theory versus reality. The literature review is complemented by a data analysis of energy access and greenhouse gas emission statistics from governmental and international sources such as the IEA, EU and the Indian government, as well as from available academic literature.

Finally, in order to complete the collection of data and provide background information of the Indian energy and climate policies, several interviews have been conducted with stakeholders from these fields. This was done during the author's participation at the COP 20 Climate Summit in Lima in December 2014 as well as through personal and telephone interviews. Although not directly used in the text, the input provided by these interviews has inspired the thrust of this work.

C. Limitations

The present analysis focuses on the impacts of energy access as an aspect of of economic development on climate change mitigation policies in the large sense, i.e. how to minimise the impact of climate change in a developing country context. By doing this, it leaves aside the adaptation side of climate policy, which focuses on how to best deal with the impacts of climate change.

Moreover, in line with the current international stance, there is no in-depth questioning of the potential benefits or shortcomings of the concept of "development" in this paper. Thus, the concept of development based on the economy-centred idea of limitless (or limited) growth as advocated by Walt W. Rostow's five stages of economic growth[11] or the Club of Rome's "Limits to growth" (Meadows et al. 1972) versus the human-centred idea of post-developmental theorists such as Arturo Escobar and Wolfgang Sachs who believe that it is "time to dismantle" the idea of development[12] are not explored in detail. Instead, this work departs from the notion that economic development along the lines of Rostow is taking place in India.

[11] The five stages being: 1. Traditional society, 2. Preconditions for take-off, 3. Take-off, 4. Drive to maturity, 5. Age of high mass consumption. Rostow, 1960

[12] Sachs, 1992, p. 1

Additionally, the question of energy access is looked at in the context of household energy access only, ignoring the population's energy access in terms of transport or social services (such as energy used in healthcare or education). This choice has been made in order to focus on one representative and important aspect of energy access.

Besides this, the health impacts of energy access would deserve a more detailed treatment, as they appear to be the main driving force for policies promoting certain GHG emission-intensive fuels such as LPG or kerosene. The focus here, however, is only on the impact of the different energy sources on climate change.

Just as health, the financial aspect of providing energy access in terms of the cost of fuel and infrastructure development is worthy of a separate analysis. The fact that it has not been included in the present paper by no means implies the lack of importance of this aspect for the policy debate.

II. The energy access challenge

A. Why is there a need for universal energy access?

1. Energy access vs. electricity access

In order to understand the issues at stake better a clarification of the use of the terms "(modern) energy access" and "electricity access", which are both used in the literature, is necessary.

The International Energy Agency (IEA) offers the following definition of "modern energy access" at the household level[13]: It is "a household having reliable and affordable access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time"[14].

The lack of energy access is often also referred to as "energy poverty"; indeed, often the terms "energy access" and "energy poverty" are used as interchangeable terms (Bhide and Monroy, 2011; Gupta and Sudarshan, 2009; IEA, 2011, cited in Srivastava et al. 2012, p. 12). However, as Srivastava et al. point out, an important distinction can be made between the two: "while energy poverty is more amenable to be defined as a benchmark, energy access can be presented as a continuum linked to different income levels reflecting different stages of development".

Even more importantly, Srivastava et al. rightly ask the question whether energy access can and should be measured at all as a quantitative target and at what point the goal has been achieved. The choice of a "focus on provision of energy, per se, would necessarily require defining the quantity of energy of each type that would qualify as 'energy access'. However, a focus on the provision of the services that would be provided by energy would allow the flexibility of choosing the optimal fuel-technology combination for a given context so as to deliver the desired outcome" (Srivastava et al. 2012, p. 11).

Hence, it becomes clear that there are two different approaches to defining energy access: one which focuses on quantity of energy supplied versus a second one which looks at the end result or outcome achieved. In other

[13] Energy access for households, which is the focus of this study, also includes three branches of energy uses or services: cooking, lighting as well as ICT and other household appliances. As most of the energy services in India relate to cooking (traditionally done with solid biomass such as fuel wood, charcoal, tree leaves, crop residues and animal dung), and lighting, but ICT and household appliances are less important, the two main types of energy services cooking and lighting are taken into account here under the concept of "energy access for households".

[14] OECD/IEA, 2012. p. 3

words, in the first approach energy access is the end objective, whereas in the second approach energy access is a means to an end. Using either of these approaches can have important consequences on policymaking, as the objective is not the same; when in the first case it is sufficient to achieve a set minimum amount of energy to the population; in the second case the objective can serve for more clearly defined purposes such as the improvement of welfare or human development.

On the international level, choosing one or the other approach has implications too. In definitions and targets which view energy access as providing a defined minimum level of energy and which set a threshold of how much energy constitutes a satisfactory level of "access to energy" there needs to be an international agreement over this threshold level in order for the achievement of the target to be comparable.

While there is no general agreement on this issue, there are nevertheless useful indicators on the issue, such as the IEA's index for measuring progress in access to the energy services provided by electricity and "modern fuels" and "clean cooking facilities" (i.e. "modern" here means "fuels and stoves that do not cause air pollution in houses"[15]), called the Energy Development Index (EDI). The EDI aggregates quantitative energy access at the household and the community level for 80 developing countries, thus allowing a broader appreciation of the penetration of "modern energy sources" in the societies of developing countries.

As figure 1 indicates, the EDI is composed of four elements: the access to electricity indicator (itself composed of electricity access rate and per capita residential electricity consumption), the access to clean cooking facilities indicator (the share of modern energy use in the total final consumption by the residential sector), the access to energy for public services indicator (calculated using the per-capita public services electricity consumption) and the access to energy for productive use indicator (composed of the share of economic purposes in the total final consumption (TFC)). According to the IEA methodology, the TFC includes the following sectors: industry, transport, services, agriculture/forestry and fishery, and it excludes the own use by the energy sector and residential energy use[16].

[15] IEA, n.d.
[16] OECD/IEA, 2012, pp. 11-12

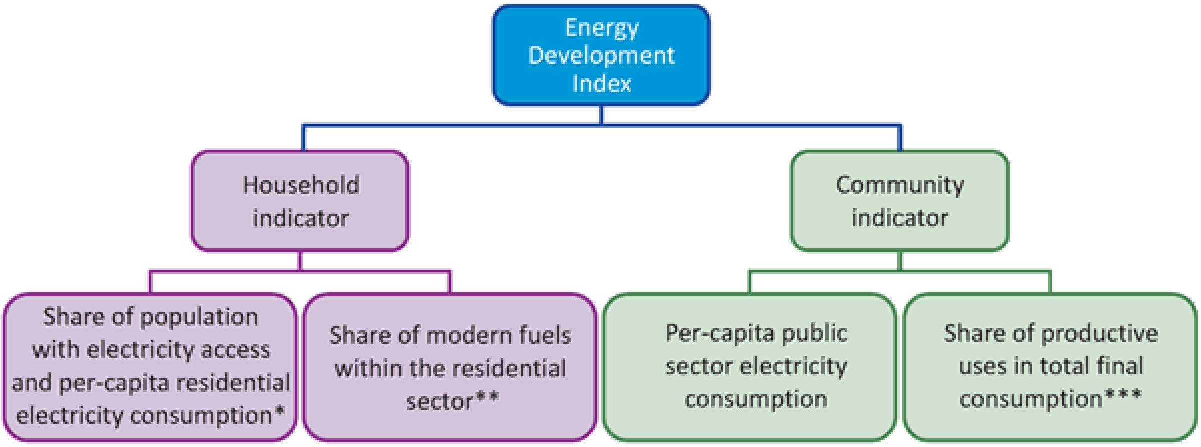


Figure 1: Composition of the Energy Development Index (EDI)

Source: IEA, World Energy Outlook 2012

A second indicator is the recently developed MEPI (Multidimensional Energy Poverty Index) proposed by Nussbaumer et al. In terms of focus, the EDI "is a measure of energy system transition towards modern fuels whereas the MEPI evaluates energy poverty" or the lack of access to energy (Nussbaumer et al. 2012, p. 237). Rather than just measuring quantitative access to a specified minimum amount of energy per year it focuses on the usefulness of the energy provided through the services it renders.

Dimensions and respective variables with cut-offs, including relative weights (in parenthesis).

Dimension	Indicator (weight)	Variable	Deprivation cut-off (poor if…)
Cooking	Modern cooking fuel (0.2)	Type of cooking fuel	Use any fuel beside electricity, LPG, kerosene, natural gas, or biogas
	Indoor pollution (0.2)	Food cooked on stove or open fire (no hood/chimney) if using any fuel beside electricity, LPG, natural gas, or biogas	True
Lighting	Electricity access (0.2)	Has access to electricity	False
Services provided by means of household appliances	Household appliance ownership (0.13)	Has a fridge	False
Entertainment/education	Entertainment/education appliance ownership (0.13)	Has a radio OR television	False
Communication	Telecommunication means (0.13)	Has a phone land line OR a mobile phone	False

Figure 2: Composition of the MEPI

Source: Nussbaumer et al., 2012, p. 235

The MEPI is composed of five basic energy services (called "dimensions": cooking, lighting, services provided by means of household appliances, entertainment/education and communication) which are measured by six indicators (see figure 2 above). It can thus be said that the MEPI is a more human-development focused indicator, while the EDI is more economic-development focused. Apart from the EDI and the MEPI several other indicators, such as the total energy inconvenience threshold (TEIT), the minimum end-use energy approach (MEE) and the total energy access (TEA) have been put forward, the scope of all of which is the national level[17].

Compared to energy access, a definition of electricity access is somewhat easier as it focuses only on the supply of one type of final energy to the end user, i.e. the number of people who have electricity in their home. For the IEA, it includes the electricity sold commercially, both on-grid and off-grid, as well as self-generated electricity[18]. Consequently, the IEA defines "electricity access" in very concrete terms: It uses the threshold of 250kWh consumption of electricity for households in rural areas and 500 kWh for urban dwellings as an indicator for having access to electricity, based on a household size of five persons[19]. The urban rate is twice the rural rate of consumption, owing to the "specific urban consumption patterns". As the subsequent example usages imply, these "specific" consumption patterns simply mean higher energy usage rates: "In rural areas, this level of consumption could, for example, provide for the use of a floor fan, a mobile telephone and two compact fluorescent light bulbs for about five hours per day. In urban areas, consumption might also include an efficient refrigerator, a second mobile telephone per household and another appliance, such as a small television or a computer"[20]. However, an explanation as to why urban consumption is by default assumed to be higher is not offered; this is a clear weakness in the methodology.

In summary, it becomes clear that energy access and electricity access are not referring to the same issue; rather, electricity access is a subset of energy access, and it can help to reduce energy poverty. In the following analysis, we will use the more global approach of energy access, which combines the access to electricity as well as "modern" cooking fuels (i.e. liquefied petroleum gas (LPG), biogas, natural gas and kerosene) , in order to capture more fully the challenges of economic and human development at the household level.

In addition, it is worth noting that it makes a difference what type of approach to measuring one takes – a focus on energy access or energy deprivation – as using one or the other provides a different kind of information which can steer decision-making in different directions.

Equipped with a clear understanding of the issue at stake, we can now move on to the question of why providing access to energy is necessary at all.

While it is true that the supply of electricity and modern fuels is not a basic human need necessary for survival (such as water), the energy services that

[17] A good discussion of the mentioned indicators can be found under Pachauri & Spreng, 2011
[18] IEA, 2010b, p. 1
[19] OECD/IEA, 2015
[20] Ibid.

can be provided through access to modern sources of energy do have substantial, or even "disproportionate"[21] (high) developmental benefits. The following areas are most commonly cited as being impacted by energy development:

- Economic benefits and poverty eradication: If aided by other economic assets (such as mobile phones), electricity can help to diversify economic activities and livelihoods, which is especially important in rural regions (e.g. Kooijman-van Dijk, 2008 and Rao, 2013).

- Clean water: Energy-based technologies using electricity such as pumps and water distillers can aid in both the distribution and purification of household water supplies (e.g. Toman & Jemelkova, 2003)

- Health: the reduction of indoor air pollution through the use of modern cooking fuels can help prevent respiratory diseases and premature deaths especially among women and children, who are the most exposed to this type of particle matter (PM) pollution (e.g. WHO, 2002, Ezzati and Kammen, 2002, cited in Toman & Jemelkova, 2003)

- Education: There is an indirect impact of energy access (modern cooking fuels and electricity) due to the alleviation of the burden of fuel wood collection on children, thereby freeing up time for going to school, extending the time available for study at home in the evenings, and making possible access to education infrastructure such as computers (e.g. Mathur & Mathur, 2005)

- Gender issues: The provision of energy (modern cooking fuels) which does not necessitate the collection of fuel wood or similar can save several hours a day. The collection of fuel wood is usually carried out by women, thereby liberating precious time for them that can be used for other activities. (e.g. Pachauri, 2004, Pereira et al., 2011)

- Environment: The shift away from the use of biomass for cooking or the use of renewable energy sources for the generation of electricity reduces pressure on the environment and ecosystems (leading to local deforestation and/or land degradation and therefore loss of habitat and of biodiversity) which are traditionally exploited for the collection of firewood or the extraction of fossil fuels for electricity generation. Providing access to modern fuels and energy sources hence has a positive impact on the environment at the local, micro level (e.g. Sovacool, 2012).

- Energy efficiency: the usage of modern cooking fuels can help cooking to become a more energy efficient exercise, as combustion of

[21] Toman & Jemelkova, 2003, p. 102

traditional energy sources (biomass) often is incomplete due to inefficient cooking stoves (Reddy, 2003, cited in Ekholm et al., 2010).

- Climate: If a sustainable pathway for the provision of energy is used, i.e. if both for cooking purposes as well as for other electricity services attention is paid to the emissions the primary energy sources create, the impact on the climate can be contained to a minimum or even reduced (Bhattacharya et al. 2002). We will analyse this question for the case of India further in the following.

As a result of this multitude of developmental benefits, some authors claim that energy access is a basic right. According to Pereira et al. "the provision of electric energy amounts to more than access to a public service and should be considered an essential right, in a context of social equity and justice, which permits social integration and the accessibility of other equally essential services [22].

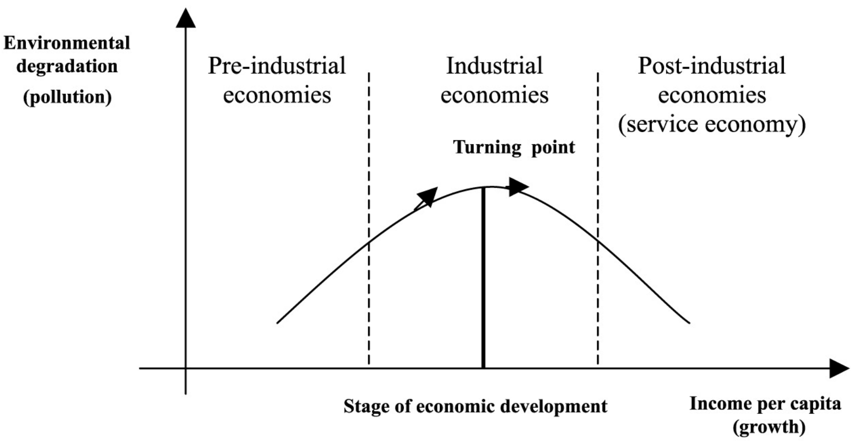
These positive socio-economic and environmental impacts of the provision of energy access are however juxtaposed by other environmental, natural resource-related and climatic considerations.

Thus, it has been widely accepted that pollution and environmental degradation are the consequence of economic development in general. According to the theory of Kuznets, environmental degradation is an accompanying phenomenon in the first stages of economic development. Simon Smith Kuznets, a Russian-American economist, had established a relationship between the different environmental degradation indicators (at the macro level) and the income per capita in the 1950s, showing that each society first sees an increase of environmental degradation up until a certain point (the "turning point"), at which the introduction of environmental legislation and effective measures reduce environmental degradation again. This process is referred to as the Environmental Kuznets Curve (EKC). Represented graphically, it has the shape of a bell-shaped curve (see figure 3 below). Several analogous studies on the relationship between energy consumption, economic growth and CO_2 emissions have also been made[23].

However, it should be added that since the development of the EKC theory in the 1950s the policy situation regarding environmental issues as well as the technology situation has evolved significantly. The awareness of environmental protection measures and the industrial and pollution-control technology used is far more advanced. This could be to the advantage of today's developing countries by giving them the potential to do the "leapfrogging" or "tunnelling through" and thereby flatten the bell shape of the EKC, avoiding harmful environmental pollution and CO_2 emissions, however, this depends on the policies that are implemented in each country.

[22] Pereira et al., 2011, p. 1428
[23] See for example Ru et al. 2012 or Wang et al., 2013

It therefore does not surprise that existing studies on the relationship between energy consumption, economic growth and CO_2 emissions have come to mixed conclusions about whether the EKC holds true also for the Indian case. Some, e.g. Kanjilal & Ghosh, 2013 and Kumar Tiwari et al., 2013 argue that the EKC also applies to India while others, such as Dietzenbacher & Mukhopadhyay (cited in Kanjilal & Ghosh, 2013) reject this theory.



Source: Panayotou (1993)

Figure 3: Environmental Kuznets Curve

Source : Panayotou, 1993 cited in Cialani, 2007

India is still in the stage of a pre-industrial economy, which, according to the Kuznets Curve coincides with a growth in emissions. It has not yet reached, or surpassed, the stage of the industrial economies, i.e. where the tertiary service sector is predominant over the secondary production sector and where there is a "high" GNI per capita (compared to other economies across the world). At the moment, India has an economy which is based for 53% on services (compared to agriculture which accounts for 17% and industry which has a 30% share in the overall GDP[24]. However, almost half of the labour force is still rural and employed in the low-revenue agricultural sector, with the industrial sector providing a further 20% of jobs, completed by the remaining 31% that work in the services industry. Consequently, the GNI per capita stood at only $1,570 yearly per person[25], thereby grouping India among the "lower middle income countries".

On the other hand, reports such as the Club of Rome's "Limits to growth" already in 1972 warned that the limitless "economic growth doctrine" cannot continue infinitely. While the hypothesis made in the "Limits to growth", which predicted an end to oil production for the year 2000 due to only linear growth

[24] 2010-14 average figures, World Bank, 2015d, World Bank, 2015e and World Bank, 2015f
[25] 2013 figures, source: World Bank, 2015g

of technology versus an exponential growth of population and human needs – a Malthusian idea[26] – may have proven inaccurate, the basic idea of increasingly limited resources in a world with a continuously growing population and hence growing demand for those resources nevertheless remains valid.

In this equation, the question of the constraint or "end" to the availability of energy sources does not pose itself for the foreseeable future, as fossil fuels still accounted for 86% of the world's primary energy demand in 2013 (see figure 4 below) and proved reserves continue to evolve positively as ever more sophisticated technology allows to reach more profound and distant levels of these prehistoric resources[27]. Marion King Hubbert's "peak oil" situation, in which global oil production reaches its historical climax at a certain point in time before decreasing again, has therefore not been reached yet on a global scale. The same observation applies to natural gas and coal, which continue to be explored and used all across the world. Adding to that come the growing use of renewable energy sources which, albeit timidly, are starting to change the energy mix (see figure 4 below).

If the trend of a dominating fossil fuel usage continues as BP and others predict, the limit that will be reached then in the foreseeable future is perhaps not the limit of energy resources but rather the limit of the scientifically calculated global "carbon budget". This "precise quantity of carbon dioxide [equivalent emissions] that humans can emit and still limit warming to 2°C above pre-industrial levels"[28] has been put forward by the Intergovernmental Panel for Climate Change (IPCC) to lie at 450ppm of CO_2 equivalent emission concentrations in order for it to have a "likely" chance (i.e. at least 66%) of being achieved in 2100. The IPCC estimated that in 2011, the CO_2 equivalent concentrations were already at 430 ppm (with an uncertainty range between 340 ppm – 520 ppm)[29]. In the baseline scenario, the carbon budget would therefore be used up by 2030, so in less than two decades[30].

[26] Thomas Malthus, Anglican pastor stated in his work "An Essay on the Principle of Population" of 1798 that the demographic evolution is quicker (grows exponentially) than the increase of food (which only increase in a linear manner).
[27] For an evolution in numbers of proved reserves of oil and natural gas since 1994 see "BP Statistical Review of World Energy 2015", pp. 6, 20
[28] Source: www.climatenexus.org
[29] IPCC, 2014b, p. 20
[30] IPCC, 2014b, p. 3

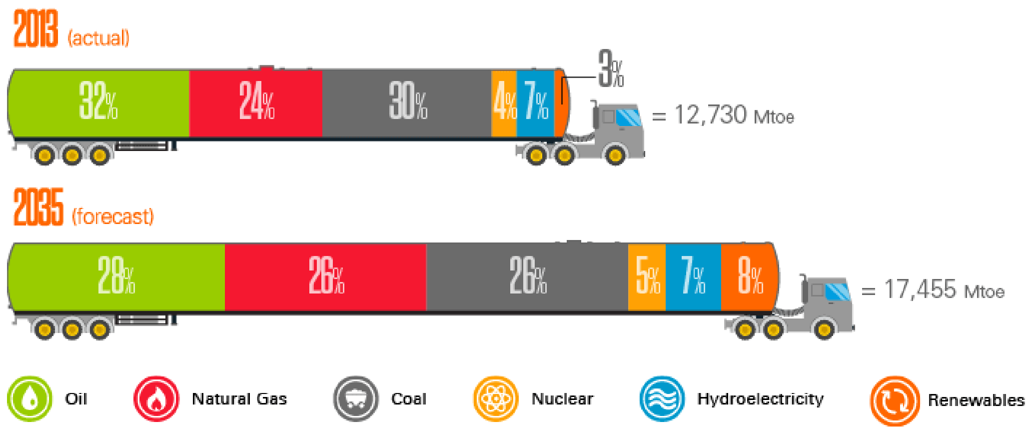


Figure 4: Outlook on the world energy mix until 2035

Source: BP, 2015

In other words there is an urgent global climate imperative to reduce emissions in order to ensure the survival of human life as we now know it. A more detailed analysis of the global climate challenge will be discussed in chapter III below.

For now, what is worth retaining is that while there are manifold socio-economic benefits to the provision of energy access – and it can even be argued to be a "right" (although without any legal grounds to support this claim), the global climate imperative of stabilising carbon emissions in order to limit the impact on the climate appears as a threat to the "right to development". Furthermore, it is interesting to note that the environmental impacts of providing energy access can be both positive and negative, although positive impacts tend to be at the micro level, while negative effects are found mainly at the macro level.

2. Global state of play on energy access - The UN's SE4 All Initiative

So how important is the issue of energy access and what is being done about it at the global level?

According to the World Bank, 1.1 billion people still have no access to electricity; that is an equivalent of 15% of the world's population or every seventh person. In addition, 2.9 billion people do not have access to non-solid fuels for cooking purposes, and 84% of those are located in rural areas[31].

However, as figure 5 below shows, the problem is concentrated in three main regions: South Asia, Sub-Saharan Africa and Pacific Asia. Within these regions,

[31] World Bank, 2015c, p. 42

it is a limited number of countries which house the majority of people lacking electricity access and access to modern cooking fuels. Regarding electricity access, two thirds of those without it can be found in only ten countries. Four of these are in Asia (India, Bangladesh, Pakistan and Indonesia) and the remaining six in sub-Saharan Africa (Nigeria, Ethiopia, DR Congo, Tanzania, Kenya, Uganda). Regarding cooking fuels the situation is even more starkly concentrated geographically: India, China and Bangladesh alone make up over half of the global population without access to clean cooking fuels. The rest of the top 10 countries in this category (Indonesia, Pakistan, Vietnam, Philippines in Asia and Nigeria, Ethiopia and DR Congo in Africa) together account for almost 80% of the population which lack modern cooking fuels[32].

The issue is therefore one of regional and rural concern, where the lack of funds of states for electricity grid development meets the low purchasing power of the rural population in the concerned countries, of which the majority lives of agriculture.

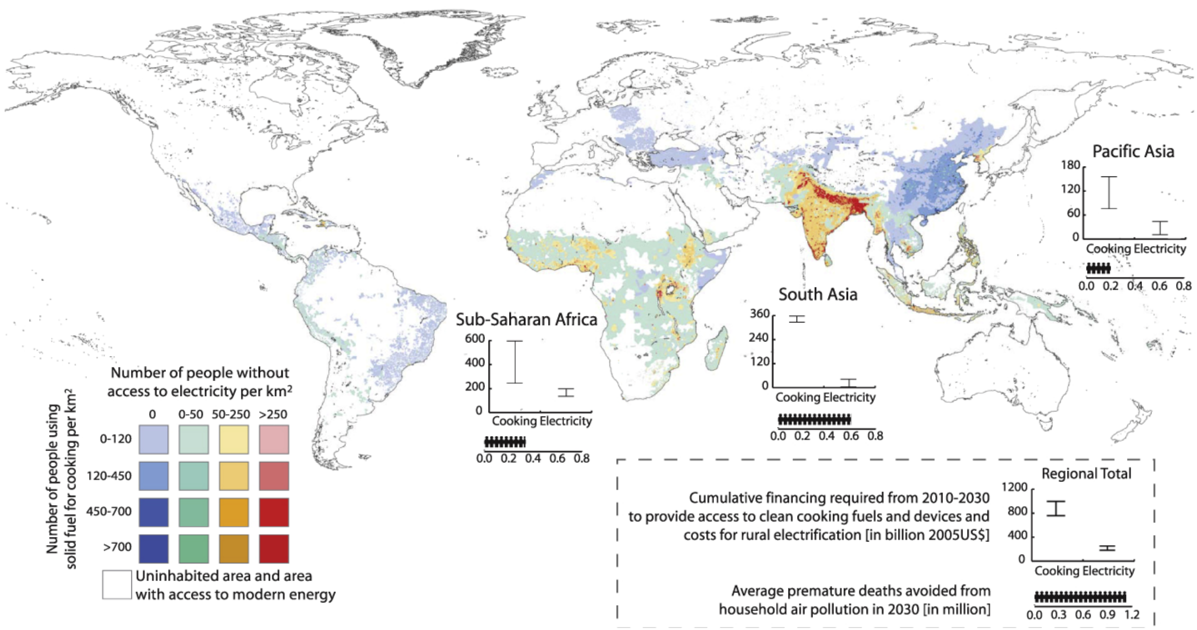


Figure 5: World regions without access to electricity and to non-solid fuels for cooking

Source: Pachauri et al., 2013

In order to tackle this situation and raise international awareness about the issue, the UN launched in 2011 the "Sustainable Energy For All" Initiative (SE4ALL). Its objectives, besides the provision of universal access to modern energy services, are to double the share of renewable energy in the global energy mix and to also double the global rate of improvements in energy

[32] OECD/IEA, 2012, pp. 533-534

efficiency by 2030[33]. As a means of increasing the political pressure, in 2014, the UN even announced a "UN Decade of Sustainable Energy for All", to run until 2024. So far, 81 developing countries have voluntarily committed themselves to the initiative[34].

Stock is taken of the progress achieved towards these goals through the Global Tracking Framework, a top-down assessment measuring on a biannual basis global progress towards the three objectives, as well as the Accountability Framework which tracks commitments and annual progress towards commitments on a local basis (from the bottom up). Moreover, stakeholders come together for assessing and reporting on the state of play in the annually held Sustainable Energy For All Forum.

Concrete measuring of progress, however, is done under the Global Tracking Framework, which quantifies through the use of country-level indicators (on the percentage of the population with an electricity connection and with primary reliance on non-solid fuels respectively) how far each participating country has come in the implementation of the SE4ALL objectives. Since 1990, there has been some progress made regarding access to electricity across the world: from 76% of the world population with access in 1990 up to 83% in 2010. This figure takes into account the equally growing world population; it can therefore be deemed a reasonably good achievement. Nevertheless, the progress has been more impressive regarding the provision of access to non-solid (modern) cooking fuels: from 47% with access to these fuels in 1990 the rate has increased to 59% twenty years later (World Bank, 2015c).

For country comparisons, the IEA's EDI discussed earlier has been added to the toolbox of measurements for the SE4ALL Initiative in addition to the separate electricity and non-solid fuel reporting mentioned above.

B. Achieving universal energy access in India

1. State of play of energy access in India

From the previous overview over the global situation on energy access it emerges clearly that India is the one country with the greatest need in absolute terms for developing energy access for its people. Of course, this is mainly due to its large population, which is currently the second largest in the world with 1.252bn (Source: World Bank, 2015b) behind China but India is set to become the world's most populous country by 2028 (UN, 2013). What is

[33] United Nations, 2012, p. 5
[34] Sustainable Energy For All Initiative, 2013, p. 6

more, more than two-thirds (68%) of the Indian population live in rural regions[35].

It follows logically then that with a quarter of the Indian population lacking modern energy access, the EDI rank for the country is not very high – in the World Energy Outlook 2012 India reached the 41st position out of 80 countries for which the indicator is calculated.

In relative terms, however, the percentage of the population with access to modern energy services is very varied depending on where people live. Overall, 75% of the total population have electricity access, however, when looking at the repartition of urban and regional electrification a similar pattern as on the global scale emerges: compared to 93% of the urban population only 67% of the rural population is electrified (2010 figures, Source: World Bank, 2015c). In addition, these figures need to be appreciated with care, as according to Indian national statistics a rural village is counted as electrified when only 10% of its households have an electricity connection[36].

What is more, when looking at the administrative map of India using the Multi-dimensional Energy Poverty Index (MEPI) one can discern that apart from being a rural problem, it is also a sub-regional one, concentrated in the North of India in 10 of the 36 Indian states and Union territories (Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Tripura, Uttar Pradesh, West Bengal; see figure 6 below).

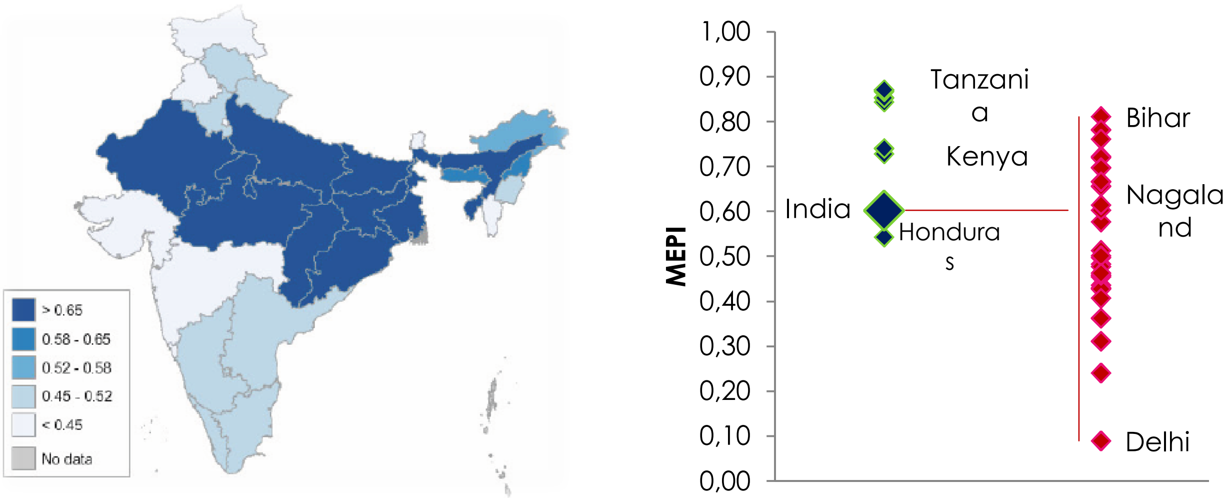


Figure 6: MEPI at 1st administrative level (left pane) in India compared with SE4ALL countries (right pane)

Source: Bazilian, 2012

[35] 2014 data, Source: UN, 2014, p. 22.
[36] CEA, 2015, p. 11

Regarding access to modern cooking fuels, only between 34% and 42% of the Indian population, depending on the data source, has access to it. Once again, the rural-urban divide is evident: While 12% of rural households have access to clean cooking fuels, 72% of their urban peers enjoy their services[37].

For on-grid electricity generation, serving for electricity access, the predominant source of primary energy used in India is coal (59%), followed by hydro (16%), other renewable energy sources (composed of wind, small hydro, biomass and cogeneration from bagasse; 13%) and natural gas (9%; see figure 7 below). Additionally, some minor electricity imports come from other countries such as Bhutan.

Following the repartition of energy uses in households used by Nussbaumer et al., one can distinguish three main uses: lighting, household appliances and communication technologies and cooking. However, household appliances and communication technologies (e.g. mobile phones and computers) are all powered exclusively by electricity. Since electricity as an energy "source" is already covered under lighting, this category will as a consequence be disregarded in the further analysis.

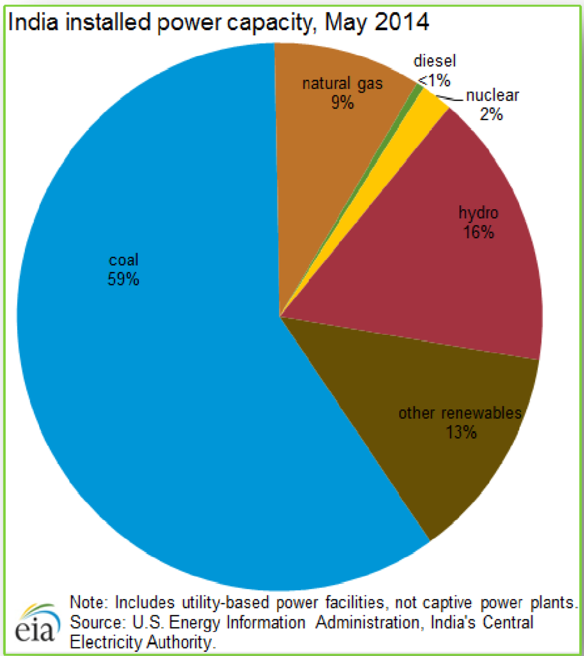


Figure 7: Installed power capacity in India, 2014

Source: U.S. Energy Information Administration, 2014

[37] Figures from World Energy Outlook, 2014 and World Bank, 2015c, Data Annex, p. 288 (2012 figures). The World Bank (World Bank, 2015c) cites rural access to clean cooking fuels for 2010 as 14% and 77% for urban areas.

An analysis of a sample of the sources of lighting in rural and urban areas makes clear that the main sources of lighting across the country are vastly dominated by only two sources: in both cities and rural regions, electricity is the main source of lighting, followed by kerosene (see figures 8 and 9 below). This is followed by other sources such as candles and other oil sources; but these are negligible, both in rural and urban households.

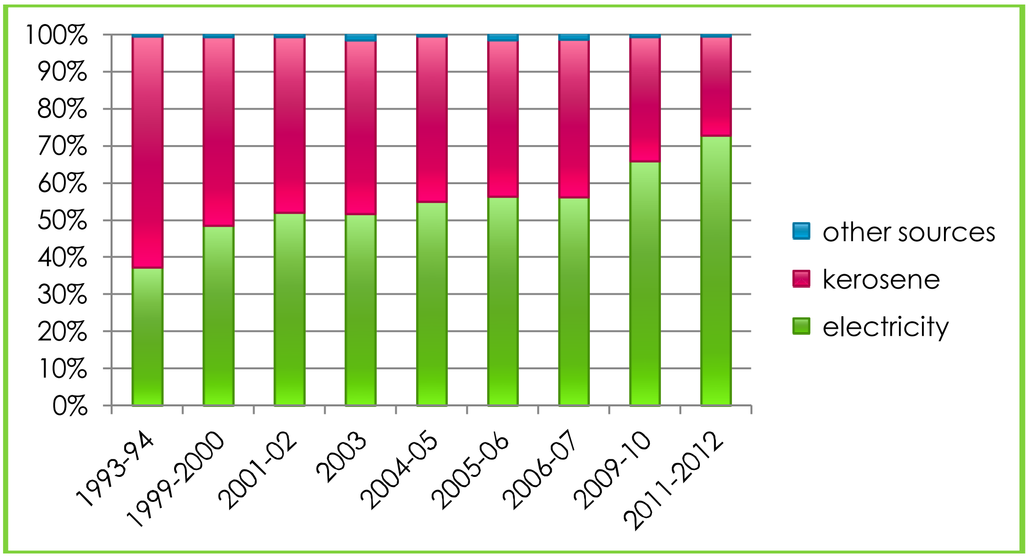


Figure 8: Evolution of the sources of lighting in rural areas, 1993-2012

Source: NSSO, 2015, p. 25

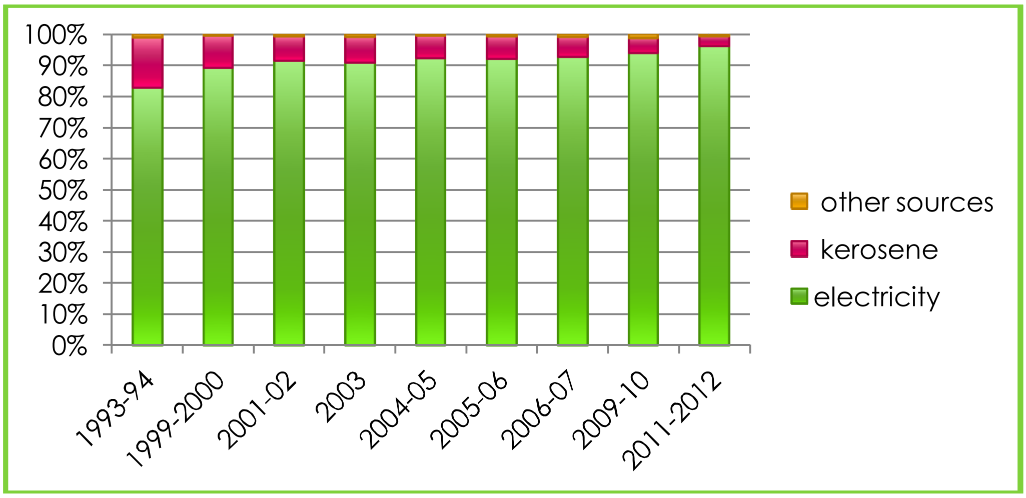


Figure 9: Evolution of the sources of lighting in urban areas, 1993-2012

Source: NSSO, 2015, p. 25

What is interesting to note is that while cities have been largely electrified for over 20 years, in rural regions electricity has only become the main source of lighting since 2005, so for the last ten years. This is a reflection of the rural electrification efforts, and yet, progress must be viewed with caution: since according to Indian statistics a village is counted as electrified when 10% of the households of a village have access to electricity there is still a high number of un-electrified households which is "hidden" by this kind of statistic.

Regarding energy supply for cooking purposes, biomass (mainly from firewood, crop residue and dung cake) is still by far the most popular choice among all income groups of rural households (see figure 10). Even though the vast majority of this biomass is either collected freely or home-grown, roughly 20% of all biomass used among the different income groups of rural households is purchased, implying that even in the poorest households a relatively significant share of the income which is spent every month for energy purposes (78%) is allocated to cooking fuels (NSSO 2009-2010, cited in EIA, 2014; Ekholm et al., 2010). In urban households the picture is inversed: here, in all income groups on average approximately 70% of the biomass that is used for cooking is bought, with home-growing or free collection, or a mix of these, making up the remaining percentage.

Overall, both rural and urban households spend a similar percentage of their monthly household income on fuel and light (between 8% and 9.5%), however, total absolute expenditure on energy is higher in cities than in the countryside (138 INR compared to 85 INR[38]). Nevertheless, Joon et al. (2009) point out that besides income, socio-cultural factors such as preference are equally important in making fuel choices at household level.

The remaining share of residential energy consumption for cooking in rural areas is split between liquefied petroleum gas or pressurised natural gas (LPG/PNG) and kerosene. Coal-derived products, electricity, biogas and other sources of cooking fuel make up a negligible part of the rural preferences for cooking fuel. As table 1 shows, rural cooking fuel consumption patterns have not changed very much over the last 20 years; merely the use of biomass has decreased somewhat and has been replaced by LPG – a result of LPG policies and subsidies.

In cities, the sources of domestic cooking fuels are mainly composed of LPG/PNG, biomass (firewood and crop residues) and kerosene. A minor share of products derived from coal and cow dung cake are also used. As in rural households, in urban areas the use of electricity, charcoal, biogas and other fuels for cooking is negligible (NSSO, 2015, p. 16). As in rural regions, in urban areas too the use of LPG has increased over the last twenty years, but here even more drastically than in rural India. Since 1993, when LPG was used by 29.3% of urban households, the rate has gone up to 68.4% of households in

[38] U.S. Energy Information Administration (EIA), 2014, p. 10

2012 (see table 1). Most other fuels have seen a decline in usage (coke/coal, firewood and kerosene).

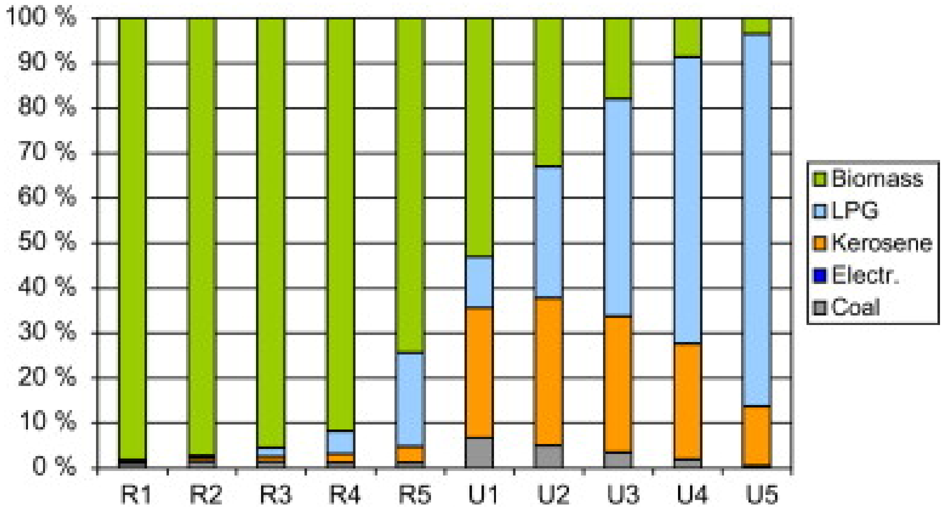


Figure 10: Sources of cooking fuel in rural (R) and urban (U) areas, per income quintile

Source: Ekholm et al., 2010

Sources of energy for cooking	Rural					Urban				
	1993-94	**1999-2000**	**2004-05**	**2009-10**	**2011-12**	**1993-94**	**1999-2000**	**2004-05**	**2009-10**	**2011-12**
coke/ coal	1.4	1.5	0.8	0.8	1.1	5.7	4.1	2.8	2.3	2.1
firewood & chips	78.2	75.5	75	76.3	67.3	29.9	22.3	21.7	17.5	14.0
LPG	1.9	5.4	8.6	11.5	15.0	29.6	44.2	57.1	64.5	68.4
dung cake	11.5	10.6	9.1	6.3	9.6	2.4	2.1	1.7	1.3	1.3
kerosene	2.0	2.7	1.3	0.8	0.9	23.2	21.7	10.2	6.5	5.7
no cooking arrangement	0.7	1.1	1.3	1.6	1.3	6.3	4.3	4.9	6.5	6.9
other sources#	4.1	3.1	3.8	2.7	4.9	3.0	1.3	1.6	1.5	1.5
all*	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

** includes households not reporting primary source of energy for cooking*
 # includes gobar gas (biogas), charcoal, electricity, others

Table 1: Evolution of primary source of energy used for cooking in Indian households (in %), 1993-2012

Source: NSSO, 2015, p. 16

Since most urban dwellers have generally easier access to alternative cooking fuels than the rural population their consumption patterns can be taken as an indicator of future consumption of rural areas. This indicates a shift from biomass (mainly firewood) in favour of several sources of energy for cooking; notably LPG and some kerosene.

What is interesting to note here is that the "energy ladder" pattern of replacement of a traditional energy source with a more modern one as income rises is not taking place[39], but it is rather a '"stacking" procedure, an addition of new alternative options for energy supply which occurs as energy access is improved (Masera et al., 2000), implying that not only one energy source is used by several ones in parallel or as alternatives. Moreover, the total energy consumption actually drops as modern energy fuels are several times more energy efficient than wood (see table 2 and figure 11). What should be noted though is that the shift to modern fuels also means a shift towards commercial sources of energy.

Fuel	Cook stove efficiency	Non-biogenic CO_2 emissions from combustion (in g/kg)	Biogenic CO_2 emissions from combustion (in g/kg)	PM_{10} equivalent pollution (kg)
Crop residue	11%	0	1302	7.54
Dung cake	8.5%	0	1046	16.26
Firewood	13.5%	1032	326	4.34
Charcoal	17.5%	1979	625	0.43
LPG	57%	3085	0	0
Biogas	55%	0	1450	0.66
Kerosene	47%	2943	0	0.52
Coal	15.5%	1559	0	17.9

Table 2: Cooking fuel efficiency and emissions

Source: Singh et al., 2014, Supplementary material

NB: The given cook stove efficiencies are for conventional cook stoves - the actual extent to which households are able to extract useful energy from a particular fuel depends on the efficiency of the cooking technology used (Nautiyal et al., 2014, p. 7) and can be somewhat improved.

[39] The concept of "energy ladder" was put forward by Hosier & Dowd in 1987. Holden & smith later defined it as follows: "the percentage of population among the spectrum running from simple biomass fuels (dung, crop, residues, wood, charcoal) and coal (or soft coke) to liquid and gaseous fossil fuels (kerosene, liquefied petroleum gas, and natural gas) (Holden & Smith, 2000, cited in Sovacool, 2012, p. 273)

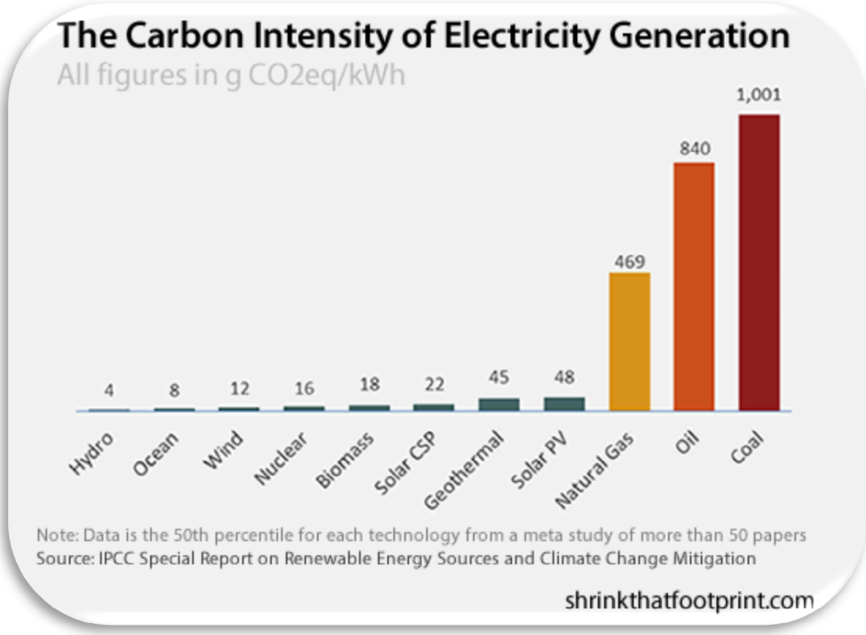


Figure 11: Carbon intensity of electricity generation (in gCO_2 eq/kWh)

Source: www.shrinkthatfootprint.com

As the CO_2 emission rates in table 2 shows, kerosene and LPG, two of the main sources of energy used both in rural as well as in urban households for cooking purposes (as well as for lighting) are very carbon intensive and therefore have high non-biogenic CO_2 emissions that are harmful for the climate, however, they have the advantage of being very low in particulate matter emissions. By contrast, particularly the biomass-based fuels (dung cake, crop residue, coal and firewood) generate additional negative health impacts and regional impacts on the climate due to high emissions of particulate matter (PM_{10}).

In addition, figure 11 highlights the carbon intensity of coal-based and other major energy source power generation, as put forward by the IPCC. It emerges that coal is the most carbon intensive fuel. In practice, though, there are differing emission intensities depending on the coal-firing technology used; e.g. Pulverised Carbon power plants in India produce roughly 800-870 g/CO_2eq/kWh and Combined Cycle and Integrated Gasification Combined Cycle (IGCC) plants emit 730-790 g/CO_2eq/kWh (2006 figure; source: Raghuvanshi et al., 2006, p. 437). The emission intensities of these two coal-based power generation technologies demonstrate that emissions can be reduced by using more modern technologies such as the Integrated Gasification Combined Cycle. However, as of today, this higher efficiency technology is still not commonly used in India.

The question that poses itself then is: With a marked rise in the use of only one fuel over the past two decades (LPG), what has been hindering the energy transition away from traditional biomass? We will explore this question in the next section.

2. Obstacles for achieving universal energy access in India

a) Geographical and socio-demographic challenges

A look at the topographical situation of India does not reveal itself conclusive as to the great lack of energy access, which is particularly strong in the North of India, as the regions with the highest elevations and therefore potentially most difficult access to provide electricity grid connections in the Northwestern extremities of the country are not the ones with the highest MEPI score (see figure 6 and Annex IV). Instead, the Northern and Northeastern regions are home to the fertile Indo-Gangetic Plain and half of the Indian population (600 million inhabitants).

Despite the overall large concentration of population in these regions an overwhelming proportion of the population does live in rural regions[40]. This fact, besides the fact that many of the State Electricity Boards (SEBs) which are responsible for new grid connections are deficient, complicates the physical connection of new households to the electricity grid. It also makes the distribution of clean cooking fuels more costly due to larger distances which need to be covered due to the physical dispersion of the population in rural areas.

It is also relevant to note the high prevalence of rural households in India, as the urban consumption rate of energy (electricity and cooking fuels) is assumed to be up to twice that of the rural rate[41]. In addition, as we have seen, the energy consumption patterns are not at all the same, making for differing emission balances per capita.

Moreover, adding to the geographical obstacles to the provision of energy access the urbanisation rate is a factor that needs to be taken into account, as it will have a critical impact on the speed and ease of provision of energy access: For one, grid connections in urban areas are easier and cheaper to make than in rural ones. Secondly, it may also have consequences on the CO_2 emission impact of energy access provision, as the overall energy consumption of urban households is higher than rural ones. Thirdly, the accuracy of projections of the provision of energy access depends on a correctly calculated urbanisation rate. In India, the current urbanisation rate is estimated to be 1.1% annually (UN, 2014, p. 22).

Finally, looking at the sometimes considerable variations of energy access among different castes and religious groups[42] conjures up the idea that there

[40] at least three-quarters in the random sample of districts chosen for analysis, see Annex I
[41] The IEA assumes double the consumption of electricity in an urban household having access to energy compared to a rural one, see chapter II.A above.
[42] As examined by Ganesan & Vishnu (2014) and Bhattacharya & Saxena (2015)

may also be an element of ethnic and religious discrimination in terms of who can get access to a certain fuel or not. Bhattacharya & Saxena analysed this issue and concluded that the Muslim population, the scheduled castes and the scheduled tribes tend to be disadvantaged in terms of energy access. The scheduled castes and tribes, also known as the "untouchables", refer to Hindu groups belonging to the lowest rung in the caste hierarchy. They make up 16% of the Indian population. As Muslims make up another 13% of the population the total percentage of minority groups being potentially discriminated against is consequently considerable, at almost a third of the total population (29%)[43].

All of these geographic and socio-demographic factors taken together, i.e. the geographical dispersion, the urban-rural population ratio, the energy consumption patterns of the urban and rural population, the urbanisation as well as the discrimination of minority groups have important consequences on the actual and the projection of emissions per capita as well as on policy-making.

b) *Commercial challenges*

In addition, the socio-economic structure of India is also commonly cited as hindering the extension of modern energy services to this population, both in terms of electricity as well as cooking fuels. This stems from the fact that the large rural population which is mainly working in low-revenue activities such as agriculture has low purchasing power. In other words, it is assumed that the part of the population with lower revenues cannot afford to pay for either electricity or cooking fuels, thus making a potential extension of energy service provision into rural regions an unattractive market for public and private utilities as it "mitigates commercial profit"[44]. Nevertheless, as we have seen previously, this concept is not quite accurate, as even the poorest population is already paying for a part of their energy consumption (biomass and kerosene).

Another commercial challenge regarding electricity is electricity losses. They are a common issue in India, amounting to a staggering 17% of total production[45]. Thus, the non-payment of electricity bills and unpaid utilisation of grid-based electricity (pilferage), combined with transmission and distribution (T & D) losses from the grid due to inefficient and old grid systems all add to the electricity utilities' deficiency. As a result, a surplus of primary energy needs to be purchased and used for the generation of electricity, creating unnecessary costs which could otherwise be used for reinvesting into the upgrading and extension of the electricity grid infrastructure, which would be beneficial for improving energy access for those that are still lacking it. It

[43] Population percentages from Bhattacharya & Saxena, 2015, p. 3
[44] OECD/IEA, 2010, p. 18, footnote 13; Bazilian, 2010, cited in Sovacool, 2012, p. 278)
[45] By means of comparison, T & D losses in Belgium are in the order of 5% and in Indonesia 9%. Source: World Bank, 2015h (figures from the period 2010-2014).

would also benefit climate change mitigation efforts as less new power generation capacities would have to be added to the system.

c) *Technological challenges*

A third impediment to providing universal energy access is the that even in cases where electricity access is provided to households, a complete switch of fuels does not necessarily come about, hampering the potential opportunity to move to more sustainable energy sources. Often, due to the unreliability of electricity supply people keep using kerosene lamps at least as a backup option.

Thus, it is not the often cited "energy ladder" but the more complex "stacking" system, where "electricity becomes in effect only one in a range of energy options by the population, which limits its capacity to engender improvement in living standards" (Pereira et al., 2011, p. 1440). The fact is that today in most states of India already today, in a situation where not 100 % of the population is connected to the grid, there is a sometimes severe shortage of power supply. And a look at the power supply shortages of April-May 2015 reveal that it is the Northern and North-Eastern regions, so those regions with the lowest energy access rates, that already now suffer from the highest power supply deficits (CEA, 2015, p. 38-39). The states of Andaman-Nicobar (-25%), Arunachal Pradesh (-22.6%) and Tripura (-15.7%) are the worst affected. Unreliable supply of fuels is also a concern for cooking fuels such as LPG, as stocks suffer from frequent distribution disruptions in many areas (D'Sa & Narasimha Murthy, 2004, p. 42).

A further aspect impacting the quality of electricity supply is the outdatedness of the state electricity grids. Currently, two sub-national grids exist[46]. However, much of the grid infrastructure systems have never been modernised since their construction and therefore do not include information and communication technology to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. Due to this, regional and state-wide variations in electricity supply and demand owing to availability of differing primary energy sources (e.g. seasonal variations of hydro energy due to monsoon) cannot be balanced out with the supply from a nationwide electricity grid (Ahn & Graczyk, 2012, p. 36). This concept, known as "smart grids", has the potential to considerably improve the reliability (quality) of electricity access and create additional financial and human resource capacities for expanding the network.

[46] Ahn & Graczyk, 2012, p. 38, 94. Prior to August 2006, 5 regional grids clustering together between 4 and 7 state grids each, existed. All regional grids except the Southern Grid have been integrated and are operating in synchronous mode, i.e. at same frequency. There are however plans to synchronise the Southern grid with the rest of the all Indian Grid by early 12th Plan (2012-2017). Presently, the Southern grid is connected with the Western and the Eastern grid through HVDC link and HVDC back to back systems. Source: CEA, 2015

Smart grids are currently being rolled out in the EU[47], but are still very much in its infancy even in developed countries. On the other hand, the great need for the upgrading of Indian electricity infrastructure provides a unique opportunity to "leapfrog" to smart grids even before other economically advances nations are doing so. It is positive to note that a first initiative in this sense has just been launched, entitled the "National Smart Grid Mission" in March 2015[48], with an initial focus on smart metering, microgrid development, use of GIS and Harmonic Filters, but also the deployment of rooftop solar PV panels and electric vehicle charging stations. However, it remains to be seen whether this Mission can be effectively combined with the rural electrification efforts.

d) Political challenges

In an attempt to tackle the challenge of sustainable energy access, the main focus of Indian policymaking has been mainly on the aspect that "sells" better in the public eye, and that is electricity access. In this regard, notably the Rural Electrification Policy and the Electricity Act (2003) are to be mentioned. Yet, as we have seen previously, currently electricity only contributes a minor share of energy consumption across India, both in rural as well as in urban households, mainly as a source of light. All efforts made to providing access to electricity alone therefore cannot solve the energy access issue (Bhattacharya, 2011, p. 516). Nevertheless, on a sector level, domestic electricity consumption does play an important role. With nearly 22% of overall electricity consumption residential electricity is the second largest consumption sector after industry (45%) and before agriculture (18%). Not only that, the electricity sector has also seen an 8.08% average annual growth figure between 2000 and 2013 (Ministry of Statistics, 2014).

Furthermore, the timely implementation of policies is an issue that raises concern. Several times the national government has adopted and announced loudly the objectives of universal energy access in strategy documents, e.g. in the Indian National Planning Commission's Integrated Energy Policy of 2006, which set objectives for electricity access for all households below the poverty line until 2010 and access to modern cooking fuels within 10 years[49]. However, it repeatedly fails to follow through on its objectives.

A further major issue is that consumer subsidies (e.g. for kerosene and LPG) provided by the government to facilitate access and improve affordability of (not necessarily clean) energy has often not reached those that need them most, i.e. the poor, but it has been the wealthier groups of society that have

[47] European Commission, 2011
[48] Minister of State (I/C) for Power, Coal and New & Renewable Energy, 2015, p. 20
[49] Planning Commission, 2006, p. 99

benefited most from them, as the subsidies concern those fuels that are consumed by higher income households (CEEW, 2014, p. 10).

A second aspect related to the issuing of subsidies is that they have focused on lowering fuel purchase costs but have neglected providing financial incentives for more sustainable alternatives such as decentralised systems for electricity access by private or cooperative investors (e.g. a grouped purchase of a solar PV plant at the village level through a government-backed loan). Instead, the focus has been on the extension of the central electricity grid.

Clearly then, besides the geographical and socio-demographic challenges of providing universal modern energy access outlined above, there are also the commercial, technological and political ones, which are better controllable than the first two, through efficient policymaking and strategic planning. We will have a look in the next section at how the Indian government tackles these challenges. We will also look at the question whether there are any climate change mitigation-relevant objectives integrated into Indian energy access policy.

3. Policy actions for achieving universal energy access

In the field of energy, "there are three major policy objectives that India pursues: energy access, energy security and mitigation of climate change" (Ahn & Graczyk, 2012, p. 16). Yet, the energy policy landscape is complex, with an interlinkage of public and private actors and policies involved at the national and state levels. Already the fact that there are five Ministries in charge of the energy sector (Ministry of Power, Ministry of New and Renewable Energy, Ministry of Coal, Ministry of Petroleum and Natural Gas, Ministry of Atomic Energy), all led by the Planning Commission which elaborates and monitors the implementation of the national five-year plans, is an indication for that. Recognising this complexity, India recently combined the leadership of the Ministries of Power, Coal and New and Renewable Energy under the guidance of one Minister, M Piyush Goyal after the last elections in 2014.

India being a country made up of federal states, besides the central government there are the "state governments (which) have their own energy departments to manage the particular energy issues and market conditions in their states" (IEA, 2007, cited in Ahn & Graczyk, 2012, p. 20). In fact, electricity is a shared competency between the central and the state governments, while the tax-raising on the sale and consumption of electricity lies in the competence of states (Ahn & Graczyk, 2012, p. 12).

The central Indian government has been making great efforts in order to eliminate energy poverty in remote areas (see Annex I). Regarding electricity, mainly the Electricity Act from 2003, the National Electricity Policy and the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY, rural electrification programme) from 2005 as well as the Rural Electrification Policy from 2006 are the main pillars ruling the sector today.

The National Electricity Policy aims to provide "access to electricity for all households to be fully met by 2012", including a "minimum lifeline consumption of 1 kWh/household/day by 2012" (Annex I). While rural electrification shall receive "highest priority"[50], no distinction between rural and urban households is made for the overall policy goal. Instead, there is a minimum threshold of electricity consumption which has been established as objective, amounting to 360kWh/household per year[51] – this figure is slightly below the average of household consumption for rural and urban households assumed by the IEA (375kWh/household per year). From a fuel point of view, the Policy aims for the "full development of hydro potential" and the "choice of fuel for thermal generation to be based on economics of generation and supply of electricity". The use of non-conventional sources such as small-hydro, solar, biomass and wind for additional power generation capacity is also stated as technological option.

Thus, although not explicitly addressing climatic or environmental concerns, the National Electricity Policy nevertheless broadly encourages the use of clean energy sources. Yet, apart from a priority on the maximum deployment of hydro power, it does not include any concrete measure such as a minimum share of clean power sources. Given that power generation is open to the private sector, it subsequently leaves a lot of freedom to the application of the rules of the market. Given that cleaner energy sources such as wind and solar are still commercially less competitive than fossil sources, the rollout of electrification is therefore biased in favour of fossil-based sources, i.e. coal, oil and gas.

The Rural Electrification Policy aims for the "provision of access to electricity to all households by year 2009, quality and reliable power supply at reasonable rates and a "minimum lifeline consumption of 1 unit per household per day as a merit good by year 2012" (Ministry of Power, 2006, Section 2.1)[52]. Set up under the Rural Electrification Policy, the RGGVY (Rajiv Gandhi Grameen Vidyutikaran Yojana) scheme is slightly less ambitious, with the objective of universal electricity access for all households "within five years", i.e. by 2011 (Ministry of Power, 2006, p.1).

[50] 2006, p. 2

[51] The size of the household is not specified in the Policy, but it is reasonable to assume a similar number to the global average of 5 persons that the IEA uses.

[52] These objectives are summarised under the acronym "AARQA", which stands for Accessibility (electricity to all households by 2012), Availability (adequate supply to meet demand by 2012), Reliability (ensure 24 hour supply by 2012), Quality (100% quality supply by 2012) and Affordability (pricing based on consumer ability to pay)

For villages for which grid connection proves cost-ineffective, the Rural Electrification Policy mentions the possibility of off-grid solutions such as solar photovoltaic panels (section 3.2). In the Policy, no discrimination is being made between conventional (meaning fossil fuel) or non-conventional (meaning all other sources, including hydro, other renewables and nuclear) methods of generation (section 3.3).

Nevertheless, in the implementing programme for villages which for cost reasons cannot be connected to the central grid, called the RVE (Remote Village Electrification) scheme of 2009, the emphasis is strongly on the use of renewable energy sources. The programme provides up to 90% capital subsidy for rural electrification projects using renewable DDG (decentralized distributed generation), i.e. power plants based on small hydro power, biomass, wind, biofuels, biogas, solar PV and hybrid or combined renewable energy source systems.

As Patil points out, "the electricity sector, especially rural electrification, is predominantly controlled by the state governments although with support from the central government. Therefore the success of the programs on rural electrification was entirely dependent on the efforts of the government institutions in terms of effectiveness of programs, efficiency of implementation, and availability of financial support and these varied across states" (Patil, 2010, p. 24). This explains the large regional variations in energy access, as illustrated by the differing MEPI scores of the various federal states (figure 6).

As we can see from the above, national targets for achieving universal electricity access have been set repeatedly, e.g. with the Rural Electrification Policy of 2006 and the National Electricity Policy from 2005 which targeted completion of the issue by 2009 and 2012 respectively, however, implementation lags considerably behind these objectives.

In terms of clean cooking fuels for the rural population, the first initiative for the supply of subsidised kerosene for cooking and lighting purposes through a public distribution system (PDS) for rural and urban users dates back to 1957. The programme is ongoing until today, however, in a time where climate concerns have become well-known, this scheme cannot be deemed to integrate climate considerations.

Regarding LPG, a generalised subsidy "is available for all the consumers irrespective of their income levels" and is therefore "not targeted at the poor" (Ganesan & Vishnu, 2014, p. 68). Additionally, the Rajiv Gandhi Gramin LPG Vitrak Yojana (RGGLVY) scheme from 2009 to provide clean cooking fuel (LPG) specifically targeted at rural women is worth mentioning. However, the RGGLVY hinges on that fact that it has "not (been) sufficiently scaled up on account of lack of availability of LPG domestically and the large amount of subsidy that is currently provided to existing consumers" (Ganesan & Vishnu, 2014, p.33).

Biogas is the third fuel being promoted for cooking. The National Biogas and Manure Management Programme (NBMMP) of 1981 not only aimed to supply lighting and "modern fuel for cooking and organic fertilizer to rural households, mitigate drudgery of women", but also to save on the use of the more polluting LPG and "reduce pressure on forest"[53]. From a technical point of view, the programme has been evaluated as mitigated (Planning Commission, 2002 and TERI, 2011), although we have seen that its impacts on the overall energy mix for rural consumption remains marginal.

Finally, apart from cooking fuels the promotion of more efficient and cleaner cooking technology has also received some attention from policymakers. Thus, the National Biomass Cookstoves Programme (NBCP) in 2009 replaced the previous National Programme on Improved Chulhas (NPIC) or cookstoves from 1983. In view of the still widely dominating use of biomass for cooking in rural, semi-urban and urban areas, the idea of this programme is to improve the efficiency of the combustion of the biomass used and thereby reduce consumption and emissions emanating from cooking with traditional fuels.

As the above overview of the numerous policies for rural energy access indicates, one notices that most policies focus on rural electrification; only a few policies such as the National Project on Biogas Development (NPBD) from 1982 address the cleaner cooking fuel issue. The success of all of them has been limited to a greater or lesser extent.

However, In 2006, almost in parallel to several of the above-mentioned policies, the Indian government asked the Planning Commission to compile a comprehensive guidance document on energy which would enable India to achieve its "economic growth imperatives and its efforts to raise its level of human development". This Integrated Energy Policy recommends a basic energy access figure of 30 units (kWh) of electricity per household per month, to be subsidised with a direct cash subsidy through smart cards to the value of INR 1 per kWh for the first 30 units of consumption, even for the poorest households below the poverty line (BPL). This is to be supplemented with 6kg of LPG or the equivalent amount of kerosene for cooking purposes.

The Policy Report stipulated that electricity shall be supplied via an enhanced RGGVY (rural electrification) policy. Decentralised generation shall be supported through feed-in tariffs and tax rebates. Moreover, the setup of community-size biogas plants and the setup of women-run sustainable firewood plantations are advocated for.

Regarding cooking fuels, the Policy Report cautions against the relatively high costs of electricity for cooking, and promotes instead biogas as the only carbon neutral cooking fuel. It furthermore favours the widespread use and subsidy of LPG, and the abolition of subsidies for kerosene, as these subsidies have not been effective in making more kerosene available to lower income

[53] Ministry of New and Renewable Energy, 2015 and Ganesan & Vishnu, 2014, p. 68

groups. Instead, the difference in price between diesel and kerosene has led to a diversion of kerosene away from its intended purpose as mixing fuel with diesel, to the point that only 56% of kerosene actually reached people as PDS kerosene[54].

Overall then, we see that on the one hand, the geographical challenges due to dispersion are well addressed through the policies targeted at the rural population and specific target groups (e.g. women), the commercial and some of the technological issues such as low profitability and decentralised energy access have been recognised by the government and are addressed through targeted measures such as free electricity connection for households below the poverty line and the installation of off-grid renewable energy systems in remote areas.

On the other hand, Indian policymaking focuses on providing energy access without regard to the question of how sustainable the promoted energy sources are. This shows in the subsidy policies of LPG and kerosene, which are both harmful for the climate, although they have a better track record for particulate matter emissions than the traditionally used biomass. It is hence suspected that this choice has been made due to the positive health impacts of using these fossil-fuel based fuels.

Furthermore, the described political challenges of setting (unrealistically) ambitious universal access targets and a myriad of energy policies for the different fuels would benefit from better streamlining. This could be done by the preparation of one (or two) coherent policies for electricity and cooking fuels access, with realistic achievement dates and sustainability as major features. The recent shift towards a more unified "umbrella approach" for energy policy through the combination of one minister for the three key energy ministries, however, is a first positive sign in this direction.

[54] Indian Planning Commission, 2006, pp. 99-101

A. The global climate challenge

In order to better understand the interplay between energy access and climate changes, let us first remind ourselves of what constitutes climate change, from the scientific as well as the policy point of view.

Scientific results indicate that climate change is driven by variations of radiative forcings (either natural or anthropogenic). According to the IPCC's definition, "radiative forcing is a measure of how the energy balance of the Earth-atmosphere system is influenced when factors that affect climate are altered. The word radiative arises because these factors change the balance between incoming solar radiation and outgoing infrared radiation within the Earth's atmosphere. This radiative balance controls the Earth's surface temperature. The term forcing is used to indicate that Earth's radiative balance is being pushed away from its normal state"[55].

One natural forcing mechanism is ocean variability; consisting of either short-term (years to decades-long) fluctuations of ocean temperatures such as the El Nino Southern-Oscillation (ENSO) or long-term fluctuations, known as thermohaline circulation. Another mechanism consists of orbital variations, also known as the Milankovitch cycles. These cycles describe regular variations in eccentricity, axial tilt, and precession of the Earth's orbit at a scale of 21,000 to 41,000 years and that have an influence on the Earth's

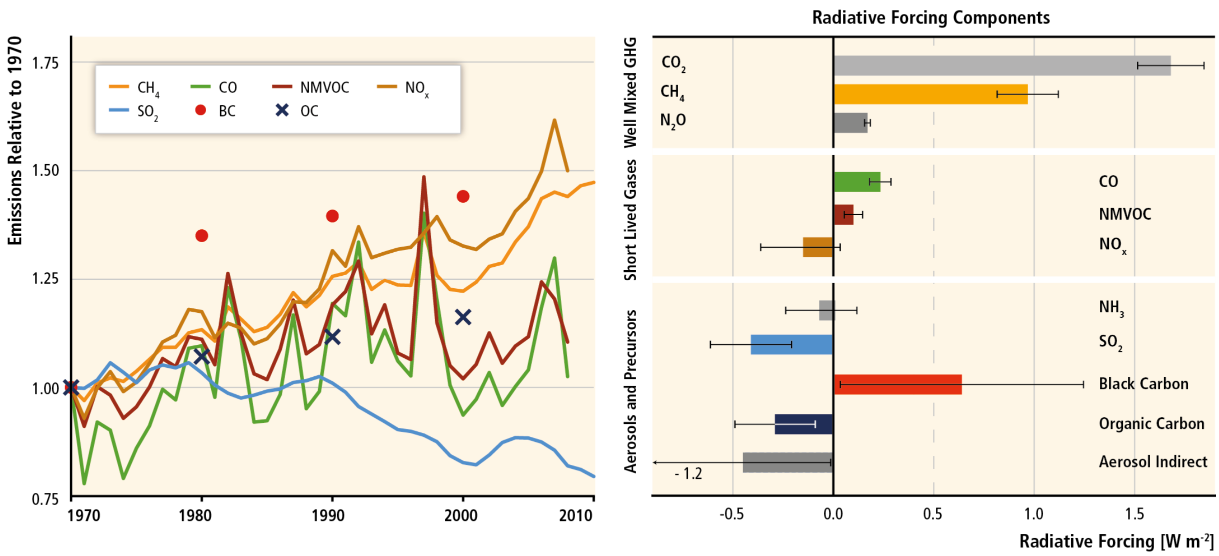


Figure 12: Anthropogenic greenhouse gases and the evolution of their emissions since 1970

Source: Blanco et al., 2014, Figure 5.4

[55] Forster et al., 2007, p. 136

climate. Other natural forcing mechanisms include variations in solar radiation, volcanic activity and plate tectonics.

Finally, human activities have been identified as the main cause of the currently observed global warming (global average temperature has increased by +0.85°C since the preindustrial era)[56]. These activities cause greenhouse gas (GHG) emissions; the four most important ones being:

- carbon dioxide (CO_2) (e.g. due to fossil fuel combustion for electricity generation, deforestation or industrial production processes such as cement production),
- methane (CH_4) (e.g. from agricultural production) – a GHG gas with a 25 times greater impact on the climate than CO_2,
- nitrous oxide (N_2O) (e.g. from livestock farming; especially manure); a gas with 298 times the global warming potential of CO_2)
- and the halocarbons (a group of gases containing fluorine, chlorine and bromine) – with a global warming potential of between 5 and 14,400 times that of CO_2, depending on the substance[57].

Besides these so-called "well mixed" greenhouse gases (see figure 13), gases that are only short-lived in the atmosphere (e.g. carbon monoxide) and aerosols and precursors (notably black carbon and sulphur dioxide (SO_2; both commonly from the combustion of fossil fuels for electricity generation or transport) have been identified as having an effect on radiative forcing and therefore the global energy budget.

As the concentration of these gases increases in the atmosphere, contributing to climate change, the impacts on the following areas are also estimated to become greater (Parikh & Parikh, 2002, pp. 5-7):

- Food production systems (geographical shift and decrease of agricultural productivity)
- Ecosystems (extinction of species, wildfires, ecosystems become a carbon source)
- Water resources (water scarcity, droughts, increased water availability in some regions)
- Oceans and coasts (Melting of polar ice caps, leading to sea level rise and reduction of sometimes densely populated coastal areas)
- Humans and Health (diseases, malnutrition, morbidity from heat waves, floods and droughts)
- Extreme weather events (hurricanes, stronger and more erratic precipitation, temperature extremes).

With this scientific background in mind, let us now have a look at how climate change is dealt with at the policy level. The first thing to point out here is that

[56] Based on measurements between 1880 and 2012. Source: IPCC, 2014b, p. 1
[57] Forster et al., 2007, p. 212

when discussing climate change in a political context, only the anthropogenic forcings are being tackled, as these are the ones that humans have an influence on. Thus, the United Framework Convention on Climate Change of 1992 defined it as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." (UNFCCC, 1992, art. 1.2)

Secondly, it is worth noting that the emissions from those halocarbons that are covered under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (CFCs and HCFCs) are not regarded under the UNFCCC framework that constitutes the global platform for climate policy (UNFCCC , 1992, art. 4.1), and vice versa.

The definition of which greenhouse gas should be dealt with by the UNFCCC has only been specified more clearly over time. According to the 1992 UN Framework Convention on Climate Change, greenhouse gases were those "gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation" (UNFCCC, 1992, art. 1.5). It is only in the Kyoto Protocol from 1997, which is the latest available legally binding document in the domain of climate change, that CO_2, methane and nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) are clearly named as the greenhouse gases to be accounted for (UNFCCC, 1997, Annex A). We notice then that apart from methane, short-lived climate substances such as black carbon are not currently being included in the scope of international climate policy.

In terms of objectives, with the Copenhagen Accord of 2009, Parties to the UNFCCC, including India, commit themselves (although not in a legally binding manner) to limit global average temperature increase to maximum 2°C above pre-industrial levels. According to scientific calculations as presented by the IPCC there is hence a need to limit global concentrations of CO_2-equivalent emissions to 450 ppm, in order to have a "likely" chance to remain below the two degree-target[58]. Albeit there may be some variations as to the exact concentration due to differing calculations of impact, at this present point in time humanity has likely already reached 420 ppm, or roughly 93% of the available "carbon budget" which should be respected in order to have a reasonable chance to prevent an augmentation of global average temperature beyond 2 degrees by 2100.

From an international policy perspective, however, the current phase is one of a "no man's land" with no legally binding targets in place, apart from those set up for the first and second commitment period of the Kyoto protocol for Annex 1 parties, which are inadequate for reaching the 2 degree target. The first commitment period of the Kyoto Protocol expired in 2012 and

58 IPCC, 2014b, p. 21

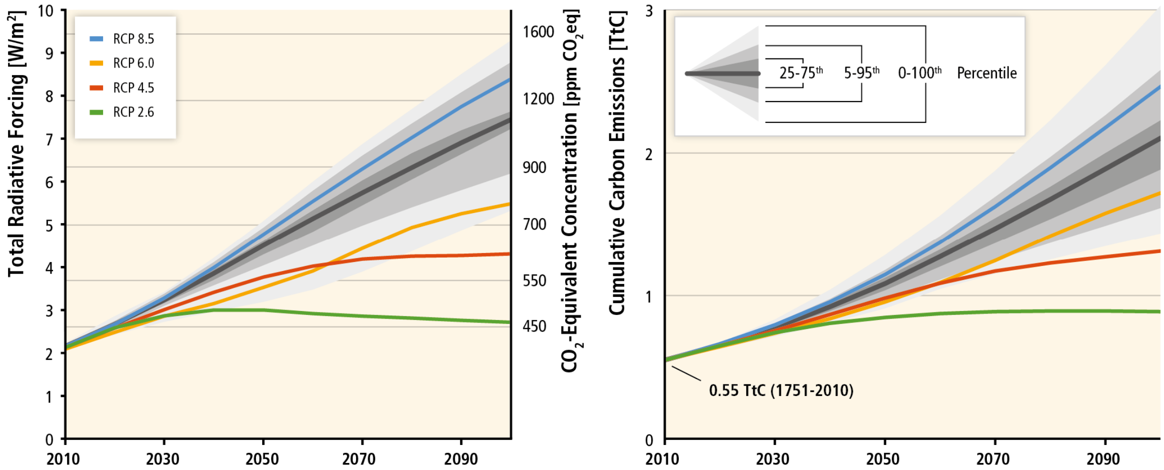


Figure 13: Projections of global emission trends depending on differing economic and energy-efficiency scenarios

Source: Kunreuther et al., 2014, Figure 5.4

the follow-up second commitment period, to be valid from 2013-2020 that was agreed on in Doha in 2012 is not in force yet as it is awaiting sufficient approvals by national governments[59]. The upcoming Conference of the Parties (COP 21) at Paris in December 2015 should see the conclusion of a new legally binding agreement for the medium-term, i.e. the period after 2020.

Depending on the results of the Paris Agreement and on national policies chosen for economic, energy and environmental development, as well as the inclusion of which types of emissions will be decisive for what the emission scenarios for the coming 70 years or so will look like, as figure 14 illustrates.

In the current scenario before the submission of the new emission reduction pledges of the major emitting countries, including emerging economies like India, ahead of the Paris Conference in December 2015 the UNEP "Gap Report 2014" calculated an "emissions gap" of 14 to 17 gigatons of CO_2-equivalent. This means that there may be up to 17Gt of GHG emissions emitted in excess of what is estimated to be compatible with the two degree target (see figure 14). However, the report insists, it is still possible to close this gap; in fact, already one third of emissions gap could be closed by the additional new Paris pledges of great emitters such as the USA, China and the EU alone.

[59] According to Article 20, paragraph 4, the amendment will only enter into force after at least three fourths of the Parties to the Kyoto Protocol (i.e. 144 parties) have accepted it. As of May 2015, only 32 countries had ratified the Doha Amendment.

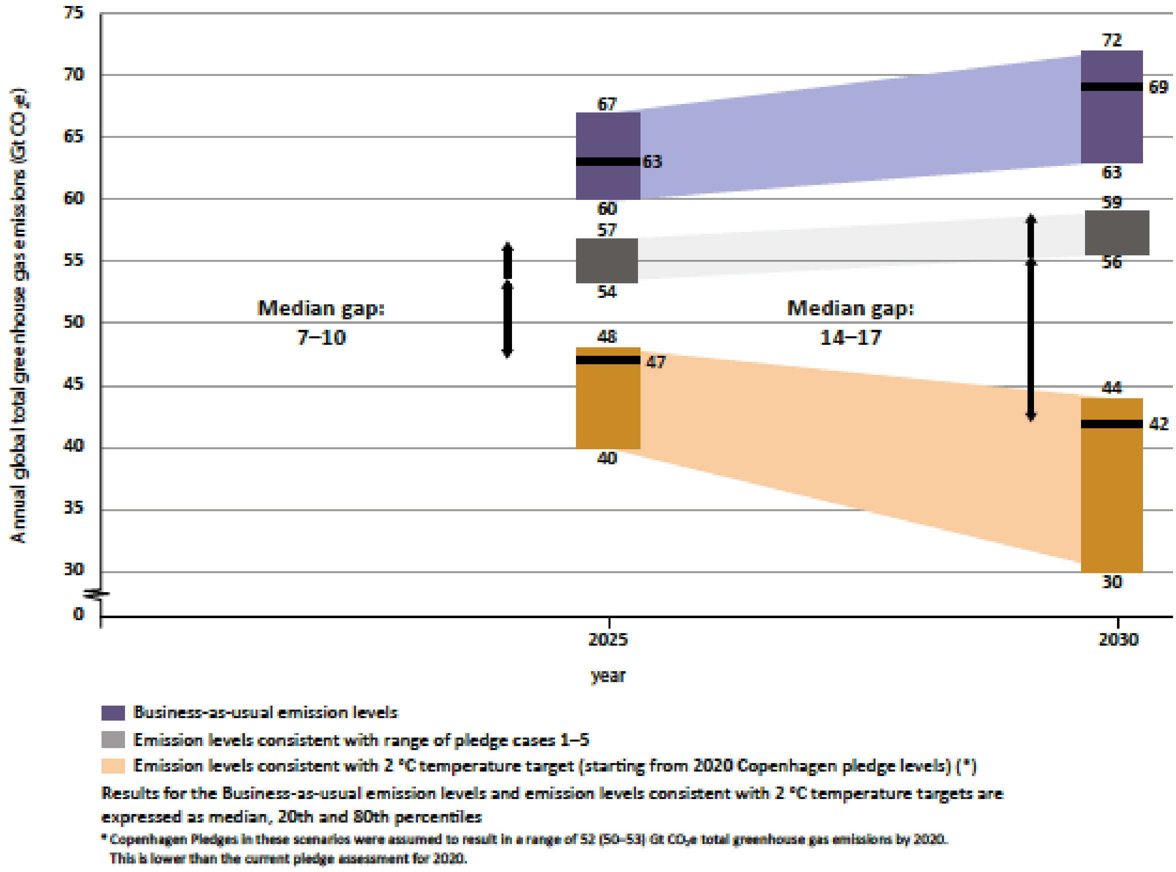


Figure 14: The projected emissions gap in 2030

Source: UNEP, 2014

Overall this means that in practice an equivalent of an estimated amount of 42 gigatons of CO_2-equivalent ($GtCO_2$-eq) emissions can be emitted until 2030, compared to global emissions which were already at approximately 50 $GtCO_2$-eq in 2010 (WRI, 2014).

B. India's role in the climate challenge

1. Contributing increasingly to the problem…

In the following, we will explore how India fits into the global climate picture, and, based on that, we will look at how the country is acting based on this knowledge.

Already today, India is the third largest emitter of CO_2, along with China and the USA. Owing to the size of their populations and/or their large consumption of energy sources these three countries alone are responsible for roughly 44% of global emissions (see Annex II). While India's share of global GHG emissions is still far behind the US and China (with 6% compared to 15% and 23% respectively), the fact that its economy is growing at steadily high rates mean that India's share of responsibility for growing emissions is becoming ever greater. In absolute numbers, emissions from fuel combustion stood at 1,954 $MtCO_2$-eq in 2012, up from 580.5 $MtCO_2$-eq. in 1990[60]. In relative terms, this means that India's emissions more than tripled between 1990 and 2013. According to a 2009 study commissioned by the Indian Ministry of Environment and Forests that compares the results of 5 Indian studies on the projected emissions until 2030, emissions are projected to grow from 4,000 $MtCO_2$-eq to 7,300 $MtCO_2$-eq, depending on the model used[61].

Figure 15 shows the results of similar research carried out by three international research institutes (the Netherlands Environmental Assessment Agency (PBL), International Institute for Applied Systems Analysis (IIASA), and Potsdam Institute for Climate Impact Research (PIK)). They also prepared medium-term projections until 2030 lying between 7,229 $MtCO_2$-eq (PIK model) and 8,060 $MtCO_2$-eq (IIASA model)[62]. The projections of the eight models, which all assume no new GHG mitigation policies will be added to the current ones, thus all span between a doubling to a quadrupling of today's emissions within the next 15 years. In the optimistic case this would mean that India's share of global GHG emissions would rise to 18%, in the pessimistic case to 21% of global emissions by 2030-2035[63]. This is comparable to the projected emissions of the other major emitters China (21.9-27.4%) and OECD countries (27.3%) and would mean that these three regions alone would be responsible for two-thirds of all global emissions[64]. While this list of "top emitters" is composed of the same countries already today, India is the one country that would be taking up a much greater share of emissions, while OECD countries would see a decline in their emissions.

Despite this potentially stark increase of overall emissions and therefore responsibility for climate change, India insists that its emissions per capita until now remain among the lowest in the world, and will continue to do so in the coming two decades. Indeed, projections under the Ministry of Environment study cited above vary between 2.77 tCO_2-eq and 5 tCO_2-eq for 2030. This amounts to an increase of today's rate of almost twice to more than three

[60] IEA, 2014d, p. 38
[61] Climate Modelling Forum, 2009, p. 6
[62] WRI, 2015
[63] Calculation based on global emissions using the IEA's 450 Scenario and the New Policies Scenario, in which global emissions would be 21,568 Mt CO_2 and 37,242 Mt CO_2 respectively by 2035 (source : IEA, 2014a, p. 47).
[64] IEA, 2014a, p. 47

times[65]. Yet, already today the global average CO_2 emission rate per person is 4.51 tCO_2-eq, with China emitting 6.08 tCO_2-eq and the USA 16.15 tCO_2-eq[66].

With these figures in mind, India has a strong argument in favour of a relaxed approach towards curbing its emissions in international climate negotiations, as its emissions are far below the emissions of any similar country, whether in terms of population and size and development level (China), highest overall GHG emissions (USA) or with regard to the global average per capita emissions.

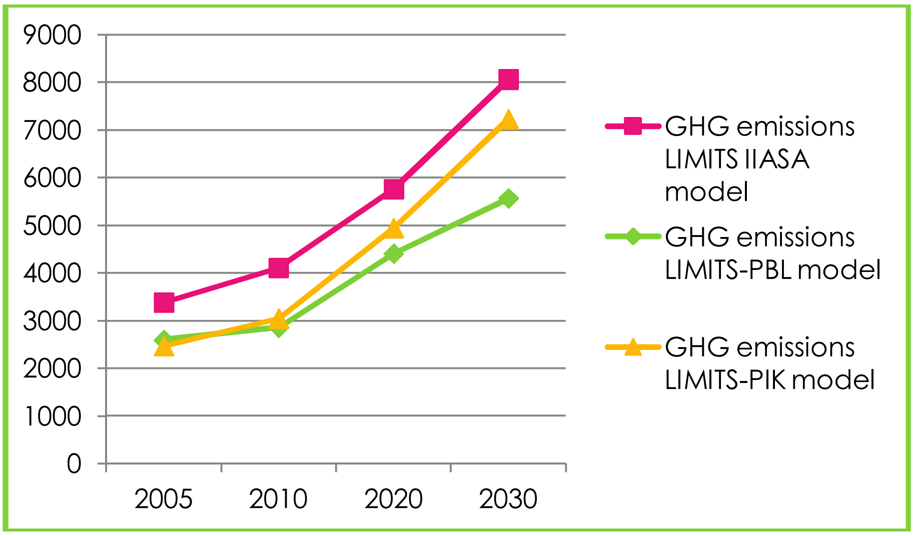


Figure 15: GHG Emissions with Land-Use Change and Forestry (in $MtCO_2$-eq) for India, 2005-2030

Source: WRI, CAIT 2.0. 2015

While India fares well in international comparisons on long-lived GHG emissions, it tops the list regarding short-lived emissions such as carbon monoxide, black carbon and particulate matter (PM2.5 and PM10) in urban regions. Thus, 6 of the top 10 cities in the world with the highest concentrations of PM_{10} are in India, with New Delhi topping the list (Ambient Air Pollution Database, WHO, May 2014). PM_{10} and $PM_{2.5}$ can lead to premature deaths and adverse health effects such as respiratory infections, heart disease and lung cancer (WHO, 2014).

On the national scale, according to calculations prepared by Ramachandra & Shwetmala (see figure 16) direct CO_2 equivalent household emissions from fuel combustion are responsible for 9% of all Indian GHG emissions[67]. However, since indirect emissions from electricity consumption are not counted under

[65] up from 1.58 tCO_2-eq per capita in 2012; Source: IEA, 2014a, p. 53
[66] IEA, 2014a, p. 49 (world, China), p. 57 (USA)
[67] The Indian Network for Climate Change Assessment (INCCA) calculate the contribution of the residential sector to be roughly 8% of total emissions, which is close to the mentioned estimate (INCCA, 2010, p. 13).

domestic emissions in this study as its production is listed as a separate sector, the actual share is somewhat higher. With the residential sector accounting for 25.87% for all electricity demand (CEA, 2013, cited in Garg et al. 2014, p. 568) and around 69% of all electricity production (see figure 7) is fossil-fuel based, the real emissions of the domestic sector including direct and indirect emissions are therefore around 13%.

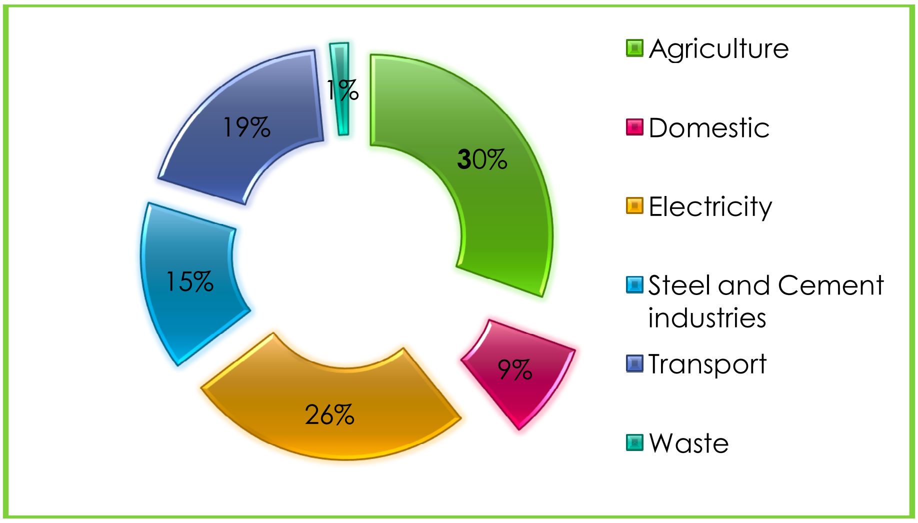


Figure 16: Total CO_2 equivalent emissions (Gg) by economic sector and energy source per year

Source: Ramachandra & Shwetmala, 2012, p. 5830

As we have seen in chapter II, the total energy consumption in terms of both cooking fuels and electricity in urban households is higher than in rural ones. In order to evaluate the impact on the climate, GHG emissions from consumption in urban households have hence been calculated for various cities across India and in other countries (e.g. Sovacool & Brown, 2012), as Ramachandra demonstrates for Delhi (11,690.43 Gg of CO_2 equivalent).

A comparison with emission rates by Kumar & Viswanathan in rural areas reveals that per capita carbon dioxide equivalent emissions in rural areas are half as high as those of urban dwellers (0.19 CO_2-eq tons/year in rural areas compared to 0.37 CO_2-eq tons/year in urban areas[68]). As a reason, Kumar & Viswanathan cite the differing household energy consumption patterns in both areas.

Yet, overall, total rural CO_2-equivalent emissions are more than one and a half times greater than urban emissions, with 138 million tons/year compared to 85.6 million tons/year in cities (see table 3). This is due to the large amount of

[68] 2004-2005 figures. Source: Kumar & Viswanathan, 2011, p. 12

biomass which is used for cooking in rural households. Striking is also the large difference between air pollution in rural and urban environments: Inhabitants of more remote areas are eight times more exposed to PM emissions due to biomass and kerosene combustion than their peers who live in urban areas. This puts rural inhabitants at much greater risks related to their health, as discussed above, while also exposing them to the regional impacts of climate change due to particulate matter pollution, which can arise due to the modification of cloud cover ("brown clouds") and the change of albedo in snowy regions such as the Himalayas (Ramanathan & Carmichael, 2008).

	Rural	Urban	All-India
Total emissions			
PM (000 tons/year)	806.4	103.0	908.4
CO_2 (million tons/year)	50.2	24.6	74.8
CO_2-hh (million tons/year)	102.0	81.4	183.6
CO_2-eq (million tons/year)	138.0	85.6	224.4
Per capita emissions			
PM (kg/year)	1.12	0.44	0.95
CO_2 (tons/year)	0.07	0.11	0.078
CO_2-hh (tons/year)	0.14	0.35	0.19
CO_2-eq (tons/year)	0.19	0.37	0.24

Table 3: Household emission profile of rural and urban areas in India

Source: Kumar & Viswanathan, 2011, p. 12

Note: PM – particulate matter, CO_2 – carbon dioxide from cooking fuels; CO_2-hh – carbon dioxide from cooking fuels (including 10% of firewood emissions to reflect the non-sustainable harvesting rate of this fuel[69]) plus electricity consumption; CO_2-eq – greenhouse gas emissions from cooking fuels and electricity consumption, expressed in carbon dioxide equivalent terms

We can see from the above that on the global scale, India may be one of the top actors already today in terms of climate-relevant emissions, however, what gives it leeway for international climate negotiations is the fact that its

[69] Normally, biogenic CO_2 emissions (from biomass combustion) are counted as carbon-neutral, i.e. without impact to the climate, as they are part of the natural carbon cycle, unless they are unsustainably harvested. In India, a conservative estimate of unsustainable harvesting is 10%; other studies estimate between 20%-40% of non-sustainable harvesting of firewood, resulting in a higher share of CO_2 emissions (e.g. Reddy and Balachandra, 2006). Consequently, for our purposes, following Kumar & Viswanathan's approach, 10% of biogenic emissions from unsustainably harvested sources are also counted as part of the emission balance of households, in order to have a more accurate picture of the emission balance.

national consumption of energy and resulting emissions are still very low by international comparisons.

Also, the national statistics on consumption and household-level emissions hide the stark contrasts between urban and rural areas. High carbon intensity[70] per person due to larger coal-fired electricity consumption in cities is contrasted with low carbon intensity in villages (0.37 CO_2-eq tons/year in cities compared to 0.19 CO_2-eq tons/year in rural areas), but on the other hand rural areas suffer significantly more from the impact of local air pollution as a result of the large biomass consumption – their PM emissions per year are eight times as high as in urban areas.

2. … and to the solution?

a) National Indian Climate Policy

Bearing in mind the relatively comfortable negotiation situation India has regarding its historic and present-day responsibility for climate change, how does its national and international climate policy spell out in practice?

On the national level, climate policy is being defined by the Ministry of Environment, Forest and Climate Change. The fact that the portfolio of climate change has been added in the title of the Ministry of Environment and Forests under the new government since 2014 is an indication that climate policy is becoming a key issue for Indian policymaking[71].

In practice, climate policy is articulated around the National Action Plan for Climate Change (NAPCC). Launched in 2008 by the Prime Minister's Council on Climate Change, the NAPCC is inscribed under India's overarching objective of achieving a "sustainable development path that simultaneously advances economic and environmental objectives" (NAPCC, 2008, p. 2).

Out of the seven guiding principles of the NAPCC, the first five point towards the provision of energy access to be as clean as possible. They are as follows:

- "Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change".
  This principle can be read as focusing on the provision of energy access for the poor through the use of fuels which do not harm further the climate, i.e. which are low-carbon.

[70] Carbon intensity is defined as the "amount of carbon by weight emitted per unit of energy". Source: http://www.epa.gov/greenpower/pubs/glossary.htm
[71] Greenpeace, 2014, p. 4

- "Achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of greenhouse gas emissions".
  It is interesting to note here the strong connotation of the expression "change of direction" in favour of the use of low-carbon fuels for energy generation and consumption. However, this change is of a qualitative nature, rather than on a quantitative one, implying an increase of low-carbon sources of energy without threatening the quantitative predominance of carbon-intensive fuels, especially coal.
- "Devising efficient and cost-effective strategies for end use Demand Side Management"
  Under this principle, regarding energy access the focus is on the improvement of efficiency of fuels and cook stoves as well as of other measures such as the use of energy-efficient appliances and light bulbs.
- "Deploying appropriate technologies for both adaptation and mitigation of greenhouse gases emissions extensively as well as at an accelerated pace".
  On the mitigation side, this principle reflects the rapid deployment of less carbon-intensive fuels such as Renewable Energy Sources and nuclear energy in order to achieve universal energy access for the population. Regarding adaptation technologies, CCS and CCT technologies to mitigate the climate impact of the widely used coal are the most prominent ones envisaged.
- "Engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development" (NAPCC, 2008, p. 2).
  Here, cooperation of public and private partners, cooperatives and private local and international initiatives for enhancing energy access at a decentralised level are favoured. This principle is of particular interest for remote areas where central grid connections are too cost-intensive for the state to implement.

The remaining two principles refer to the importance of cooperation of the different actors in society, such as civil society and local governments, as well as to international cooperation in terms of research and development and the transfer of technologies in the framework of the UNFCCC.

Beyond these guiding principles, the NAPCC is composed of eight National Missions or thematic areas which focus on several aspects of climate change mitigation and adaptation. They are:

1. Jawaharlal Nehru National Solar Mission. Its objective is to "establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible".
2. National Mission for Enhanced Energy Efficiency. Its objective is to "achieve growth with ecological sustainability by devising cost

effective and energy efficient strategies for end-use demand side management".

3. National Mission on Sustainable Habitat. Its objective is to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste including recycling and power generation, modal shift towards public transport and conservation".
4. National Water Mission. Its objective is to "conserve water, minimise wastage and ensure equitable distribution both across and within states through integrated water resources development and management".
5. National Mission for Sustainable Agriculture. Its objective is to "transform agriculture unto an ecologically sustainable climate resilient production system while at the same time, exploiting its fullest potential and thereby ensuring food security, equitable access to food resources, enhancing livelihood opportunities and contributing to economic stability at the national level".
6. National Mission for Sustaining the Himalayan Ecosystem. Its objective is to: "evolve management measures for sustaining and safeguarding the Himalayan glaciers and mountain ecosystem and mountain ecosystem and attempt to address key issues namely impacts of climate change on the Himalayan glaciers, biodiversity, wildlife conservation and livelihood of traditional knowledge societies".
7. National Mission for a Green India. Its objective is to "use a combination of adaptation and mitigation measures in enhancing carbon sinks in sustainably managed forests and other ecosystems, adaptation of vulnerable species/ ecosystems, and adaptation of forest-dependent communities".
8. National Mission on Strategic Knowledge for Climate Change. Its objective is to "identify the challenges and the responses to climate change through research and technology development and ensure funding of high quality and focused research into various aspects of climate change" (MoEFCC, 2014, pp. 4-11) .

The most important Mission in connection with the issue of energy access is the National Solar Mission, of which the ambition has been raised since its creation in 2008. Thus, in November 2014, the Indian government announced that instead of the initially planned 20 GW it would deploy 100 GW of installed solar capacity by 2022. This includes the installation of 40 GW of grid-connected solar rooftop systems that have just been approved by the government[72]. In addition, 2 GW of off-grid applications, 20 million square metre of solar thermal collector area as well as 20 million solar lighting systems are planned to be deployed by 2022 under this Mission" (MoEFCC, 2014, p. 4).

The National Solar Mission has thus the potential, together with other initiatives for low-carbon energy supply such as the proposed National Wind Mission (see below), to lower the carbon intensity of India's electricity production. In

[72] MNRE, 2015b

other words, it will help to use less carbon-emitting fossil fuels and lower the so-called "emission factor" of the energy sector in India[73]. This in turn will have positive consequences for keeping the emissions balance of the country in check in light of soaring energy demand of the developing economy. Between 1990 and 2012, India's carbon intensity decreased from 0.41 to 0.35 kg CO_2/GDP PPP. This figure is comparable to the US's 0.36 kg CO_2/GDP PPP, and well below China's 0.63 kg CO_2/GDP PPP[74]. The challenge for India will be to maintain or even lower this indicator in the future.

Having set the above-mentioned national objectives, they are then translated into State Action Plans for Climate Change (SAPCC) in the federal states. Up until December 2014, 30 of the 36 states and Union Territories had prepared their SAPCC.

A National Clean Energy Fund, funded by a "carbon tax" on coal, was set up in 2010 to finance and promote clean energy initiatives and funding research in this field. This carbon tax, called the "coal cess", applies to domestically produced and imported coal and raises 100 INR per ton (approx. € 1.50). For the Budget 2015-2016 an increase of the cess to 200 INR has been proposed, which is supposed to finance the increased ambition of the National Solar Mission to increase solar capacity to 100 GW[75].

Since its existence, a total of 46 projects with a total value of 2.75 billion US$ (2014 figures) have been approved for funding (MoEFCC, 2014, p. 13). While still modest in terms of amount taxed, the coal cess is an important contribution towards raising additional finance for the development of clean energy sources in India. However, in view of the fact that the cess is being charged to the consumer[76], the equitability of such a tax is questionable, as the poorer households are potentially as much affected as the richer households. In a context where energy access is still widespread this could worsen the success of any electrification efforts such as with the Rural Electrification Policy.

A smaller National Adaptation Fund was also set up in 2014. The 16.67 million US$ (INR 1 billion) allocated to it so far are destined to cover the "cost of adaptation measures in areas that are particularly vulnerable to the adverse effects of climate change" (ibid).

Secondly, the National Mission for Enhanced Energy Efficiency is also relevant for climate mitigation measures and could affect energy access, as energy efficiency measures in households that are already connected to the electricity grid and use electricity for lighting, household appliances and ICT

[73] An emission factor is defined by the UNFCCC as the "average emission rate of a given GHG for a given source, relative to units of activity". Source: UNFCCC, http://unfccc.int/ghg_data/online_help/definitions/items/3817.php
[74] IEA, 2015a-c
[75] Press Trust of India, 2015
[76] Ibid.

and communication means can save precious energy. This in turn could free up power capacity as final power demand would be reduced. This would lead to a lower energy intensity rate per person and therefore a lower demand and less funds necessary for the installation of new power generation capacities. The rate of annual residential electricity demand growth which the NAPCC cites (8.25% between 1990-2003) could thus be lowered. The lower demand growth would give utility providers and the governmental institutions that provide the funding more flexibility to extend the current grid to so-far unconnected populations.

Thirdly, the National Mission for a Green India is also worth mentioning in the context of GHG mitigation policies in relation to energy access, insofar as the Greening India Programme is working for the sustainable management of forests and the creation of carbon sinks. The Programme foresees a reforestation of 5 million hectares of degraded forest land and an improvement of the quality of another 5 million hectares of forest/non-forest land and plans to cover a total of one third of the surface of India with forest[77] (NAPCC, 2008, p. 34). The current forest area in India is around 69 million hectares, representing 21% of the total area. Of these, 45% are degraded forests (Pandey, 2010, p. 31). It can thereby contribute to reducing the percentage of unsustainably used firewood (estimated to be between 10% and 40% as we have seen previously) in the biogenic carbon emission balance, although this also only partially, if one considers that only about 20% of firewood used by households comes directly from forests[78].

Regarding the overall emission balance accounted for under the UNFCCC framework, these afforestation measures are included under the category LULUCF (land use, land use change and forestry). Additionally, this type of measure is eligible under the REDD+ mechanism of the UNFCCC[79].

Not only may it be helpful in sustaining the basic energy needs for cooking of the poorest sections of the population, but also this National Mission, if managed sustainably, could make a contribution to the provision of clean energy in the form of electricity generated from wood and partial replacement of fossil fuels as source, as suggested by Pandey (Pandey, 2010, p. 24). This would also complement the National Policy on Biofuels of 2009.

Finally, the 2014 "Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth" of the Indian Planning Commission suggests that a

[77] The Integrated Energy Policy of 2006 talks about only 6 million hectares of degraded forest land to be afforested (IEP, 2006, p. 34).
[78] This is an equivalent of 52 million cubic metres of wood. The remaining 209 million cubic metres come from farmland, community land, homesteads, roadsides, anal sides and other wasteland. Source: NSSO, 2009 cited in Pandey, 2010, p. 31
[79] Since the Cancun Agreement (COP16) in 2010, REDD, which was first focused on reducing emissions from deforestation and forest degradation, became REDD+ and now includes actions that target the reduction of emissions from deforestation and from forest degradation; the conservation of forest carbon stocks; the sustainable management of forests as well as the enhancement of forest carbon stocks. Source: http://theredddesk.org/what-is-redd#toc-2

National Wind Mission should be created in order to provide the wind energy sector with the required impetus for development (Planning Commission, 2014, p. 85). It can be estimated that the objective for such a Mission would be to achieve around 50-100 GW by 2022 or a similar time horizon, to be aligned with the National Solar Mission or medium-term development goals.

As we can see from the above, the National Solar Mission for decentralised solar energy access is the most powerful contributor to reducing the carbon intensity of electricity production and sustainable energy access in general, while the National Missions for Enhanced Energy Efficiency and for a Green India have more indirect impacts, through the liberation of resources for the extension and sustainability of the electricity grid and for the provision of (traditional) cooking fuels respectively. Lastly, should the National Wind Mission become reality, it would be a strong signal both for boosting domestic investment as well as for underlining any future international climate commitments.

b) International Indian Climate Policy

(1) The pre-2020 ambition

The previous section has illustrated that despite its comfortable position in terms of GHG emissions compared to other nations, India's national climate policy is tackling various fronts such as renewable energies, energy efficiency and reforestation to mitigate its impact on the global climate. On the international scene too, India is an active player in the global climate regime. It is a signatory to the UN Framework Convention for Climate Change; it also ratified the Kyoto Protocol in 2002 and it has agreed to the Copenhagen and Cancun agreements in 2009 and 2010 respectively. However, as it is considered a developing country and therefore it is listed under the so-called "non-Annex I countries" there is currently no formal obligation for India to limit its GHG emissions as is the case for "Annex I countries", i.e. those countries that are considered to be developed.

Despite this, India has voluntarily committed itself at the Copenhagen Climate Summit in 2009 to a concrete emission reduction target; it pledged to reduce the emissions intensity of its GDP by 20-25% by 2020 based on 2005 emission levels. This will be done through the abovementioned increase of forest cover to sequester 10% of its annual emissions; the increase of the share of electricity derived from renewable energy sources (mainly wind, solar, small hydro and biomass) from the current 13% to 20% by 2020, through the increase of fuel efficiency standards and through the adoption of building energy codes. The country also committed itself to not having higher per capita emissions than the average per capita emission rate of developed countries (Indian Planning

Commission, 2014, p. 11). As the Indian government just approved a plan to ramp up its ambition to install 100 GW of solar power by 2022 instead of the initially targeted 20 GW under the National Solar Mission (Government of India, 2015), future international voluntary climate commitments (INDC, see below) could well see an increase of ambition of this emission intensity target. This could be the case even if the target is not fully achieved by that date, thanks to other emission intensity reduction measures.

It is worth noting though that India also insists that “emissions from the agriculture sector would not form part of the assessment of its emissions intensity” and that “the proposed domestic actions are voluntary in nature and will not have a legally binding character”[80]. In other words, approximately 17% of the country’s total GHG emissions are not included in the emission count[81], and India cannot be held accountable in case it does not achieve its self-set target.

On the practical implementation side of international climate policy, India is the world's biggest recipient of climate-related development aid, with a total of 2.8 billion US$ committed in 2013 for climate mitigation actions (OECD, 2015). According to the same source, globally, 28% of the climate-related development aid goes to energy generation and supply, which – assuming the Indian sectoral split is similar to the global one – can have an important impact on the provision of energy access.

Moreover, India is also the second most active country after China in the international exchange system between developing and developed countries of emission rights against climate mitigation and adaptation projects, also known as the CDM (Clean Development Mechanism) project market.

Thus, by July 2015, 2217 CDM projects in India were approved by the UNFCCC, with more than 75% of them being in the renewables sector[82]. This number of projects equates to 11.4% (or 113,033,967 t CO_2-eq) of the total generated certified emission reductions (CERs) by the CDM mechanism[83].

A look at the CDM projects by state reveal a very uneven distribution, with the four states of Tamil Nadu, Maharashtra, Gujarat and Rajasthan being responsible for over half (54%) of all projects in India[84]. This fact points towards greatly differing state policies regarding CDM projects, resulting in clear variations in impact of these projects. Since CDM projects aid in the deployment of clean energy sources in India, the applicable state policy on

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[80] UNFCCC, 2015

[81] Source : INCCA, 2010, p. 43

[82] UNEP DTU, 2015

[83] Out of a total of 991,526,024 tCO_2-eq (figures as of 30/6/2015). Again, with this India is second only behind China, which is expected to generate 60.1% of all global CERs. Source: http://cdm.unfccc.int/Statistics/Public/index.html

[84] Ibid.

CDMs can have some implications for energy access, especially for rural areas.

(2) India's Post-2020 climate objectives – The INDCs and beyond

2015 is set to become an important date for international climate politics. At the 21st Conference of Parties (COP 21) in Paris in December 2015 the 195 signatories of (Parties to) the UNFCCC should conclude a new, legally binding and universally applicable international climate agreement for the period after 2020. This will be done to reflect changing economic realities since the UNFCCC was adopted during the Rio de Janeiro Earth Summit in 1992.

The UNFCCC entered into force in 1994. In 1997, the Kyoto Protocol to the Framework Convention is the first legally binding document which commits developed countries to adopt emission reduction targets. The Protocol, to which 192 Parties adhere, has two commitment periods: the first one started in 2008 and ended in 2012 and the second commitment period began in 2013 and will end in 2020.

In order to include a commitment from all Parties in the new Paris Agreement, it has been decided at the COP19 in Warsaw[85] to have each state propose national commitments on mitigation and, if so wished, adaptation actions. These national commitments are applicable to all countries, even if they are not defined as an "Annex I" country, and are referred to as Intended Nationally Determined Contributions (INDCs).

At the time of writing (summer 2015), India has not yet submitted its INDC for Paris, despite the invitation of the COP secretariat at COP 19 to provide the INDCs "well in advance of COP 21 (by the first quarter of 2015 by those Parties ready to do so)". With seven out of the top ten global emitters already having submitted their national commitments, including China and the USA, the contribution of India as the second most populous country will give an important indication regarding the chances of success for the Paris climate negotiations. Even more importantly, the Indian INDC will provide a clearer picture as to the chances of the world's climate to stay below the agreed 2°C above pre-industrial level-limit that the international community has set itself.

Although the actual INDC has not been communicated yet, the issues that are important for India and that are therefore likely to be reflected in the INDC are clear. The Indian INDC will probably have as the main priorities a balanced approach between mitigation and adaptation, in line with the

[85] UNFCCC, 2014, p. 4 (art. 2b)

view of many developing countries which request additional international financing to be made available for adaptation costs. This is due to the fact that the countries least responsible for climate change, i.e. the poorest countries, are also going to be the countries that may suffer worst from its effects. Consequently, this is going to be very costly for their respective economies, e.g. in case of more regular natural disasters happening, which developing countries would like to be compensated for. Thus, already in the NAPCC India spelled out the minimisation of "negative impacts of climate change through suitable adaptation measures in the countries and communities affected and mitigation at the global level" as one of the country's main climate objectives (NAPCC, 2008, p. 52).

It is furthermore well possible that the INDCs would also "project the requirement of support in terms of finance, technology transfers and to some extent capacity building requirements"[86], reflecting the other three main topics that are typically discussed and claimed for by developing nations in international climate negotiations.

In terms of content, India's INDC is going to be consistent with national climate, energy and environmental policy and focus on energy access, energy efficiency and the inclusion of environmental externalities, with concrete targets "drawn from all the National Missions and other initiatives under the National Action Plan on Climate Change (NAPCC) as well as State Action Plan on Climate Change (SAPCC) and targets set by the government" as well as by other international bodies, such as the sustainable development goals (SDGs).

In terms of form, the INDC is "likely to come in two parts: an unconditional pledge and an outline of what more could be achieved with international finance and technology support"[87]. Together with many other developing countries, India is a strong advocate for the principle of common but differentiated and respective capacities (CBDR-RC)[88]. While this principle enshrines the historic responsibility of developed countries for climate change, it also concedes that all Parties to the UN Climate Convention should contribute to mitigating its global impact.

We can see from the above that India's position in the international climate negotiations is that of an ambitious developing country. This implies that it defends the principle of CBDR-RC with all its financial and technological implications (i.e. it advocates for a financial and technology transfer from developed countries). India's active involvement in the CDM mechanism and in international climate finance for development testifies to its position; it also proves that developed countries' hear what India asks for.

[86] according to a recent presentation of the Indian Environment Secretary Ashok Lavasa. Source: Mohan, 2015
[87]Roy, 2015
[88] NAPCC, 2008, p. 52

Overall then, owing to its size and economic importance, India has the potential to become a key leader of developing countries in the upcoming rounds of climate negotiations for a post-2020 agreement to achieve global consensus at the Paris Conference of Parties (COP 21) in December 2015. However, with the current pledges for emission reductions put forward by seven of the ten greatest GHG emitters the global objective of remaining below the 2°C increase is not likely to be achievable[89].

[89] With current pledges from Annex I countries standing at 10-15% below 1990 emission levels in 2020, when 25-40% reduction are needed according to IPCC GHG reduction recommendations. Source: UNEP DTU, 2015b

IV. The climate impact of the provision of universal energy access

Next we will explore what the impact that the universal provision of energy access might have on climate change.

In order to answer this question, it is first of all worth noting that in view of overall economic development in India and across the world, energy production and consumption and therefore also CO_2 emissions are projected to grow (IPCC, 2014, p. 431; IEA, 2014c, pp. 86-93), at least until around 2020, at which point, depending on international mitigation efforts, the global peak could be reached (figure 13). Depending on the type and amount of pollutants released, this rise of previously locked-up carbon emissions is likely to have an impact on the natural carbon cycle as well as on the overall climate system. This may have as a consequence that even those countries that contribute comparatively little to climate change may suffer from its effects. As we have seen above, in fact the model projections of the IPCC indicate that it is indeed the countries with least carbon-emitting activity, i.e. developing countries, which are likely to feel the greatest impact. This puts India’s good performance in terms of climate and energy intensity indicators in a different perspective: Even if in relative comparison with other emitters the country does well, in absolute figures the emissions produced are nevertheless of a great magnitude. It is therefore important to ask the question how energy demand is likely to evolve in India until 2030, when “Sustainable Energy for all” should be achieved. In this respect, it is also essential to analyse how the carbon intensity or emission factor is going to develop in light of the growing demand. We will now take a closer look at these.

Firstly, we have seen that there are very different consumption patterns of energy according to whether the place of residence is in a rural or urban area. Of course, these consumption patterns are strongly linked to the available income, which explains the large predominance of use of freely available biomass in rural and poorer urban areas for cooking purposes. However, we have also observed that although income is an important factor determining the choice of fuel for cooking, some socio-cultural factors such as preference are also important in making fuel choices at household level (Joon et al., 2009). Not only that; according to Reddy et al. "the energy usage pattern among Indian households has a clear linkage with poverty, living conditions, health, education, gender and livelihoods" (Reddy et al., 2009, p. 4655).

Nevertheless, it has also been shown that even the people with the lowest income in society spend some of their income on meeting their household energy needs. In 2009-2010, the National Sample Survey Organisation (NSSO) of India found that around 8% of average household expenses are used for lighting and cooking[90].

What then are the prospects for universal energy access by 2030?

Since most urban dwellers are connected to the electricity grid and have generally better access to alternative cooking fuels than the rural population, their consumption patterns can be taken as an indicator of future consumption on newly connected rural areas. As we have seen, this indicates a shift from biomass (mainly firewood) in favour of several other sources of energy; namely electricity, kerosene and LPG. This tendency is positive insofar as these energy sources are more efficient combustion fuels than biomass. Since their carbon emissions are higher than biomass, however, from a climate point of view they are not the ideal solution. As table 2 revealed, there is only one cooking fuel which has both low emissions and high combustion efficiency, and that is biogas. Since this one fuel cannot fully replace the more polluting cooking fuels the challenge is to find the optimum energy mix which is available, affordable and low in carbon emissions.

Regarding overall energy demand, Ganesan et al. (2014) forecast an increase of most of the currently used fuels, whether it is traditional biomass, LPG/PNG or electricity; only kerosene is deemed to reduce further in popularity (see table 4 below). Indeed, total household energy demand is estimated to rise from 153 million tons of oil equivalent (mtoe) to 240 mtoe in 2031.

Year	Solid (=biomass)	Gas (=LPG/PNG)	Liquid (=kerosene)	Electricity	Total mtoe	Population (million)	GDP growth rate
2011 (data)	123.48	12.48	5.75	16.20	158	1.201	–
2011 (back cast)	115.15	14.48	5.32	17.90	153	1.201	–
2016	120.62	17.35	6.75	26.24	171	1.278	8.5
2021	124.30	23.30	7.56	32.30	187	1.370	8.4
2026	128.89	29.20	5.45	45.90	209	1.439	8.2
2031	141.20	34.50	4.78	59.07	240	1.523	8.0
Percentage of total household energy demand in 2031	59%	14%	2%	25%	100%		

Table 4: Future household energy consumption in India, breakdown by fuel type, (2011-2031)

Source: adapted from Ganesan et al., 2014, p. 57

90 NSSO, 2009-2010, cited in Nautiyal et al., 2015, p. 4

The consumption of electricity is also likely to more than triple, from the current 17.9 mtoe to 59.07 mtoe by the year 2031. This would mean an increase of the share of electricity compared to other sources of energy by 13% to 25%, up from 12% in 2011.

While the actual figures may differ in the various existing scenarios for energy consumption across India, there is no disagreement about the fact that coal is and will remain the predominant source of electric power. Even in the low carbon growth scenario of the Indian Planning Commission of 2014, coal will provide 65% of the primary energy source needs for power generation in 2030[91]. This is in line with the objective expressed in the Low-Carbon Growth Report that "at least one third of power generation by 2030 [should] be fossil-free"[92].

The projections of Ganesan et al. as well as others also indicate a continued rise in the energy consumption per capita. If we assume that the per capita consumption of energy continues to evolve at the same rate it has developed over the past eight years or so, there will be an annual compounded average growth rate (CAGR) of the per capita energy consumption of 8.56%. In absolute figures, this meant a doubling of per capita consumption from 3,497.59 kWh in 2005-2006 to 6,748.61 kWh in 2012-2013.

This actual rise in consumption per person is accentuated by the real growth of the population as well, which is projected to be the world's largest by 2030 with 1.523 billion. This figure is compounded by the accelerating urbanisation rate, which increases demand for electricity as incomes improve. According to the Planning Commission (2014, p. 66), urbanisation is expected to increase from 29.8% in 2011 to 33.3% by 2030.

Hence, a continued rise in the share of electricity as a main source of total household energy consumption (lighting, appliances and cooking) will be the consequence. This in turn will lead to a shift towards more indirect household emissions through the generation of electricity rather than through direct emissions from lighting and cooking fuels. Having said that, in accordance with current urban consumption patterns and estimations by other authors such as Ganesan et al., direct emissions are likely to keep the upper hand in future all-India household energy consumption in the period until 2030 at least.

Finally, according to current national policies and international commitments in place, electrification is supposed to be continued, to reach 100% in both rural and urban areas of India by 2030 (or even by 2017 according to the 12th

[91] Planning Commission, 2014, p. 3
[92] Ibid.

Five-Year-Plan or by 2020 according to the Planning Commission's "Low Carbon Growth Report")[93].

In other words, rather than achieving the "sustainable energy for all" objectives by 2030 and switching the Indian population to "modern fuels", Ganesan and his colleagues project that almost 59% of the energy needs of the residential sector of India will still be met by traditional biomass. Under this scenario, the relative dependence on biomass is estimated to reduce from the current 75% of the total energy demand (2011 figures) to 59% in 2031. This is an assessment which also van Ruijven et al. agree with (2011, p. 7758).

Seeing the evolution of the percentage of electricity and modern cooking fuels used in rural areas (figure 8 and table 1), these assessments seem reasonable, as policy efforts for providing energy access in India have seen most impact with regard to electrification, but not with regard to cooking fuels. Under the current definition of "modern energy access for all", this means then that the objective of universal sustainable energy access would not be reached by 2030 in India. Instead, chances are good to achieve "universal electricity for all" by this date.

In terms of carbon emissions, India's citizens are likely to emit a projected 2.67 tonnes per person in 2020, up from 1.43 tonnes in 2007 (Indian Planning Commission, 2014, p. 18). Depending on which of the two scenarios provided in the Low Carbon Growth Report will be closer to reality – the BIG (baseline, inclusive growth) scenario or the LCIG (low carbon inclusive growth) scenario – CO_2 emissions per capita could consequently lie between 2.6 and 3.6 tonnes CO_2 per person in 2030.

However, as we have already seen, the situation regarding GHG emissions among the rural and urban Indian population is and probably will remain very different. Indeed, as table 3 showed, in absolute numbers total CO_2-equivalent emissions from electricity and cooking fuel consumption in villages are more than one and a half times greater than urban emissions[94]. This is due to the large amount of combustion-inefficient biomass which is used for cooking in rural households. On the other hand, the GHG emissions per capita of urban households are twice as high as that of rural households owing to the higher relative and absolute consumption of electricity, kerosene and LPG, which are all mainly or totally fossil-fuel based.

It can therefore be concluded that moving towards an energy mix such as that of the more "modern" urban households is not very sustainable as emission intensity per capita increases with the increasing use of fossil fuels for

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[93] Although even if successful, the Indian definition of electrification still leaves in actual fact an important share of rural India un-electrified, despite "perfect" (100% electrification) statistics.

[94] 138.0 million tons CO_2-eq/year in rural regions compared to 85.6 million tons CO_2-eq/year in cities. This includes 10% of firewood (biogenic) emissions to reflect the non-sustainable harvesting rate of this fuel

cooking, lighting and household appliances. Nonetheless, in terms of overall GHG emissions there is a short to medium-term climate-related benefit in shifting to energy sources with higher end-use efficiencies such as kerosene, LPG and electricity – provided they replace the use of energy-inefficient fuels such as unsustainably harvested wood and other biomass (see table 2) and provided other, less polluting sources of energy such as wind power or biogas, are developed for large scale use in parallel.

With all these factors in mind, several studies conclude that the impact of providing 100% household electricity and modern energy access in India is negligible (Planning Commission, 2014; Chakravarty et al., 2013; Pachauri et al., 2013). Thus, Pachauri et al. calculate for universal energy access across the globe that GHG emissions would increase by about 2-4% by 2030 over the baseline scenario. Together with other assessments such as that of the Planning Commission, they even estimate that both on the global as well as on the national, Indian level, there might be a reduction of CO_2 emissions thanks to the displacement of traditional biomass emissions[95].

However, in these analyses only basic energy access with a minimum energy use rate has been considered[96]. This type of conclusion only holds true for the short term, as access to modern (commercial) sources of energy imply an increasing amount of disposable income to pay for these fuels. Energy access is therefore only the stepping stone for an increase of consumption in the medium term. The annual growth rates of electricity demand of on average 8% as well as of total energy consumption per capita testify to this. These figures indicate that the increase of household energy demand until 2030 could be a lot more substantial than what has been assumed in the existing studies. Both the continued subsidy of certain fuels and of basic electricity access of 1kWh per person per day under the Rural Electrification Policy itself (for rural populations) as well as the forecast growth in income (for inhabitants of urban zones) can contribute to this.

Another weakness is the assumption that a fixed ratio between urban and rural population exists. If this parameter is modified, i.e. a stronger or weaker than projected urbanisation takes place in the period under analysis, it can alter the results obtained. The political choice of the regional energy mixes to be used can be greatly influenced by the urban-rural ratio as the various energy sources have different space and access to primary energy requirements, e.g. biogas plants are difficult to be set up in urban areas. This weakness has been recognised by Pachauri et al. (2013, p. 6).

Thirdly, results can vary a lot according to the population size used. Projections below from the Indian Population Foundation indicate a population growth up to 1.453 billion people by 2031. A comparison with the

[95] Pachauri et al., 2013, pp. 5-6

[96] 420kWh per year (Pachauri et al., 2013, p. 2) and 250KWh for rural areas and 500 kWh for urban areas respectively (IEA, 2012b, p. 3).

figures used by Ganesan (1.523 billion) shows that already between these two scenarios there is a difference of 70 million persons, or an equivalent of 4.6%. This is illustrative of how the use of different figures can quickly bring about different results.

	2001	2011	2021	2031
Total population	1028.7	1192.5	1339.7	1453.3
Rural population	742.6	834.	5 907.1	951.6
Urban population	286.1	357.9	432.6	501.7

Table 5: Projections for the Indian rural and urban population until 2031 (in million)

Source: Population Foundation of India (PFI, 2007), cited in Indian Planning Commission, 2014, p. 66

We can therefore conclude that the type of energy sources used determines strongly the climate impact of providing energy access for all. If current trends continue, coal is set to remain the main source of energy in India for at least the coming two decades (due to the good domestic availability of coal in India, the low coal price and the number of coal power plants being planned or built currently[97] which have an average lifetime of 30 years.

The speed of urbanisation and population growth in general is a second important factor which contributes to the impact on the climate, as a growing and more urban population is associated with a different energy mix and a higher overall energy consumption than in the current situation.

Hence, while we note that the climate impact of energy access could be small or even positive for India under existing projections until 2030, we also realise that the results could be different depending on the policy scenario applied and the socio-economic figures used. In view of these uncertainties, which could potentially shift the emissions balance back to the negative side, it is therefore imperative to develop an energy mix which is considerate of socio-economic, logistic as well as climatic aspects rather than to continue "business as usual" policies.

[97] As of January 2015, 386 new coal-fired power plants with a total capacity of 614,359 MW and total CO2 emissions of 3,633,132,353 were either in the planning or construction phase. For further details see Annex III.

V. Making the link between universal energy access policy and climate policy in India

A. The repercussions of providing energy access onto national climate and energy policies

We have seen in the previous chapter that the climate impact of providing basic energy access to the entire Indian population is only marginal or could even have positive impacts as it has the potential to reduce overall amount of greenhouse gas emissions produced by households with access to modern sources of energy, provided that either electricity consumption remains a marginal fuel source in Indian households or that electricity generation is decarbonised. Since we have seen that electricity consumption is rising steadily and at a fast pace, the former assumption is not very likely. Consequently, in the interest of both the welfare and health of its citizens as well as of climate change mitigation efforts, the Indian government has every interest to enable or at least facilitate the provision to clean energy and by this combine the efforts of a successful energy policy with an effective climate change mitigation policy. But how can this work in practice?

In India, one variable is certain in energy policy: Energy demand will continue to grow as the country is on its way to soon becoming the world's most populous country. Of course, this is also reflected in growing electricity demand.

In this domain, policy choices for increasing supply have been made based on economic choices. Thus, the new Minister in charge of Power, Coal as well as New and Renewable Energies, Piyush Goyal envisages that coal production should go up to 1 billion tons by 2019, from the current levels of 500 million tons[98]. While this is rational from a short-term, budgetary point of view, the long-term effects risk being more costly owing to potential lock-in of carbon-intensive technologies and consequently higher air pollution levels as well as to resulting growth of emissions from the electricity production sector. Additionally, on the basis of the medium and long-term climate change impacts as outlined by research and summarised by the IPCC, climate change adaptation costs through the more frequent occurrence of natural disasters and extreme weather events may in fact outstrip the initial investment costs.

In order to achieve a more sustainable energy mix, for large-scale electricity generation, which is of importance especially for urban areas, it is therefore recommended to phase out electricity production from coal-power plants

[98] This is equal to 18% CAGR in 4 years. Source: Minister of State (I/C) for Power, Coal and New & Renewable Energy, 2015, p. 11

and to replace coal by less emission-intensive energy sources such as natural gas, nuclear energy, hydro electricity and other renewable energy sources such as solar PV or on-shore and off-shore wind.

In view of the fact that India's power generation industry is strongly reliant on coal, natural gas has especially large development potential in centralised electricity generation, as it has been assessed to be a "workable" alternative fuel to existing coal-fired power plants in the short to medium term[99]. As natural gas is easily and cheaply available and has less than half of the carbon intensity as coal (see figure 11), it could therefore serve as useful "bridge energy" in the necessary energy transition. In practical terms then, merely the conversion costs for the power plants would have to be borne in order to implement the shift[100]. The necessary financing could come either from the Indian government or from international donors to support fast-track climate mitigation actions.

Depending on the speed of the energy transition there could also be a congruent shift towards electricity as cooking fuel especially in urban areas, if so wished by the government. However, in light of the current negligible share of electricity as cooking fuel in both urban and rural areas, there would need to be some strong incentives and measures, such as the subsidisation of energy-efficient electric cookers and the uninterrupted supply of electricity, to be introduced by the government in order to achieve that. This would only be advisable in a scenario where a significantly larger share of electricity was sourced from low-emission fuels.

Kerosene, the second major source of lighting and cooking as well as LPG both have similar characteristics and are therefore treated together here. Both have good end-use efficiencies of around 50% (compared to 10-20% of biomass), but as they are both fossil-fuel based their carbon intensity is high. Policies to promote their use have also been similar over the years, with price subsidies for both. With this mixed profile – positive in terms of energy efficiency but less impressive in terms of climate change mitigation potential – these two fuels are the most questionable items on the list in terms of how to best combine energy and climate policies most effectively and should therefore be used only if the availability of other more sustainable alternative fuels is not given in the region in question.

Besides lighting and the use of appliances and means of communication, the third energy use in households – cooking also needs to be looked at. Here, biomass, which is still the most widely used cooking fuel in rural and urban households, needs to become the priority of policymaking.

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[99] Leung and Lee, 2000, cited in Kadian et al., 2007, p. 6207

[100] As a second alternative, so called "repowering" is also an option, where a gas turbine is added to the power plant. However, this procedure is a lot more costly than simply "refuelling" the power plant from coal to natural gas. Source: Binkiewicz et al., 2010

Although biomass emissions are part of the natural carbon cycle the combustion of this fuel has a very low efficiency and causes substantial indoor air pollution. Besides, the excessive use of biomass from forests (in the form of firewood) can lead to deforestation and the degradation of ecosystems and reduce the carbon sink effect of forests (Nautiyal et al., 2015, p. 4). It is therefore advisable to use the existing biomass and to transform it into biogas, thus creating a more efficient and clean cooking fuel than the original biomass. According to a study done by Nautiyal et al., biogas based on animal waste even has the potential to replace 29.52% of the total energy supplied by fuel wood, kerosene and LPG combined for all of India[101]. A further advantage of biogas is that it can also be used as fuel for the generation of heat, electricity and, after conversion, even for transport (Surendra et al., 2014, p. 847).

As biomass use and the potential for biogas generation are mainly limited to rural areas, and here also in some regions more than in others (e.g. the states Uttar Pradesh, Mizoram, Sikkim, Goa have been identified as having very high biogas potential) policies should be tailor-made in the states exhibiting large potential and they should target the rural populations[102]. The measures employed by the national or state governments should follow the recommendations of existing studies, which suggest that beside the need of micro-financing it is mainly on knowledge and awareness that the accent should be laid in order to promote this fuel (Surendra et al., 2014, p. 857).

In addition, biomass should be explored further in terms of commercial biomass power through sustainably managed forests. This could have a double effect: it could ensure that 100% of biomass as primary energy source is sustainably harvested instead of the current 60-90% and that additional carbon sinks are created. Furthermore, such a measure "can be realized by an integrated approach, in which national and regional fuelwood policies are adapted, improved systems for charcoal production are implied and improved stoves, in combination with chimneys, are distributed" (Maes & Verbist, 2012, pp. 4204-4221).

We see from the above options for policy development that in order to make energy access truly sustainable in the spirit of the UN's "Sustainable Energy for All" Initiative significantly greater efforts need to be made. Rather than basing policies for rural access to energy mainly on cost-effectiveness reasons, as it appears to be the case now, some climate-relevant considerations should also be taken into account. This would have the benefit of supporting the decoupling of energy consumption from CO_2 emissions.

Following on this route necessarily also implies that energy and climate policies are aligned with each other, which is currently not the case in

[101] Nautiyal et al., 2015, p. 10
[102] Ibid.

India[103]. The preceding analysis has brought afore the idea that climate change and energy are closely linked to each other. Therefore, in order to ensure maximum coherence, climate change issues ought to be dealt with under the umbrella of the energy ministry. For this purpose, a reshuffling of ministerial powers would be necessary as the current setup still separates these two policy fields through ministerial dividing lines – in total, six ministries are competent for energy and climate change-related issues respectively, with four Ministers in charge. Such a fusion of energy and climate competencies has already taken in place in several countries, such as the UK, Denmark or Australia and in regional organisations such as the European Commission.

Integrating climate change and air pollution concerns into energy policies would then have ramifications for providing subsidies or other types of support for certain types of fuels and energy infrastructure development as outlined above. It is understood that improving access to cleaner cooking fuels would necessarily lead to a greater demand for these fuels. For the subsidised fuels (e.g. natural gas) greater public expenditure would be the consequence, which could however be partially covered by international climate-related financing mechanisms such as the CDM or the Global Climate Fund (GCF).

As the previous analysis has shown, in order to reap the potential emission benefits of the calculated positive impact of a transition to modern and clean energy, any meaningful policy to improve access for households while also mitigating climate change should take into account the main carbon-emitting sources of electricity and cooking fuels, i.e. coal, firewood, LPG and kerosene. Only by choosing the right mix between fuels with low carbon and low particulate matter emissions and by offering affordable and accessible alternatives sources of energy can the decoupling of energy consumption and GHG emissions happen. In other words, providing clean energy access implies providing supply-side management measures that privilege climate-friendly energy sources (e.g. renewable and nuclear energy, biogas, charcoal or sustainable biomass) to achieve a sustainable household energy mix. At the same time, though, it is important to develop new climate-friendly sources of energy such as ocean and tidal power for deployment in the medium term and as a replacement of more polluting fuels. It is also noted that while alternative clean energy sources for electricity generation are rather abundant, truly clean cooking fuels are more difficult to find. For sustainability reasons therefore, a shift towards electricity as cooking fuel appears a logical conclusion.

Moreover, in order to create the best possible enabling environment for these recommendations to be implemented a closer linkage between the energy

[103] As a reminder, in India there are five Ministries for energy (Coal, Power, New & Renewable Energies, Ministry of Petroleum and Natural Gas, Ministry of Atomic Energy), and climate change is dealt with by the Ministry of Environment, Forests and Climate Change.

and climate change policies should be created, ideally through the integration of the climate affairs into one of the energy ministries.

B. The link between energy access and international climate policy

From a climate-policy point of view it is interesting to note that, in accordance with UNFCCC rules, all biomass emissions are not counted in national reporting to the UNFCCC. Scientific studies rather use the figures of between 10% and 40% of the biomass which is unsustainably harvested for calculating the actual CO_2 emission equivalents of households.

Due to the fact that biogenic carbon emissions, i.e. most emissions from biomass are not accounted for in the UNFCCC framework[104], India has an interest to keep biomass energy production in the "memo item" field of unaccounted-for emissions of its National Communication to the UNFCCC. This category includes also aviation, marine and international bunker emissions. Nevertheless, it should be noted that the emissions that are associated to a change of land use, e.g. through deforestation for use of the wood for energy use, are included under the category land-use, land-use change and forestry (LULUCF). In India though, the majority of biomass used for fuel does not have its origins in forests and is therefore not counted under LULUCF (Pandey, 2010, p. 25).

India's interest in not shifting all non-commercial biomass energy production to commercial sources such as LPG or electricity is all the greater as emissions from biomass are larger than the emissions by the agricultural sector and those of industrial processes combined[105]. In other words this means that from an international climate policy point of view it would be advantageous for India if it did not develop energy access to its poorest citizens and develop electricity as cooking fuel as less of the country's total emissions would be accounted for.

Indian policymaking on providing clean, low-carbon access to energy is therefore likely to be a balancing act between its national and international climate policy interests. This finding also shows that there is a link between the national and international levels of climate policy: Indeed, the policy as well as the message needs to be adapted to the differing target groups – the

[104] "Under international GHG accounting methods developed by the IPCC, biogenic carbon is part of the natural carbon balance and it will not add to atmospheric concentrations of CO2. However, non-biogenic CO2 released by the combustion of LPG, kerosene, charcoal and natural gas is accounted for in computing the atmospheric concentrations of GHGs." Source: Kadian et al. 2007, p. 6199

[105] 566,800 Gg compared to 514,859 Gg, (2007 figures). Source: MoEF, 2012, p. 80

citizen and other countries' governments respectively (Parties to the UNFCCC; Beck, 2012).

India's favourable position with comparatively low emissions and a large population in the international climate regime gives the country an advantage for attracting climate-related finance. As we have seen a lot of this international funding can be used for improving energy access for the Indian population in a sustainable manner. India being one of the top three global carbon emitters with low historical responsibility for climate change, it is therefore expected to continue to be one of the main recipients of climate-related donor funding. The policy level should also advocate for this to happen, as it is not only in the national but also in the international interest regarding climate.

Besides the biogenic emission issue, another link between energy access and climate policy can be observed. India's Copenhagen pledge to reduce the emission intensity of its GDP[106] by 20-25% compared to 2005 level by 2020 also has implications for the provision of energy access. Although the pledge could be called not ambitious as it is only half of what China promises to do in the same time[107], it can nonetheless give an impetus to providing clean electricity access through the National Solar Mission. And as several Indian and international studies suggest, "India is likely to meet – or even exceed – this pledge based on its existing policy package and macroeconomic trends"[108]. While the pledge is voluntary in nature and has thus no legally binding character, it nevertheless constitutes a moral commitment towards the international community which countries are generally not keen to break.

In addition, such commitments can also have economic repercussions as "increasing access to clean and renewable energy can reduce poverty in India by creating new jobs, businesses (including those run by the rural poor), and markets". This in turn generates higher incomes which enhance the purchasing power of the population and thus accelerate the energy transition ("stacking").

It can thus be said that India's international climate commitments can have a positive impact on the implementation of domestic energy access policies as it creates a moral obligation to deliver on the international promises made. It also has an indirect impact on the choice of fuels used through the enhancement of economic opportunities for the population.

[106] The emission intensity is defined as the level of GHG emissions per unit of economic activity.
[107] China promises to reduce its CO2 emission intensity by 40-50% in 2020 based on 2005 levels. Source: Bapna, 2010
[108] Pahuja et al., 2014, p. 1

VI. Conclusions

In our analysis of the climate impact of providing energy access to the entire Indian population and the interlinkages between policymaking on energy access and climate change we have seen that energy policy and climate policy are intrinsically linked to each other, to the extent that it is sometimes hard to draw the line between them. It therefore appears logical that "climate change should be treated as a subset of energy (and other sectoral) policy rather than vice versa in order to be most effective and influential" (Bazilian et al. 2010). Linking the two fields could also help in "achieving policy goals that otherwise may not seem weighty enough for sufficient societal investments"[109], e.g. alleviating the commercial challenges of energy access. This would facilitate political decision-making regarding the provision of energy access which is at the same time respectful of the climate as well.

Besides a direct linkage, we have seen that indirect links between climate and energy policies already exist, to the extent that India's international climate commitments have an impact onto national energy access policies. With this in mind, India could even turn "into a leader in the race to a low-carbon economy" (Bapna, M. 2010) and therefore, by extension, also into a global leader in climate policy.

Hence, if the two policy fields are consciously integrated, criteria regarding climate impact should be defined and included in policies regarding energy access in order to make energy access more sustainable. However, these criteria need to be carefully chosen: The analysis of existing data on energy access in rural and urban areas as well as on emission intensities in this paper has shown that different figures can tell rather different stories, e.g. in terms of energy access projections and electrification rates. Also, the change of compilation methodologies as was done with the EDI can falsify the result of progress tracking.

Hence, in order to measure energy access which is sustainable, i.e. compatible with climate change mitigation policy objectives and which provides a meaningful indication of progress in this area any useful indicator needs to take into consideration a standardised emission impact of energy access (based on CO_2-equivalent emissions or GHG emissions) for both national and international progress tracking. For international comparisons, the idea of a "low carbon EDI" has already been put forward by the IEA (IEA, 2012b, p. 543), however, it has not been further developed yet. Such an indicator could also take quality aspects of energy access into consideration, for instance by "shifting focus of rural energy delivery from providing access to energy services (through build up of a massive rural electricity

[109] Ürge-Vorsatz & Tirado Herrero, 2012, p. 84

infrastructure) to a more service oriented indicator like availability of electricity at the rural household level?" (Deloitte, 2013, p. 34). The downside of this approach is that climate considerations would move to the background with the "service approach". It is therefore preferable to define energy access as the end objective rather than as the means to an end, despite the fact that service-focused indicators could be clearer in showcasing achievement. With an adequate minimum supply of energy the same can be achieved, and it has the advantage of not presupposing a certain usage of energy by the consumer.

Furthermore, the analysis of existing energy access-related policies and of the hindrances for achieving universal energy access has shown that the various obstacles to providing energy access need to be addressed better by policymaking. The cross-check for energy policies' inclusion of climate change mitigation considerations has been negative and hence need to be integrated into those policies. On the positive side, it has also been shown that in fact the development of modern energy access can help to reduce GHG emissions thanks to the higher end-use efficiency at combustion of certain fuels (notably kerosene and LPG) and lower carbon emission-fuels (e.g. biogas or natural gas instead of coal for electricity production). Nevertheless, from the analysis of data on emissions of the main domestically used fuels in India it has emerged that certain fuels which are commonly cited as "modern" are not necessarily climate-friendly in terms of GHG emissions. Rather, they have either lower climate impacts (natural gas) or a lower impact on local (often indoor) air pollution (LPG and kerosene). Only biogas has the benefits of having both low particulate matter and GHG emissions.

The analysis of the various challenges for achieving climate-friendly energy access has pointed out the weaknesses in the current policies. Thus, regarding geographical and socio-demographic challenges, such as distances and internal urbanisation patterns, more region-specific sustainable energy mixes need to be elaborated by the state governments and policies ought to be tailor-made accordingly. So far, policies have focused mainly on technical aspects such as the provision of equipment or the lowering of fuel costs. Instead, they ought to take into account the comparative energy source advantages of the states and regions in question, e.g. regarding the production of biogas. Following our analysis, cultural factors such as the discrimination of minority groups, e.g. Muslim or lower caste populations, should equally be included in the characteristics to be used for more socially effective interventions.

Regarding commercial challenges which concern the low purchasing power of the population for whom energy access is to be improved, generalised subsidies such as of LPG should be converted into becoming target-group specific subsidies. If climate and energy policies are linked, it would facilitate the use climate-related financing (national or international sources such as through the CDM mechanism) in order to finance these measures.

As to what concerns the technological challenges, namely ensuring the quality of supply of electricity as a result of the current unreliability of the existing network and a lack of grid interconnection at state level, several solutions can be offered. These are all on the level of the national government and require considerable investment. Namely, this implies that the losses need to be tackled by the upgrading of existing electricity infrastructure, the interconnection between the regional state grids needs to be improved and the rollout of smart grids across the country should be pursued in order to minimise losses of existing production of electricity and optimise its effective use. This will have the beneficial "side effect" of saving an important share of currently needed additional energy production capacities and therefore carbon emissions, as the bulk of Indian electricity is produced from coal. With losses currently accounting for 17% of production the double impact for the climate and energy access could be rather substantial.

Finally, it has been shown that the political challenges, namely the focus on electrification, the setting of unrealistic goals for achieving universal energy access or the lack of thorough implementation of policies need to be addressed. Rather than having individual "top down" "promotional policy packages" for each fuel and to take away the policy focus on electricity, it would make more sense to address the clean energy access issue "bottom up", first on the state-level which sets individual targets and dates, including an adapted choice of fuels to be promoted, and then to define a goal for the achievement of clean energy access at the national policy level. On the state level, it is possible to do a more concrete planning and tracking of progress of achievement and the consideration of any encountered obstacles and constraints, thereby also alleviating the problem of the chronic setting of unrealistic national deadlines.

As we can see from the above, a constraint of this paper is that only national level policies have been analysed in this paper although India's political federal constellation would make a state-wise analysis of climate and energy access related policies an interesting further domain of research. It could provide examples of best practice which could be replicated by other less-well performing Indian states, and inform national policymaking.

Also, as mentioned above, developing further a practical "low carbon" EDI, which takes into account available and useful data for following up on the progress of sustainable energy access across the world would be interesting. Not least would it put the "sustainable" back into the UN's "Sustainable Energy for All Initiative".

Finally, there is one remaining point: India has been analysed here as a case study, so what message can we take away for other countries with similar energy access problems as India, and that also need to face the climate change challenge? While India may be a special case compared to the other, mainly sub-Saharan countries also facing energy access issues – in terms of climate responsibilities and climate politics due to its size and geopolitical importance – it can nevertheless serve as a useful example for how a targeted ambitious intervention in favour of the parts of the population lacking clean energy access in a developing country can be successful, if the above recommendations are taken into consideration. The analysis of the Indian case has made clear that the development of primary energy sources for clean energy access is of strategic importance, not only for the national energy sector but also for the global climate. It is therefore paramount to link the two issues.

However, in the end, perhaps the solution for solving the energy challenge across the world is not only a question on how to improve supply to those populations that lack it but perhaps the question needs to be addressed on a more holistic level. Perhaps it is the Western-style consumption patterns which need to be addressed first and foremost; in a world where the energy-intensive lifestyles of Western countries become the norm and ideals to imitate. For this to happen though, a complete overhaul of societal priorities would have to take place.
Starting in Western countries, could a new focus on values such as happiness or peace rather than material wealth bring about a lasting change to soaring global energy demand and the subsequent threat to the world's climate? If we shift the focus to human abundance instead of economic growth, could we perhaps truly experience human development rather than only material comfort – and with that also "protect the climate" after all?

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VIII. Annexes

A. Annex I – Major national policies and programmes for expanding energy access in India

a) Electrification

Policy/ Programme	Objectives, scope and impacts	State of play
Minimum Needs Programme (MNP) in 1974	Provided100% loans from the central government for last mile connectivity for rural electrification projects in less electrified states (less than 65% rural electrification)	discontinued in 2004-05 on account of "difficulties in implementation". (Bilolikar & Deshmukh, 2006)
Kutir Jyoti (bright hut) Scheme in 1988	Provided a single point lighting connections to households below the poverty line (BPL). Connected nearly 7.2 million rural households to the grid till March 2006 with a total grant amount of about Rs. 6.12 billion	merged into the "Accelerated Electrification of One Lakh Villages and One Crore Households" in May 2004 and later into the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY).
Pradhan Mantri Gramodaya Yojana (Prime minister's village development programme) in 2000	Rural electrification was one of the many programmes. It offered financing through loans (90%) and grants (10%). It was coordinated and monitored by the Rural Development Division of the Planning Commission	Discontinued from 2005 onwards
Rural Electricity Supply Technology Mission in 2002	Identification and promotion of decentralized technologies, in addition to conventional grid connection, review of legislation	Ongoing
Accelerated Rural Electrification Programme (AREP) in 2002	Interest subsidy of 4% was provided on loans availed by state governments/power utilities from financial institutions for carrying out rural electrification programme. It was limited to electrification of un-electrified villages, smaller settlements of lowercaste people and tribal villages, and through both conventional and non-conventional sources of energy	Merged into RGGVY
Remote Village Lighting Program (previously Remote Village	Objective: Electrify all the remote census villages and remote hamlets of electrified census villages through non-conventional energy sources such as solar energy	Ongoing

Electrification Model) in 2002	(Solar PV), small hydro power, biomass, wind energy, hybrid systems, etc. This programme covers all villages which were not covered under RGGVY grid connected program and have been designated as remote.	
The Electricity Act 2003	Specific directions for expanding rural electricity access and for the first time mentions rural electrification in a statute. Mandates universal service obligation and formulation of a national policy on rural electrification. States that the state and central governments shall jointly endeavour to provide electricity access to all	In force
Accelerated Electrification of One lakh villages and One crore households in 2004	Village and household electrification. Accelerated electrification of 100,000 villages and 10 million households by merging the interest subsidy scheme of AREP and Kutir Jyoti programme. Provision was made for providing 40% capital subsidy and the balance as loan assistance on soft terms from REC	Accelerated Electrification of One Lakh Villages and One Crore Households, MNP and Kutir Jyoti have been merged with the RGGVY
National Electricity Policy in 2005	Access to electricity for all households and demand for power to be fully met by 2012, and minimum lifeline consumption of 1 kWh/household/day by 2012	In force
Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY; rural electrification programme) in 2005	Scheme for developing rural electricity infrastructure and expanding household electrification with 90% capital subsidy and 10% loan assistance. Final connection is provided free of cost for BPL households. The total cost of the programme is Rs. 287 billion and the achievements as on April 2010 are electrification of 79,000 villages and 12 million rural households	Subsumed by "Deendayal Upadhyaya Gram Jyoti Yojana" programme (Ministry of Power, 2014)
Rural Electrification Policy in 2006	The rural electrification policy elaborates on the issues mentioned in the national electricity policy and makes specific recommendations for effective implementation of the rural electrification programme	ongoing
Jawaharlal Nehru National Solar Mission (JNNSM)	Objective: Promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. By the end of the 13th Five-Year Plan, in 2022, the JNNSM should have led to an installed capacity of 20 000 MW and the deployment of 20 million small and off-grid	ongoing

	solar lighting systems in rural areas, including DDG based power plants.	
"Deendayal Upadhyaya Gram Jyoti Yojana" (DDUGJY) in 2014	Objective: rural areas electrification "for completion of the targets laid down under RGGVY under 12th and 13th Plan"	Ongoing – replaces Rajiv Gandhi Grameen Vidyutikaran Yojana

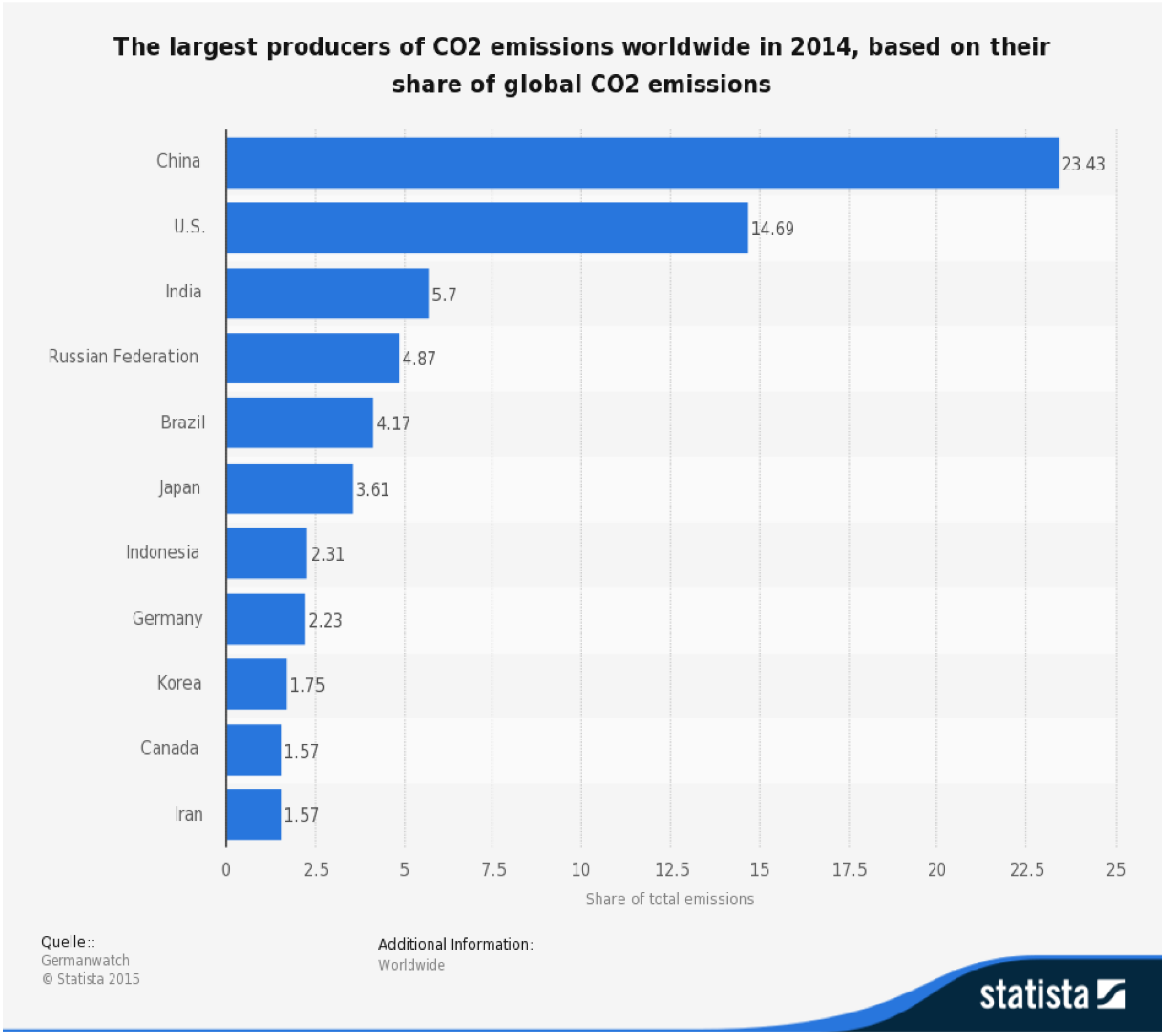
b) Cooking fuels

Policy/ Programme	**Objectives, scope and impacts**	**State of play**
Supply of kerosene through public distribution system (PDS) with quantity restriction, in 1957	Objective: Ensure benefits are reached to the poor and needy people. Households are allotted kerosene consumption quotas that vary by state and region (urban and rural), and whether they have an LPG connection or not. Nearly 40% of the PDS kerosene gets illegally diverted and is used to adulterate diesel and petrol for transport. Subsidy is prevalent to this day.	Ongoing
Subsidies on household cooking fuels like kerosene and LPG in late 1960s	Objective: Provide affordable access to modern fuels for the poor. Subsidy on LPG is available for all the consumers irrespective of their income levels. Subsidy on kerosene is available for those without an LPG connection. Thus, subsidies for both costing about Rs. 485 billion (in 2008) are not targeted at the poor	Ongoing
National Biogas and Manure Management Programme (NBMMP) (previously National Project on Biogas Development (NPBD)) in 1981	Objectives: Disseminate family type biogas plants. Modern fuel for cooking and organic fertilizer to rural households, mitigate drudgery of women, reduce pressure on forest. Help in combating and reduction in causes of climate change by preventing emissions of carbon dioxide and methane into the atmosphere. Biogas plants built till 2009 is estimated at 4.17 million. Estimates suggest that only about 28% of them provide primary cooking fuel to relatively rich rural households	Ongoing
National Programme on Improved Chulhas (NPIC) or cookstoves in 1983	Objectives: Disseminate advanced biomass cookstoves. Efficient use of fuel wood and avoid deforestation, reduce drudgery for women and health hazards caused by indoor pollution. By 2003, over 35 million stoves had been built;	Discontinued in 2002

	however, the NPIC was found to be ineffective in promoting a shift to improved stoves therefore the funding was stopped in 2002	
National Biomass Cookstoves Programme (NBCP) in 2009	Objectives: To develop and deploy improved biomass cook-stoves for providing cleaner cooking Energy solutions in rural, semi-urban and urban areas using biomass as fuel for cooking. To mitigate drudgery of women and children using traditional chulha for cooking. To mitigate climate change by reducing the black carbon and other emissions resulting from burning biomass. The biomass cookstoves promoted under this programme are of two types: fixed type and portable type. The portable cookstoves are also of two types: natural draft and forced draft. Advanced cookstoves utilizing fans are more efficient cookstoves compared to natural draft ones.	Ongoing – replaces NPIC
Rajiv Gandhi Gramin LPG Vitrak Yojana (RGGLVY) in 2009	Objectives: Eliminate ailments due to use of chulhas and to provide clean cooking fuel to rural women. By 2015, the scheme aims to have a minimum of one LPG distributer per block in the country, all districts to have 50% LPG coverage, all states to have minimum 60% LPG coverage and 75% LPG coverage in all of India.	ongoing

Source for both tables: Ganesan & Vishnu, 2014, pp. 68-69, adapted and updated using Bilolikar & Deshmukh, 2006, Ministry of Power, Government of India, 2014, Hanbar, R D & Karve, P, June 2002, Deloitte Touch Tohmatsu, 2013; Sahu et al., 2014 and Ministry of New and Renewable Energy website: http://mnre.gov.in

B. Annex II – The largest producers of CO_2 emissions worldwide in 2014



Source: www.Statista.com

C. Annex III – Summary statistics for proposed coal plants in India as of January 2015

Status	Number of Plants	Capacity (MW)	Annual tons of CO_2
Uncertain	6	11,260	66,588,271
Unconfirmed	20	24,685	145,979,704
Cancelled	21	30,420	179,894,778
Deferred	27	45,230	267,476,687
Advanced development	47	53,340	315,436,801
Construction	98	82,765	489,447,447
Newly commissioned (since 1/1/2010)	112	56,815	335,986,911
Early development	113	155,262	918,173,014
Planning	128	154,582	914,148,740
Total	**572**	**614,359**	**3,633,132,353**

Source: *http://www.sourcewatch.org/index.php/Proposed_coal_plants_in_India#Proposed_coal-fired_power_plants_in_India_.28updated_January_2015.29* *[accessed 15/7/2015]*

D. Annex IV – Map of India

Source: www.delhitourism.gov.in