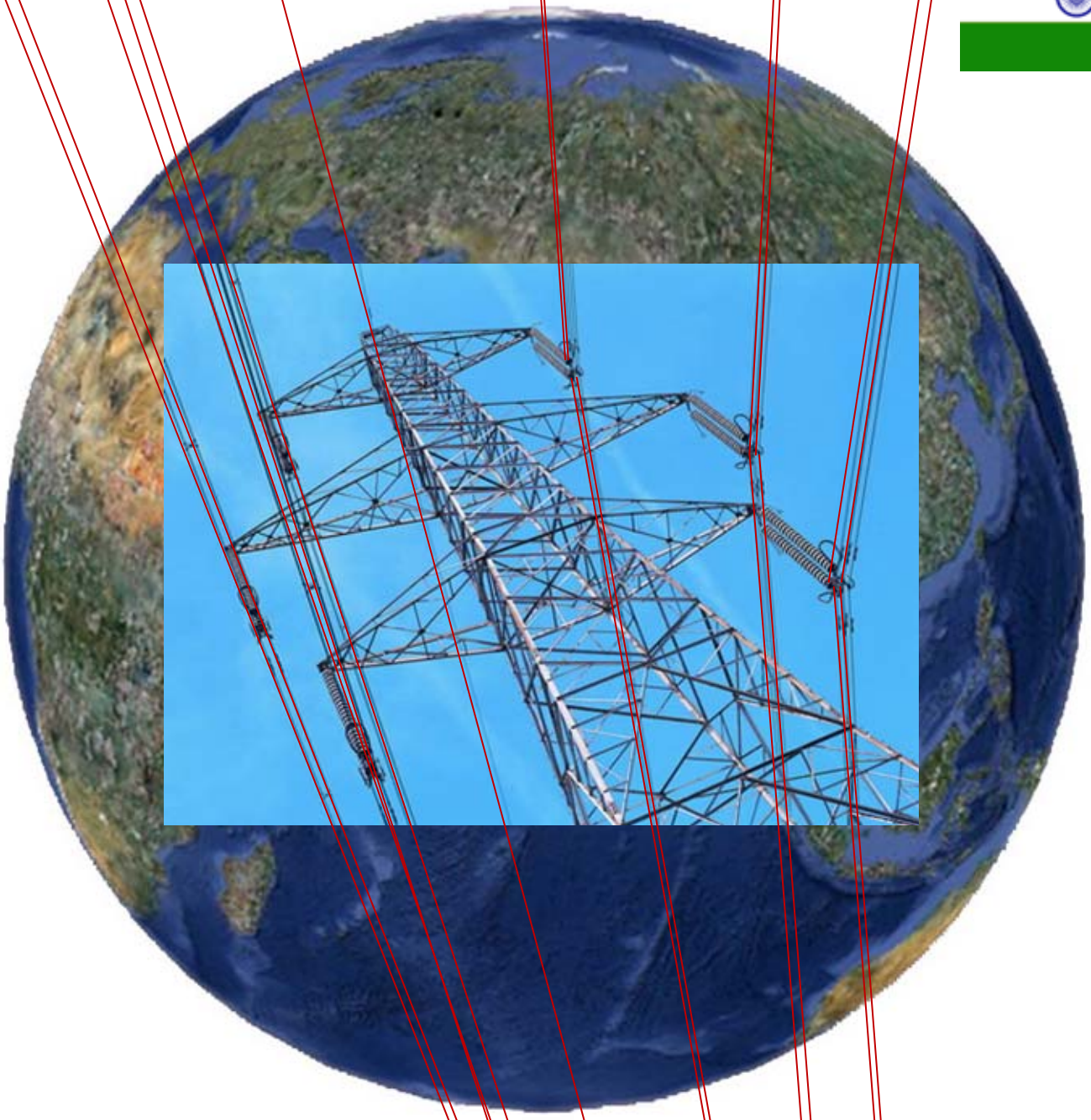
Inventory of country specific electricity in LCA

- India

Inventory report v2



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Preface

Together with Danisco, 2.-0 LCA has initiated the current electricity project with the aim of establishing consequential and attributional LCIs on electricity in different countries. The project is established as a club to which anyone can subscribe. The LCA electricity club is administrated by 2.-0 LCA consultants. For more information and subscription, please contact 2.-0 LCA consultants:
http://www.lca-net.com/projects/electricity_in_lca/

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Contents

1 Introduction

This report presents a life cycle inventory of Indian electricity. The inventory includes three consequential scenarios and one attributional scenario. The goal and scope definition including system delimitation is presented in the methodology report of the current project: Schmidt et al. (2011).

2 Data on Indian electricity production

Data on electricity production from different energy sources and the application of these data in the three consequential scenarios and the attributional scenario are presented in this section. **Table 1** shows the generation in 2000 and 2008 and the predicted generation in 2020. Data are from IEA (2002, p 298) and IEA (2010, Annex B, p 697).

Table 1: Data for power generation in India 2000, 2008 and 2020. Data are obtained from IEA (2002 p 298; 2010, Annex B, p 697).

Source of electricity	Generation in 2000 TWh	Generation in 2008 TWh	Predicted generation in 2020 TWh
Coal	420	569	1039
Oil	5	34	36
Gas	25	82	203
Biomass	0.4	2	14
Nuclear	17	15	66
Hydro	74	114	226
Wind	0.6	14	57
Geothermal	0	0	0
Solar	0	0	11
Marine	0	0	0
Total	**542**	**830**	**1652**

Based on the information in **Table 1,** the four scenarios of electricity mixes are derived. In **Table 2,** the scenario 'Consequential future' is calculated from the predicted changes from 2008 to 2020. 'Consequential historical' is calculated in the same way, but by using the historical data from 2000 and 2008 in **Table 1**. 'Consequential coal' only includes coal, and the scenario 'Attributional 2008' is calculated directly from 'Generation in 2008' in **Table 1**.

The columns 'Applied electricity mix' in the consequential scenarios only include electricity sources, which are predicted to respond to a long term change in demand. Suppliers which are not likely to respond to changes in demand are marked with * in **Table 2**. This includes suppliers with negative changes (they are regarded as being phased out) and suppliers which are constrained. No constraints on the electricity sources applied in the consequential modelling have been identified.

Table 2: Data for the three consequential and the attributional scenario. *Not included in the consequential scenario, see text above the table.

Source of electricity	Consequential future		Consequential historical		Consequential coal	Attributional 2008
	Change in generation 2008-2020, TWh	Applied electricity mix	Predicted change in generation 2000-2008, TWh	Applied electricity mix	Applied electricity mix	Applied electricity mix
Coal	470	0.572	149	0.514	1.000	0.686
Oil	2	0.002	29	0.100	--	0.041
Gas	121	0.147	57	0.197	--	0.099
Biomass	12	0.015	2	0.006	--	0.002
Nuclear	51	0.062	-2*	0.000	--	0.018
Hydro	112	0.136	40	0.138	--	0.137
Wind	43	0.052	13	0.046	--	0.017
Geothermal	0	0.000	0	0.000	--	0.000
Solar	11	0.013	0	0.000	--	0.000
Marine	0	0.000	0	0.000	--	0.000
Total	**822**	**1.000**	**288**	**1.000**	**1.000**	**1.000**

3 Inventory data on Indian electricity

In the table below, the inventory data for the three electricity markets 'at grid' are documented. The grid losses in the table, i.e. the inputs of electricity to the activity, are quantified in the methodology report of Schmidt et al. (2011).

Table 3: Inventory data for transmission, distribution, and transformation of Indian electricity.

Low voltage grid	Amount	LCI data
Output	1 kWh	Based on 'Electricity, low voltage, at grid/UCTE U'
Input	1.226 kWh	Electricity, medium voltage (see below)
Medium voltage grid	**Amount**	**LCI data**
Output	1 kWh	Based on 'Electricity, medium voltage, at grid/UCTE U '
Input	1.021 kWh	Electricity, high voltage (see below)
High voltage grid	**Amount**	**LCI data**
Output	1 kWh	Based on 'Electricity, high voltage, at grid/UCTE U '
Input	1.019 kWh	Electricity production mix, see **Table 4**.

Table 4: Applied electricity mixes in the consequential and attributional versions of Indian electricity.

Flows	Consequen-tial future kWh	Consequen-tial historical kWh	Consequen-tial coal kWh	Attributional kWh	LCI data Ecoinvent (2010)
Outputs					
Electricity, at pp	1	1	1	1	Reference flow
Inputs					
Elec. coal	0.572	0.514	1.000	0.686	See **Table 5**
Elec. oil	0.002	0.100	--	0.041	See **Table 5**
Elec. gas	0.147	0.197	--	0.099	See **Table 5**
Elec. biomass	0.015	0.006	--	0.002	See **Table 5**
Elec. nuclear	0.062	0.000	--	0.018	'Electricity, nuclear, at power plant pressure water reactor/CN'
Elec. hydro	0.136	0.138	--	0.137	'Electricity, hydropower, at reservoir power plant, non alpine regions/RER'
Elec. wind	0.052	0.046	--	0.017	'Electricity, at wind power plant 800kW/RER' '
Elec. geoth.	0.000	0.000	--	0.000	--
Elec. solar	0.013	0.000	--	0.000	'Electricity, production mix photovoltaic, at plant/CH'
Elec. marine	0.000	0.000	--	0.000	--

In **Table 5** the amount of fuel needed per kWh and the applied inventory data for producing and burning the fuels are described. The amount of fuel needed is identified via the efficiencies in the power plants. Data on efficiencies are derived from IEA (2011) as the ratio between electricity generation and use of fuel for each type of fuel.

Table 5: Applied LCI data per electricity technology. Data on efficiencies are derived from IEA (2011, p II. 152)

Coal	Amount	Efficiency	LCI data. Ecoinvent (2010)
Outputs			
Elec. coal	1 kWh		Reference flow
Inputs			
Burning coal	1/0.264 = 3.79 kWh	26.4%	Assumed that burning coal in Indian PP can be represented by burning coal in China PP: Hard coal, burned in power plant/CN U
Oil	**Amount**	**Efficiency**	**LCI data. Ecoinvent (2010)**
Outputs			
Elec. oil	1 kWh		Reference flow
Inputs			
Burning oil	1/0.283 = 3.54 kWh	28.3%	Assumed that burning oil in Indian PP can be represented by burning oil in China PP: In ecoinvent China oil PP is represented by burning oil in a Czech Republic PP: Heavy fuel oil, burned in power plant/CZ U
Gas	**Amount**	**Efficiency**	**LCI data. Ecoinvent (2010)**
Outputs			
Elec. gas	1 kWh		Reference flow
Inputs			
Burning gas	1/0.451 = 2.22 kWh	45.1%	Assumed that burning gas in Indian PP can be

			represented by burning gas in China PP: In ecoinvent China gas PP is represented by burning gas in an Eastern Europe PP: Natural gas, burned in power plant/CENTREL U
Biomass	**Amount**	**Efficiency**	**LCI data. Ecoinvent (2010)**
Outputs			
Elec. biomass	1 kWh		Reference flow
Inputs			
Burning biomass	1/0.150 = 6.67 kWh	15.0%	See the inventory of the burning of biomass in the methodology report of Schmidt et al. (2011).

4 References

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