Energy and Employment: Case Study Hydropower in India

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Author: Dr Henrike Koschel

This article describes and evaluates the methodology and results of an ex-ante evaluation of employment effects of the investment in a hydropower plant in India. In the quantitative impact analysis, which was conducted by Professor Andreas Löschel, Heidelberg University, on behalf of KfW Development Bank, the induced (gross-) employment effects created by the construction and operation were determined, but not the long-term effects of an improved electricity supply.
The model calculations show, that taking into account all direct, indirect and income-induced effects, the investment amounting to EUR 380 million ensures approximately 30,000 jobs per year during the construction phase and around 2,500 jobs during the operational phase. Around half of this total effect is caused by the multiplier effect arising from an increase in income. Due to the low labor productivity, relatively high employment growth in the agricultural sector can be expected: 42 % of job creation is attributable to the agricultural sector, 33 % to the manufacturing sector and 25 % to the service sector.

High priority: development of the energy generating capacity and creation of jobs

The Indian economy, currently growing at a rate of 6-7 % p.a., is still one of the fastest growing economies in the world. However, 30% of the population at present lives below the poverty line of 1 USD per capita and day, while 25 % of the population has no access to electricity. The average labour productivity is much lower as compared to international standards. The reasons for this are mainly a lack of skilled labour, power breakdowns and obsolete machinery. More than half of the employees in India work in the agricultural sector, which contributes only 14 % to GDP. In the service sector, this relation is reverse: 30 % of the employees here generate almost 60 % of GDP. To overcome mass poverty, the Indian government aims to create new jobs, especially in the fast growing sectors of the manufacturing industry and the service sector. An annually growing demand for electricity is associated with economic growth, which at present is not being met due to a limited capacity in the power generation sector and network instability: The electricity gap between generation and demand amounts to some 10 %. Therefore, the Indian government sees the development of generation capacity and electricity networks as a major task.

Positive employment effects of KfW projects in the energy sector

On behalf of the Federal Government, KfW has been financing infrastructure projects in the Indian energy sector for many years. The objective is to improve the standard of living and income opportunities for the Indian population and to support a sustainable economic and social development through a reliable, high-quality and environment-friendly supply of energy. Investments in the energy sector create short- and medium-term employment during the construction and operational phase of a power plant as well as long-term employment due to better power supply for productive use paving the way to growth.

So far KfW does not have any empirical analysis on the impact of employment initiated by the projects of the Financial Cooperation (FC) in the energy sector.[1] In order to have an initial assessment of the magnitude of these impacts, KfW has appointed Professor Andreas Löschel from the University of Heidelberg to quantitatively assess the economic and sectoral employment effects through the construction and operation of a hydropower plant in India.

Case study: hydropower plant Shongtong Karcham

The hydropower plant Shongtong Karcham has a planned installed capacity of 450 MW. It will be constructed along with the necessary infrastructure in the state of Himachal Pradesh (India) and jointly funded by KfW, the Asian Development Bank (ADB) and the project executing agency, Himachal Pradesh Power Corporation Ltd. (HPPCL). The power plant, with an expected plant load factor of about 42 %, generates an average of 1,650 GWh electricity annually, feeding into the regional transmission grid of northern India. Therefore, electricity users in Himachal Pradesh as well as in neighbouring states will benefit from the project.

The model for the ex-ante assessment of the employment effects

To determine the induced sectoral and economic employment effects through the investment and operation of the power plant, an open static Input-Output-Model is used, which represents the intermediate goods linkages of the Indian economy. The basis for this model is an Indian Input-Output-Table for 35 sectors to which employment coefficients for low-, medium- and high-skilled workers have been added (see www.wiod.org). Given an additional demand, the model calculates the sectoral and macroeconomic production, income and employment effects at all stages of the value chain in several iterative steps. A distinction is made below between direct and indirect effects and induced effects:

- The direct effects include the *initial effect* (incentive effect). It is initiated across all sectors that are directly involved in the planning, construction and operation of the hydropower plant (e.g. construction, mechanical engineering industry, services). Among the direct effects is also the so-called *first round effect*. It results from the fact that the sectors directly involved in the

[1] See corresponding analyses for KfW-Programmes in Germany: http://www.kfw.de/kfw/de/KfW-Konzern/KfW_Research/Economic_Research/Evaluationen/index.jsp.

planning, construction and operation purchase intermediate goods, leading to higher production and employment at the first upstream production stage.
- *Indirect effects* arise because all supply sectors in turn get intermediate goods from other upstream sectors according to the intermediate input linkages, and so on.
- *Induced effects* occur because the employees spend a part of their disposable income on consumer goods and services. According to the sectoral consumption pattern, this additional demand induces additional production, employment and income; and another multiplier effect arises from the circular flow of income.[2]

Determination of the exogenous demand stimulus during the construction and operational phase

The total investment cost of the project is estimated at around EUR 380 million. This includes costs for project planning, project management and construction of the hydropower plant. On the basis of a dynamic cost plan for the planned six-year construction period of the plant the annual, exogenously given investment stimulus was determined and assigned to the corresponding sectors of the Input-Output-Model. The investment stimulus is highest for the construction sector, followed by mechanical engineering industry (e.g. turbine), electrical equipment (e.g. generator, control engineering, 400 kV gas-insulated switchgear GIS), services as well as agriculture and forestry sectors.

In determining the exogenous demand stimulus, assumptions are made to what extent the internationally tendered goods and services are provided by Indian or foreign suppliers. It is assumed that almost all exogenous investment stimulus have a demand effect on the Indian domestic market. Only in the case of the 400 kV GIS, it is considered that a foreign supplier might receive the order. Therefore, two scenarios have been calculated: Scenario "with GIS" and Scenario "without GIS". In the latter scenario, the investment stimulus for the Indian economy is only EUR 364 million. A distinction between domestic production and imports is made not only for the final demand, but also for intermediate goods. It is assumed that a given (empirically determined) share of intermediate demand is met through imports.

After commissioning of the hydroelectric power plant, i.e. after the seventh year from the start of construction, operation and maintenance, costs mainly associated with an additional final demand in the construction sector, electrical and mechanical engineering industries arise.

Results: employment effects of the hydropower plant Shongtong Karcham

Investment effects and multiplier effects due to higher income during the construction of the power plant: In the scenario "with GIS", during the six-year construction phase of the hydropower plant, the average increase in the number of employees per year compared to the reference case is about 30,000. In the scenario "without GIS", the increase in the number of employees per year is slightly less at around 29,100.
25 % of the total employment growth (equivalent to almost 7,500 jobs, including 5,200 in the construction industry) is due to the initial effect. 15 % of overall job creation occurs in the directly related supply sectors, 13 % result from further indirect effects due to intermediate linkages. Figure 1 shows the importance of the income-induced effects in a country like India: 47 % of the total annual increase in employment during the construction phase of the hydropower plant (corresponding to almost 14,000 jobs) is induced by the additional income.

The initial effect mainly creates employment in the manufacturing industry, whereas the induced income effect increases demand for consumer goods. As a consequence, the agricultural sector benefits more than average, but also individual manufacturing sectors such as food and textile industries, electricity, petroleum processing as well as individual services will profit from the investment in the power plant.

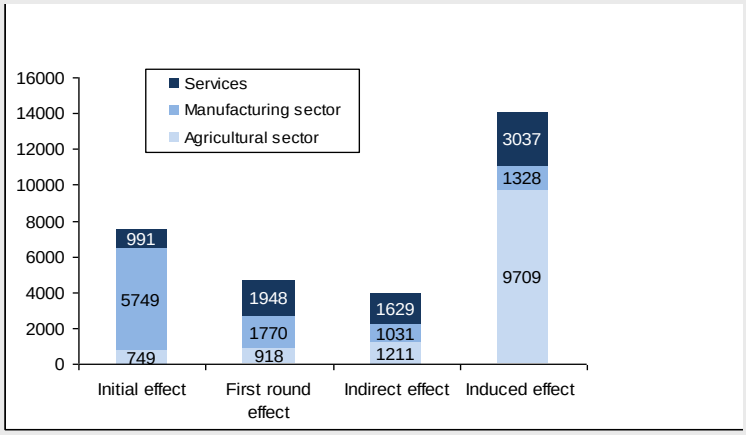
When differentiated according to skill level, there is an overall employment effect per year amounting to about 2,400 for highly qualified workforce, about 9,000 for medium-skilled and about 18,600 for unskilled workforce in the scenario "with GIS" (see Figure 2).

Operational and multiplier effects due to higher income impact during the useful life of the power plant: Whereas the investment effect arises temporarily, the operation of the plant causes permanent effects over its useful life. Approximately EUR 6.5 million are expected to accrue from the ongoing operation and maintenance work every year. The resulting demand triggers direct production effects of around EUR 10 million per year in the mechanical and electrical engineering and construction industry as well as the directly related supplier sectors. With the initial effect (about 420 jobs), the first round effect (about 450 jobs), the indirect effects (about 450 jobs) as well as the induced effects (about 1,210 jobs), a total of about 2,540 jobs are created every year over the useful life of the plant.

Final assessment

Input-Output-Models have their strengths in differentiated impact analysis of the short-to-medium term employment effects of small-to-

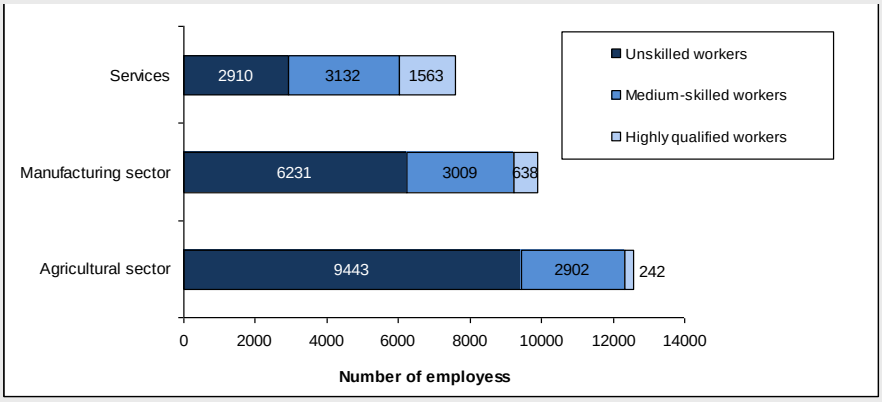
Figure 1: Sectoral employment effects per year (Construction phase; Scenario „with GIS“)



Source: Author's own illustration based on the results of A. Löschel

[2] To calculate the induced employment effects in India, values from Shukla (2010, Page 50) were used and converted to gross income.

Figure 2: Employment effects per year (Construction phase; Scenario „with GIS“, differentiated by Skills)



Source: Author's own illustration based on the results of A. Löschel

medium sized projects that do not result in price changes at the macroeconomic level. They are based on the assumption that, for a constant sectoral labour productivity and constant capacity utilization, the exogenous increase in the final demand causes an increase in production, which leads to more employment.

The total employment effects induced by the construction and operation of the hydropower plant Shongtong Karcham in India are estimated at approximately 29,000 to 30,000 employees per year in the six-year construction phase and about 2,500 per year during the operational phase. These strong effects are not least a result of the fact that the primary investment stimulus is completely effective in India, intermediate goods industries are well developed and the average sectoral labour productivity is relatively low.

In the programmes proposed by FC in the energy sector, until now rough estimates (if any only in a specific case or partially) are provided for the employment impact of the initial effect. The numerical model calculations for the Indian case study indicate that in determining the overall economic employment impact, the effects subsequent to the initial effect with a share of total employment growth of 75 % play a very important role – perhaps even a more substantial one. In particular the multiplier effect due to higher income is enormously significant with a share of nearly half of the total increase in employment. The use of economic models or model-based multipliers, which can at least roughly indicate the induced effects, appears to be indispensable if one wants to get a realistic picture of the magnitude of the economic promotional effects in the employment sector.

The results show only the *gross effects* on the Indian economy and do not consider the cost of financing. However, not too much importance should be attached to this potential negative budget effect, considering that the availability of additional electricity will help to bring the Indian economy onto a higher level of growth. The employment effects induced by economic growth, which cannot be quantified by the model, could compensate for any potential negative financial impacts.

References:

Auswärtiges Amt (2012), Indien - Wirtschaft, http://www.auswaertiges-amt.de/DE/Aussenpolitik/Laender/Laenderinfos/Indien/Wirtschaft_node.html

Germany Trade & Invest (2011), Indien im Fokus 2012, www.gtai.de

Shukla, Rajesh (2010), How India Earns, Spends and Saves, Unmasking the Real India, New Delhi, www.sagepublications.com

Further information:

Dr Henrike Koschel

Sector Economist, Sector and Policy Division Energy

Henrike.Koschel@kfw.de

KfW website for employment:

www.kfw-entwicklungsbank.de/employment/