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Effects and mechanisms of market-based reforms on access to electricity in developing countries

A systematic review

November 2016

Systematic Review 31

Energy

3ie International Initiative for Impact Evaluation

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Effects and mechanisms of market-based reforms on access to electricity in developing countries: a systematic review, was submitted in partial fulfilment of the requirements of grant SR5.1232 issued under Systematic Review Window 5. This review is available on the 3ie website. 3ie is publishing this report as received from the authors; it has been formatted to 3ie style. This review has also been published in the Campbell Collaboration Library and is available here.

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Funding for this systematic review was provided by the Global Affairs Canada (formerly the Department for Foreign Affairs, Trade and Development Canada).

Suggested citation: Bensch, G, Sievert, M, Langbein, J, Kneppel, N, 2016. *Effects and mechanisms of market-based reforms on access to electricity in developing countries: a systematic review*. 3ie Systematic Review 31. London: International Initiative for Impact Evaluation (3ie).

3ie systematic review executive editors: Edoardo Masset and Beryl Leach
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Summary

Background

Today more than 1.1 billion people lack electricity access, with negative implications for the livelihood of people as well as for the economic performance of a country. In many developing countries, poor people cannot afford an electricity connection. In addition, complete areas are without electricity, often due to prohibitive costs of centralized electricity supply. Costs are further increased through inefficiencies in all stages of electricity provision, namely generation, transmission, and distribution. Among others, this is related to financial obstacles and a lack of human resources and technical capacity, which may partly explain interregional differences: the majority of people without electricity access live in Sub-Saharan Africa (55 percent) followed by South Asia. In 2012, Nigeria had an electrification rate of 56 percent, India of 79 percent whereas Bolivia was almost fully electrified with 91 percent (World Bank and IEA 2015), despite all three being classified as lower-middle-income economies by World Bank.

Against this background, the Sustainable Energy for All initiative (SE4All), launched in 2011, was set up to channel activities for achieving universal access to electricity by 2030. Given this enormous challenge, it is vital to bring together the latest knowledge and evidence on most (cost-) effective mechanisms for achieving this goal. Market-based reforms are one potential vehicle for such mechanisms.

Objectives

The overall objective of this review is to systematically examine the impacts of market-based reforms on access to electricity in developing countries, compiling evidence from both quantitative and qualitative rigorous impact evaluations. Specifically, this review seeks to explore the following three main review questions based on the existing literature:

- What are the effects of different market-based reforms on electricity system parameters and electricity access for different groups of populations in developing countries?
- What mechanisms help explain these differences?
- What is the cost-effectiveness of the market-based reform measures?

Search methods

A systematic and comprehensive search was conducted to identify published and unpublished studies. Eight international electronic databases were searched as well as well as organization websites. Furthermore, bibliographic back-referencing and citation tracking were performed and recommendations from key experts were accounted for. The search was conducted in June/ July 2013 and July 2015.

Selection criteria

To be included in the review, studies were required to meet several eligibility criteria.

First, the study needed to have evaluated a market-based reform interventions, namely privatisation, private sector involvement, decentralisation, liberalisation, or changes in electricity tariff design. The review put no particular restriction on the dependant variables assessed by these studies as long as they served as performance indicators in a broader sense. The primary outcome of the review is access to electricity measured by electrification rates complemented by household welfare indicators. In light of the paucity of articles that address this primary outcome in the context of electricity market sector reforms, secondary (intermediate) outcome indicators are included as well. Any indicator playing a role in the causal chain underlying the interventions was included. We categorized them into (i) Technical and financial efficiency or inefficiency, (ii) Labour force, (iii) Supply and investment, (iv) Quality, and (v) Tariffs and costs. Together with the primary outcome type household welfare, these outcome types are reproduced in Table 1.

Table 1: Reviewed intervention and outcome types

Intervention Type	Outcome Type
1 | Privatisation	1 | Efficiency
2 | Liberalisation	2 | Labour force
3 | Private Sector Involvement	3 | Supply and investment
4 | Regulation	4 | Quality
	5 | Tariffs and costs
	6 | Household welfare

Second, the study setting must have been a low-or middle-income country (LMIC), defined in accordance to the World Bank classification as of June 2013 with only slight review-specific adaptations. In terms of the level of aggregation of participants (or, more generally, observation units), no restrictions were imposed in this review. They range from individual households, over power plants and utilities, to countries.

Third, eligible study designs for the effectiveness synthesis (review questions 1) were higher-quality causal inference designs, mostly including panel data methods, difference-in-differences, and similar regression-based approaches. Eligible comparison conditions applied in these studies were no intervention, staggered implementation, or “business as usual.” In addition, we allowed the before situation to serve as comparison as long as any kind of statistical control was employed. Quantitative evaluation approaches based on simulation or modelled benchmarking evidence are not part of this review, e.g. Data Envelope Analysis, Stochastic Frontier and Computable General Equilibrium models. For the second review question on mechanisms, any approach based on factual evidence was eligible, such as sector

and institutional analyses, as long as they focused on electricity market reforms in developing countries and certain quality thresholds according to critical appraisal were met. These articles generally compile empirical and anecdotal information in the form of (non-counterfactual) assessments or case studies in order to assess the research questions based on deep contextual knowledge. Finally, cost-effectiveness (review question 3) was allowed to be answered by either of these two types of quantitative and qualitative evidence.

Data collection and analysis

Information from the included studies was systematically coded and critically appraised. The standardized mean differences served as the key effect size measure for the effectiveness assessment. Due to data availability issues, it was partly relied on a set of alternative standard deviations and newly developed standard deviation approximations. Data of the same construct was separately synthesized along two dimensions: intervention type and outcome type. Given the heterogeneity of included outcomes, it was case-specifically decided whether it was appropriate to calculate overall pooled effect sizes using inverse-variance random effects meta-analysis. To the extent that the limited number of included studies allowed doing so, we conducted heterogeneity and sensitivity analyses focusing on individual continents, intervention sub-types like unbundling, main specific outcomes like transmission losses, or econometric specification details.

The findings from the quantitative synthesis were then brought together with those from a synthesis of the qualitative information on mechanisms, which focused on the identification of themes that help enriching the programme theory and its assumptions. We conducted an iterative logic model approach in which we used the hypothesized programme theory as our overall framework throughout. Specifically, we synthesized study findings on mechanisms according to all pairs of the four individual intervention and six outcome types used in this review. We thereby, for example, identified main mechanisms emerging from the primary studies that relate liberalisation measures with changes in efficiency.

Results

To start with, no data could be retrieved on reform costs so that cost-effectiveness of reform measures could not be assessed in this review.

The synthesis of results of the primary quantitative evidence studies showed that there is no robust evidence for a general trend in any relevant outcome triggered by market-based electricity sector reforms. There are merely weak indications that ownership (i.e. privatisation) plays less of a role than other market-based interventions and that regulation can show mixed results depending on how it is designed as part of a broader reform agenda. Among outcomes, supply and investment indicators are the only ones that coherently present positive, though weak, impacts.

Despite a careful separate pooling by the Intervention and Outcome Types listed in the table above, the quantitative synthesis has been plagued by substantive heterogeneity among primary studies in terms of study designs, units of analyses and applied outcome variables. The whole set of meta-analytical instruments could thus in many cases not be applied. This is also true for the few studies that jointly assessed reforms as combined interventions. The evidence base neither allowed embarking on relevant participant sub-group analyses.

The synthesis of the qualitative evidence illustrated that four factors linking the individual interventions and outcomes at the heart of the underlying theory of change are critical to increase the likelihood of positive effects of electricity sector reforms: (i) a commercial approach, (ii) competitive arrangements, (iii) cost-reflective pricing, and (iv) independent, empowered and efficient regulation. Beyond that the synthesis rather revealed the complexity of market-based reforms and the various technical, economic and political factors that need to come into play in order to reach desired outcomes.

Authors' conclusions

This review has shown that insufficient evidence is at hand to provide guidance for practice and policy. Findings merely suggest that electricity sector reforms are no panacea on their own. They rather have to be understood as complex interventions taking place at the intersection of the technological, economic and political sphere meaning they are complicated techno-economic and political economy matters that require strong collaboration between these fields of expertise.

Thus, considerable knowledge gaps have been exposed – in terms of absolute and relative reform costs as well as reform effectiveness. The paucity of quantitative evidence seems to be less a problem of lacking attention by the research community. It can rather be traced back to a combination of two factors: first, the lack of sufficiently detailed and internationally comparable data. And, second, the methodological challenge to develop a convincing rigorous framework to empirically isolate reform effects from confounding factors. To counter these problems, regulators and ministries around the world are to be motivated to provide the data necessary for effectiveness and cost-effectiveness studies. Moreover, more effort may be made to also cover indicators on potential key technical, economic, and political mechanisms. Additionally, researchers would do good to consistently apply best practise in panel estimations and make greater use of mixed methods to provide robust impact evidence that is linked to the underlying mechanisms of reform successes and failures.

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List of abbreviations

BAU	Business as usual
CCGT	Combined cycle gas turbine
CI	Confidence interval
DEA	Data Envelope Analysis
DiD	Difference-in-Differences
EGU	electricity-generating unit
FE	Fixed Effects
GDP	Gross Domestic Product
GEE	Generalized Estimating Equations
IEA	International Energy Agency
IPP	Independent Power Producer
IV	Instrumental Variable
LMIC	Low and middle income country
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
RCT	Randomised controlled trial
SE4All	Sustainable Energy for All Initiative
SMD	Standardized mean difference

cn	China
in	India
LA	Latin America
pe	Peru
pk	Pakistan

1. Background

1.1 Description of the problem

Electrification interventions have been an important pillar in infrastructure development in developing countries throughout the last 60 years. Yet, today more than 1.1 billion people still lack electricity access, representing about 15 percent of the worldwide population (World Bank and IEA 2015). This problem is particularly pronounced in rural areas, which account for 87 percent of those without electricity. In many developing countries, complete areas are without electricity, often due to prohibitive costs of centralized electricity supply given low population densities, a generally low demand for electricity or extreme climate and challenging topographical conditions. Costs are further driven up through inefficiencies in all stages of electricity provision, namely generation, transmission, and distribution. Even if an area gets electrified and low-voltage distribution lines are accessible, households do not necessarily connect to the grid. Lee et al. (2015), for example, find that half of the unconnected households in their sample of 150 rural communities in Western Kenya live within just 200 meters of a low-voltage power line.

At the same time, various constraints hold back decentralised energy alternatives. They include financial obstacles, pricing and regulatory policies, a lack of human resources and technical capacity as well as strong path dependence in energy infrastructure (Ki-Moon 2011). This may also partly explain interregional differences: the majority of people without electricity access live in Sub-Saharan Africa (55 percent) followed by South Asia. In 2012, Nigeria had an electrification rate of 56 percent, India of 79 percent whereas Bolivia was almost fully electrified with 91 percent (World Bank and IEA 2015), despite all three being classified as lower-middle-income economies by World Bank.

The lack of access to electricity has various negative implications for the livelihood of people as well as for the economic performance of a country. Among others, people usually have to light their homes with dim and sooty kerosene lamps and are cut off from means of telecommunication and broadcasting. In a broader context, the competitiveness of economies is considered to depend crucially on electricity supplies that are free from interruptions and shortages so that businesses and factories can work unimpeded (World Economic Forum et al. 2013). Access to electricity can also be seen as a precondition for development and the achievement of development goals (UN 2005, 2010, Guruswamy 2011).

1.2 Description of the intervention

Electricity interventions that may contribute to the electricity access goal can be classified into four categories:

- *Category 1: Interventions providing new or improved access to electricity* for communities and individuals through electricity grid construction and expansion using different types of technologies. These include projects and programmes whose main objective is to increase the number of people with

access to the electricity grid, as well as policies that commit to universal service obligations.

- *Category 2: Interventions to increase supply efficiency, mainly to reduce technical and non-technical system losses.* These include network maintenance or workers' capacity building for reducing technical losses due to old, deficient or badly maintained installations and incentive schemes to reduce non-technical system losses mainly caused by electricity theft.
- *Category 3: Governance and accountability improvements* including designing and administering support mechanisms for the poor and non-poor, institutional strengthening, management support, transparency and similar measures.
- *Category 4: Market-based reforms in the electricity sector*, i.e. reforms that seek to establish or increase the reliance on competition instead of government mandates and the involvement of public entities in rate-setting, financing, or administration. Those reforms encompass the following intervention types: private sector involvement, complete or part privatisation of market players, liberalisation of electricity markets, decentralisation or regulatory interventions such as changes in the pricing design.

The interventions are either implemented by the concerned governmental bodies such as the Ministry of Energy or Ministry of Finance, or directly by the electricity utility, or either agents. The utility is usually an electric power company that engages in the generation, transmission, and distribution of electricity for sale in a regulated market. Public utilities are the default in many developing countries and external donors may play a role in a broader network of actors.

There is typically a variety of ways in which these interventions are operationalized. The implementation mechanisms, or simply mechanisms, may range from the installation of a regulatory body over the unbundling of electricity generation, transmission and distribution to the introduction of consumption metering systems.

The availability of evidence on all four categories of electricity interventions was assessed during a preparatory scoping phase. We were able to identify few empirical studies on interventions to reduce technical and non-technical system losses (category 2) and governance and accountability improvements (category 3) in developing countries. Furthermore, there is obviously a mechanical relationship between new or improved provision of access to electricity (category 1) and the access to electricity goal, although not necessarily for policies to encourage universal service. Finally, market-based reforms (category 4) are often introduced with the intention to indirectly achieve what is intended to be achieved directly by the categories 1 to 3. This systematic review therefore focuses on market-based reforms. The other categories of interventions will only be covered insofar as they may be provided as co-interventions of the market-based reform intervention of interest.

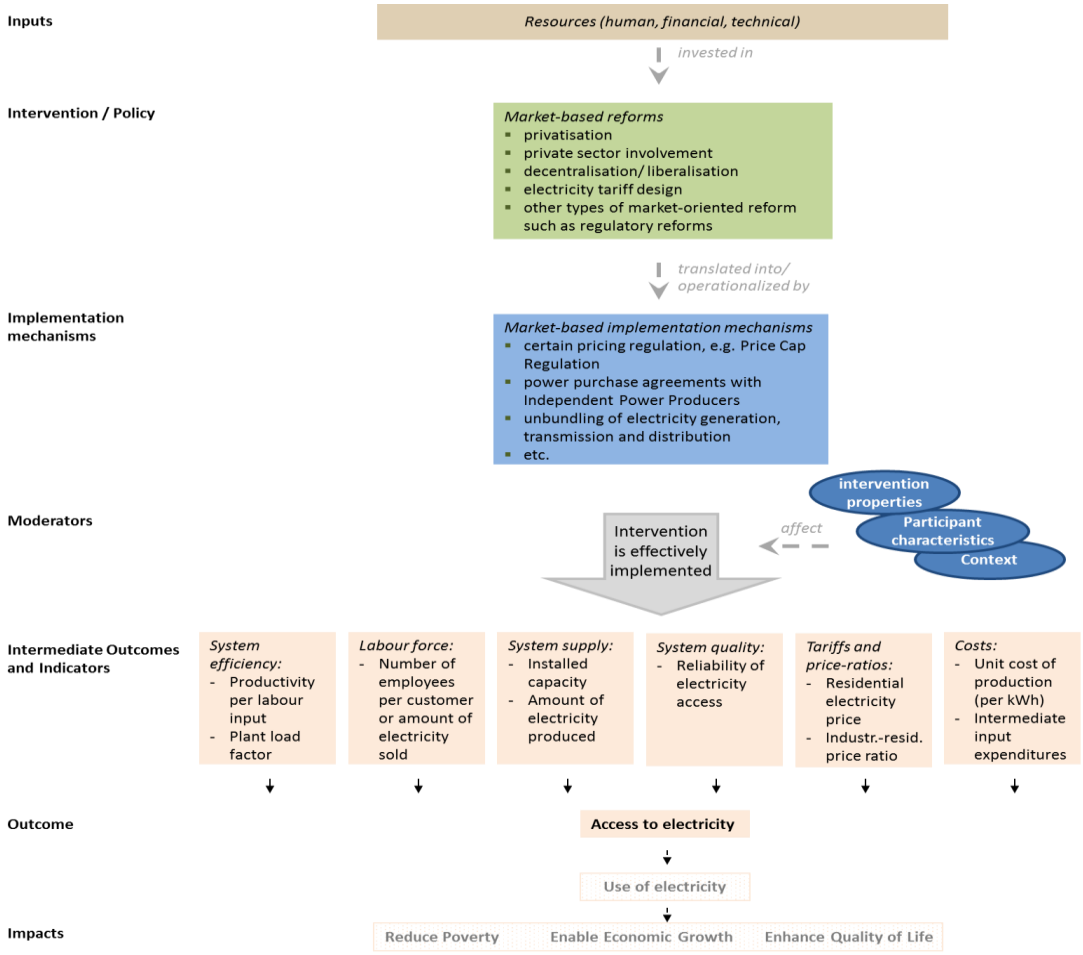
1.3 How the intervention might work

The focus of this systematic review is delineated in more detail in Figure 1, the logic model of the intervention: market-based reform interventions in the electricity sector in developing countries and their effect on the outcome *(increased) access to electricity* among households or other customer types.

The potential pathways and transmission channels between the intervention types and this outcome are rather implicitly found in the literature. One of the few studies that explicitly looks at electricity sector reforms in the context of improving access to electricity is Zhang et al. (2008), who develop hypotheses how privatisation, competition, and regulation affect electricity provision. One hypothesis, for example, states that competition will lead to higher labour productivity and higher capacity utilisation. We included these hypotheses in a neutral, non-judgemental manner in the logic model in Figure 1, which is therefore rather generically sketched in this figure. The qualitative synthesis on mechanisms conducted later on in this review enriches the model as part of an iterative logic model approach, in particular when it comes to implementation mechanisms.

Notwithstanding the narrowed focus in terms of intervention categories, market-based reform interventions themselves can be interpreted as “complex interventions” as they are delineated in a set of methodological articles in the *Journal of Clinical Epidemiology*. In their contribution to this journal series, Anderson et al. (2013) highlight the need to account for different forms of complexities that clearly exist in case of market-based reforms: effects of the interventions on resource use and costs are likely to depend on the specific implementation mechanism that is applied in the reform like power purchase agreements (see Figure 1). They are furthermore, to a greater or lesser extent, likely to be moderated, i.e. moderators can be expected to co-determine the relationship between the general intervention types and outcomes. We apply a broader definition of moderators in which we include variant properties or characteristics of the interventions and participants themselves, and of system settings and contexts in which interventions are implemented. These can be the existing energy mix and the institutional capacities of regulatory authorities, for example.

Figure 1: Logic model for market-based reforms in the electricity sector



Source: own illustration

A specific complexity feature is that certain implementation mechanisms can be outcomes at the same time, as it is the case for pricing: Pricing may either be used as a regulatory instrument in order to achieve improvements in intermediate outcome indicators (e.g. efficiency of distribution), or it may be an intermediate outcome of market-based reforms indicator itself, such as privatisations. Further intermediate outcome indicators are mentioned in the figure. They are all expected to create a more conducive environment to eventually achieve the outcome of interest, *access to electricity*, which is understood as *reliable access to electricity* (meaning that use and a sufficient level of service quality of the electricity access are guaranteed). The link between the interventions and access to electricity depend on three overarching assumptions: First, more market-based structures and procedures on the supply side help to increase resource efficiency. Second, these efficiency gains are reinvested in the system by increasing electrification efforts. Third, potentially adverse effects are mitigated.

While we will get into more detail about specific transmission channels in the results sections 4.3 and 4.4 , a few examples shall illustrate these assumptions: ideally the

different reform types privatisation, private sector involvement, liberalisation, or regulatory interventions instigate improvements in the technical and financial efficiency of the electricity sector through competition and profit orientation, which may go along with adjustments in the labour force. Increased efficiency and the opening of the market to new, private investors may then ramp up system supply. This, in turn, is supposed to affect quality, costs and tariffs and eventually the welfare of existing electricity consumers and lead to increased connections of new customers. Given the strong techno-economic and political complexities of the electricity sector, this causal chain is, however, far from certain. Depending on the context, uncoordinated competition may trigger system inefficiencies and profit-orientation hamper investments in socially desirable expansions of supply. Similarly, cost reductions may not translate into tariff reductions but rather be captured as a rent by private players with market power. Not least, the neglect of less profitable customer segments may create severe equity concerns, in particular across urban and rural populations. Reductions in average prices often go along with changes in the tariff structure, potentially at the detriment of the formerly (cross-)subsidised poor. Against this background, net effects of reform measures are hard to predict and also difficult to trace empirically, as will be discussed later in this review.

While utilities may see enhanced efficiency or increased access to electricity already as an end in itself, from a policy perspective the more aggregate impacts are ultimately poverty reduction, economic growth and enhancement of the quality of life of the population. The accomplishment of these ultimate welfare outcomes again depends on a variety of demand and supply-side factors, first of all the use of electricity but also others like targeting, grid reliability, and the productive use of electricity. These are, however, not the subject of this review.

1.4 Why it is important to do this review

The Sustainable Energy for All initiative (SE4All), launched in 2011, was set up to channel activities for achieving universal access to electricity by 2030. The initiative is the first to be jointly chaired by the UN Secretary-General and the president of the World Bank Group, underscoring the emphasis placed on energy access. Similarly, the aim to ensure access to affordable, reliable, modern and sustainable energy for all by 2030 has been adopted in a dedicated UN Sustainable Development Goal (SDG 7), which further underpins the relevancy of energy for economic and social development.

The investments required to achieve this goal are enormous – IEA (2011) finds that funding to improve access to modern forms of energy is less than one-fifth of the needed amount. The study quantifies investment needs to some 650 billion US Dollars additional to spending in a business as usual scenario (BAU). These BAU projections are that 1 billion people will still lack access to electricity in 2030, more than 60% of whom will live in sub-Saharan Africa.

Given this enormous challenge posed by the goal of universal access to electricity, it is vital to bring together the latest knowledge and evidence on most (cost-) effective

mechanisms for achieving this goal. The systematic scoping of the existing primary research in the preparatory phase of this systematic review indicated that there is literature available on the performance of market-based reforms as one potential means to support the achievement of this goal.[1] The specific attention to mechanisms is supposed to go beyond "black box" policy evaluations and to ask about how effectiveness is achieved instead of whether, or not at all.

As part of the present systematic review, we also comprehensively searched for data that would allow an analysis of cost-effectiveness. Cost-effectiveness seeks to further go beyond effectiveness by calculating the ratio of the amount of "effect" a programme achieves for a given amount of cost incurred (Dhaliwal et al. 2011). In the given context, the relevant effect is the provision of household electricity connections, though alternative measures among the intermediate outcomes are imaginable as well (e.g. percentage improvement in plant efficiency). Such information would potentially also allow comparing the relative effectiveness of different types of reforms or, more generally, different development interventions.

This review is thus intended to provide the technical background to inform policy makers engaged in developing conducive policy frameworks as part of energy access promotion efforts under the Sustainable Energy for All initiative (SE4All) and beyond.

So far, no systematic reviews exist on this exact topic. There is only a systematic review on private involvement (including public private partnerships) in the delivery of water, telecommunication and electricity services and its impact on improved access and quality of service in developing countries (Annamalai et al. 2013)[2]. The authors, however, focus exclusively on private sector involvement and explicitly exclude other aspects of market-based reforms that are an integral part of the present systematic review, which are privatisation, regulation and liberalisation in more general terms. In addition, the study synthesises unstandardized *t*-statistics rather than effect sizes, which represent a measure of the magnitude of change in outcomes comparable across studies.

A number of additional publications exists that give an overview of impacts of sector reforms and private sector involvement focused on the power sector. One recent publication is by Jamasb et al. (2015) who analyse the linkage between power sector reforms, economic and technical efficiency, and poverty reduction. The authors find a general improvement in efficiency and productivity in the power sector due to the sectoral reforms but these improvements do not always reach the end consumer. However, there is no systematic assessment or synthesizing of the findings. Other relevant publications tend to be relatively old and, more importantly, do not pursue a

[1] The study type eligibility criteria had to be refined in the course of the review process given the particularities of the methodologies applied in the primary studies. This led to the exclusion of many studies originally considered eligible for this review. The final number of included studies therefore ended up being relatively small.

[2] See also Devkar et al. (2013) and John et al. (2015) for published versions of this systematic review.

systematic approach of searching and synthesizing findings: Albouy and Nadifi (1999), Andres et al. (2009) and Jamasb et al. (2005). In a similar vein, there are summarizing publications on impacts of interventions that directly provide access to infrastructure in general and electricity in particular (referred to as category 1 in Section 1.2), i.e. the assessed interventions are unrelated to sector reforms (Estache 2010; World Bank IEG 2008).

2. Objectives of the review

The overall objective of this review is to systematically examine the impacts of market-based reforms on access to electricity in developing countries, compiling evidence from both quantitative and qualitative higher-quality impact evaluations. To do so, the review also relies on intermediate outcome indicators related to electricity system parameters, notably on system efficiency. This information is supposed to be fed into an analysis of the cost-effectiveness of such measures.

Specifically, this review seeks to explore the following three main review questions based on the existing literature:

Review question 1: *What are the effects of different market-based reforms on electricity system parameters and electricity access for different groups of populations in developing countries?*
Review question 2: *What mechanisms help explain these effects?*
Review question 3: *What is the cost-effectiveness of the market-based reform measures?*

Question 1 is a causal effect question and requires quantitative impact evaluation approaches. Impacts are assessed for different classes of market-based reform interventions, which are privatisation, private sector involvement, decentralisation, liberalisation, and changes in electricity tariff design.

Quantitative studies generally provide a stronger link between outcome and intervention, but they do not necessarily delve into the causal chain, notably into the question on mechanisms and assumptions, which are instrumental in this study. To augment the robustness of quantitative studies, this review therefore has the additional objective to unpack the logic model and contextualize the findings. This is addressed in review questions 2, which relies on qualitative evidence and, to the extent possible, also on the quantitative evidence. We thus link qualitative to the quantitative findings, drawing on and further developing the causal chain model outlined in Figure 1 on page 4.

Finally, review question 3 seeks to make use of both quantitative and qualitative evidence. The purpose is to facilitate comparing the studied intervention types with alternative measures in terms of their effectiveness in accomplishing energy access or even broader development objectives. Thus, this review addresses three main review questions based on two types of evidence, quantitative and qualitative, which are specified in the next chapter.

3. Methods

3.1 Title registration and review protocol

The title for this systematic review was published in The Campbell Collaboration Library of Systematic Reviews on March 3, 2014. The review protocol (Bensch et al. 2015) was published in the 3ie Systematic Review database on December 14, 2015. No deviations have been made in terms of the methods applied.

3.2 Criteria for considering studies for this review

Overall, we conducted this review according to the Campbell Collaboration Review Methods Guidance (Campbell Collaboration 2014) and accounting for the 3ie systematic review methods appraisal check (3ie 2011). In order to address the overall objective of this review, we conducted an integrated mixed-methods review that synthesizes quantitative evidence and complementary information on mechanisms and costs-effectiveness. Whenever applicable, we explicitly differentiate the sub-chapters along the three review questions presented in Section 2 or along the quantitative and qualitative evidence. These two types of evidence are defined in the following sub-Section 3.2.1.

3.2.1 Types of studies and methods of analysis

Quantitative evidence

As quantitative evidence, which may contribute to answering all review questions, we considered higher-quality causal inference designs. They include experiments, matching, regression and (within-country and cross-country) panel data methods, difference-in-differences, instrumental variable estimations, regression discontinuity designs, as well as interrupted time series designs.

Quantitative evaluation approaches that can be found in the literature based on 'non-factual', i.e. simulation or modelled benchmarking evidence are not part of this review. These include, on the one hand, efficiency analysis approaches like Data Envelope Analysis (DEA) introduced by Charnes et al. (1978) and Stochastic Frontier Models (independently proposed by Aigner et al. 1977; Battese and Corra 1977; Meeusen and Van den Broek 1977). On the other hand, simulation approaches are excluded, namely Computable General Equilibrium (CGE) designs and the so-called social cost and benefit analysis methodology proposed by Jones, Tandon and Vogelsang (1990), in which the continuation of baseline conditions is simulated as counterfactual (see as well Anaya 2010).

Qualitative evidence

Any approach based on factual evidence was eligible for review questions 2 and 3 relying on qualitative evidence. Among others, this comprised sector and institutional analyses, satisfaction surveys or methods which are not counted among the abovementioned higher-quality causal inference designs. These articles generally compile empirical and anecdotal information in the form of (non-counterfactual)

assessments based on deep contextual knowledge to provide some analysis of factors and mechanisms influencing success and failure. We differentiate between institutional analyses of institutional actors, structures, and processes and case studies. In line with Rehfuess et al. (2014), we define case studies as assessments that rely on at least one source of empirical information (if primary data, the study is additionally supposed to report information on sampling and data collection) and report information on the analysis.

We included studies that met the following criteria:

1. *Focus* on electricity market reforms in developing countries. This also covered studies on infrastructure market reforms, but excluded, for example, studies on other sectors that address the electricity market only parenthetically.
2. Reference to *mechanisms* behind observed reform effects or to reform *costs*, since these are the core aspects of the second and third review question related to qualitative evidence. This also excluded a few studies that address particular projects on the micro level, which provide no insights on general mechanisms or reform costs.
3. *Higher-quality* studies according to critical appraisal. Higher quality of included articles was safeguarded based on the quality assessment detailed in Section 3.4.3: only those studies were considered that scored “high” for either the *methodology* or the *analysis* criterion and at least “medium” for both.
4. The exclusion of ‘non-factual’ evidence implied excluding studies on planned or upcoming reforms, thus including only *previous or ongoing* market-based electricity sector reforms.

3.2.2 Types of participants and settings

In accordance with our main objective we only included studies carried out in low and middle income countries (LMIC). Low and middle income countries were defined in accordance to the World Bank classification as of June 2013 (see Appendix 0). We slightly adapted this definition by excluding the former Soviet Union, former Yugoslavia and Turkey. These countries have virtually full electrification coverage for some decades already and insights from their electrification process were considered to contribute little to the learning process on how to reach the universal access goal in today’s developing countries. In addition, studies were excluded that do not differentiate between low and middle income countries and high income countries, i.e. global cross-country studies that do not conduct any sub-group analysis of LMICs. In cases, where authors conducted their analysis on self-defined groups of countries (e.g. “Asian Developing Countries” in Nagayama 2009), we included those analyses where the majority of countries belonged to our eligible study participants.

In terms of the level of aggregation of participants (or, more generally, observation units), no restrictions were imposed in this review. The lowest level encountered in this review as the ultimate electricity customer is the household, though we also allowed for other types of customers like enterprises. Beyond them, further levels include electricity-generating units (as parts of power plants), power plants, utilities

(the companies that engage in electricity generation and/ or distribution), sub-country regions, and countries.

3.2.3 Types of comparisons

Quantitative evidence

Eligible comparison conditions were no intervention, staggered implementation, or "business as usual." In addition, we allowed the before situation to serve as comparison as long as any kind of statistical control was applied.

Qualitative evidence

Here, comparisons are neither necessary nor in many cases identifiable.

3.2.4 Types of interventions

Among the intervention types outlined in Section 1.2, we focus our review exclusively on market-based electricity reform policy interventions. These interventions may be individual projects or elements of either combined interventions involving multiple reform types or larger energy policy measures. In particular, we considered the following intervention types:

- *Privatisation,* which refers to a change in ownership from governmental to private actors. In the present case, this means that former national utilities start being operated by private actors.
- *Liberalisation*, which encompasses the opening of the electricity market to competition. Liberalisation mostly addresses the generation stage, since networks are usually considered as natural monopolies. Still, the distribution and transmission stages may as well be liberalised. Previously vertically integrated energy markets may, for example, undergo *unbundling* of network services from other business fields as a prerequisite for common access of different actors to the network. Another main example is the introduction of a *wholesale electricity market*, which is the trading platform where competing generators offer their electricity output to retailers at the distribution stage. Finally, there are *other competition-enhancing policies* such as granting the free choice of suppliers or open access to network and introduction of retail competition.
- *Private sector involvement,* which implies that tasks that previously had been handled by the public sector are transferred to private entities. In our case this can take the form of, for example, private investment in generation, distribution or transmission of electricity. The first, private investment in generation, is particularly common in the electricity sector, referred to as *Independent Power Producers* (IPPs).
- *Regulation*, which usually accompanies the abovementioned interventions to guarantee a level playing field, including for example *changes in the electricity tariff design.*
- *Decentralisation,* where formerly centralized decision power is dispersed over various hierarchical, administrative levels.

These definitions of reform intervention types are not necessarily clear-cut and mutually exclusive. We followed the definitions of the original authors as reflected in the designation of intervention variables, but also scrutinized their validity as part of the sensitivity analysis. Taking the example of an estimation in a quantitative evidence study that uses a dummy indicating whether an independent regulatory agency is in place, this estimation is considered to assess the intervention type regulation.[3]

A comprehensive list of electricity sector reforms realized around the world since 1978 can be taken from Appendix 0.

3.2.5 Types of outcome measures and other data recorded

Review question 1 on effectiveness

Primary outcomes

The primary outcome is access to electricity measured by electrification rates, be it at national level or at the level of a smaller administrative unit. These electrification rates are measured as the percentage of the respective population reached (preferably individuals instead of households). If reported, consumer-level welfare indicators, e.g. related to the health of households, are as well considered among primary outcomes.

It was furthermore intended to account for the reliability of access to electricity as long as information on service quality of the electricity access was available, e.g. in terms of households suffering from different levels of blackouts and/or brownouts. This information could have been used to define thresholds that determine a reliable electricity access. Such information, however, could not be retrieved from the original studies.

Secondary outcomes

In light of the paucity of articles that address our primary outcome in the context of electricity market sector reforms, secondary (intermediate) outcome indicators are covered in this review. In principle, we included any indicators that played a role in the causal chain underlying the interventions as it is outlined above. We categorized them into (i) Technical and financial efficiency or inefficiency, (ii) Labour force, (iii) Investment, (iv) Supply, (v) Quality, (vi) Costs, (vii) Tariffs, (viii) Price ratios, (ix) Revenue.

All primary and secondary outcomes included in this review are listed in Table 2 together with examples of specific outcome variables.

[3] See 3.4.10 for more details on how this review dealt with specific parametrizations of intervention types.

Table 2: Outcomes included in this review

Outcome type	Detailed outcome variables collected (examples)
Intermediate (secondary) outcomes:	
Technical and financial efficiency or inefficiency	
○ utilities	Overall productivity (per customer) Fuel productivity (ln) Labour productivity (ln)
○ generation	Capacity utilisation, i.e. the ratio of electricity generation to average capacity Plant load factor, i.e. the ratio of a power plant's actual to its potential output according to its nameplate capacity Plant availability, i.e. the share of hours in a given time period a power plant was available for generation Operating heat rate (ln), i.e. the sum of energy carriers burned per kWh multiplied by the their heating value
○ transmission and distribution	Transmission and Distribution losses (% of total electricity generated)
Labour force	Number of employees (in ln terms, per 1000 customers or per MkWh sold)
Investment	Real Private Investment
Supply	(Net) electricity generation (per capita or per employee*) Electricity generation capacity (per capita) No. of electricity connections (in ln terms or per employee*) Electricity sold (per year in ln terms, per year and employee*)
Quality	Duration of interruptions Frequency of interruptions
Costs	Unit cost of production (per kWh) Intermediate input expenditures
Tariffs	Average residential or industrial or overall electricity price

Outcome type	Detailed outcome variables collected (examples)
Price ratios	Industrial-residential price ratio
Revenue	Price-cost ratio
Primary (final) outcome:	
Electricity access (supply)	(Rural) electricity access rates (% of population or households)
Household welfare	Birth rate proportion less than 2500 grams

Note: * These per-employee supply indicators have all been included in the Supply category even though it has to be borne in mind that they may as well be affected by system efficiency.

For all measures, we differentiated between the household level, the community or municipality level, and other levels of analysis such as the utility, system, grid, region, or country.

Main adverse and unintended effects are already reflected in these indicators, for example quality deterioration in terms of higher distribution losses. By their very nature, it remained to be seen (and documented), which types of adverse and unintended effects were raised in the reviewed literature.

Review question 2 on mechanisms

To answer review question 2, we included any evidence on mechanisms raised in the literature that may explain effectiveness or ineffectiveness of market-based reforms. To give an example, network access rules have been highlighted in relation to liberalisation processes.

Review question 3 on cost-effectiveness

Related to review question 3, any sort of cost data on electricity sector reforms reported in the literature were as well collected.

3.2.6 Duration of follow-up

No restriction was placed on the timing of outcome measurements. Since most studies are based on secondary (annual) panel data, follow-up duration is mostly not an issue in this review. For the few other study designs, the duration between the "follow-up" and the intervention was determined and highlighted in the synthesis if deemed of particularity or relevance.

3.2.7 Date, language and form of publication

For this review, eligibility extended to studies published or reported within the period 1 January 1980 to 30 June 2015. Studies published before that date were considered to contribute little to the learning process on how to reach the universal access goal in today's developing countries. Studies published in any language were eligible, regardless of their publication type. We thus did not exclude specific forms of publications, such as unpublished working papers, theses or dissertations.

3.3 Search methods for identification of studies

3.3.1 Electronic searches

A total of eight international databases were systematically searched during a scoping phase for this review. The covered databases were: *ABI/INFORM Global*, *British Library for Development Studies*, *Business Source Complete, Econlit, Energy Citation Database*[4]*, PAIS International, World Wide Political Science Abstracts* and *Google Scholar*[5]. The search strategy comprised the five intervention types mentioned in Section 3.2.3: (i) privatisation, (ii) liberalisation, (iii) private sector involvement, (iv) decentralisation, and (v) changes in the electricity tariff design.

The database-specific search strategies are shown in Appendix 0. We furthermore manually searched the websites of development aid institutions, which are listed in Appendix 0. A single search was conducted to address all review questions. We used the reference management database Citavi to organize and keep track of references identified through the electronic database search.

3.3.2 Searching other resources

We carefully evaluated any literature provided by advisory group members approached during the early phase of the review. Having a set of included literature at hand including the electronically searched articles, a final step of the search and selection process of relevant primary research involved bibliographic back-referencing (reviewing references of included studies) and citation tracking (reviewing references in which the included study has been cited). When there was more than one record of the same study, we included all records meeting the inclusion criteria, but used the most relevant one, i.e. the publication containing the most complete data set, as the main record.

3.4 Data collection and analysis

3.4.1 Selection of studies

The studies identified in our primary search (electronic search, suggested literature) and the literature identified through back-referencing and citation tracking underwent a three-stage process.

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[4] Search results for this database are only available until June 2013, the time of our first search round. The American Department of Energy phased out the “Energy Citation” database shortly after that by the end of August 2013. It was merged with the "Information Bridge" into a newly created database called "SciTechConnect". We abstained from using this database in our second search round in July 2015, since it uses different search technologies that do not allow to filter papers potentially relevant for this review. In addition, the database proved to be irrelevant for this review given that none of the documents published before June 2013 were eligible. It is therefore safe to state that the exclusion of the last two years from this database does not bias our results.

[5] For each of the four queries presented in Appendix 0, the first 60 hits were recorded in the two search rounds (where the time period was limited to the previous two years in the second round). Thus, in total 480 were screened.

In the first stage, three junior reviewers and one senior reviewer (MS) single-screened titles. Selection at this stage was focused on the criteria Participants, Interventions and Outcomes of interest (Sections 3.2.2, 3.2.4 and 3.2.5). With regards to types of Comparisons and Study designs, we only excluded theoretical modelling at this stage. The inclusion decision form shown in Appendix 0 was used. Studies classified as “yes” or “maybe” to all three questions made up the pool of potentially relevant studies that were imported in our Citavi database. Reviewers were over-inclusive to ensure relevant studies were not omitted because sufficient information was not reported in title. In some cases, they referred to study abstracts to clarify doubts right away.

In the second stage, the same team of reviewers screened study abstracts. For non-English studies, the English abstracts were reviewed, which were available in all cases. In particular, they categorized the potentially relevant studies according to their methodological approach into either quantitative evidence or qualitative evidence. Those documents that only inform on the implementation of an intervention without drawing conclusions or analysing impacts were excluded at this stage. If required, full texts were checked. Doubts about inclusion, in particular of “maybe” studies, were resolved among the review team.

In the third stage, the inclusion criteria with regards to types of Study designs and Comparisons (Section 3.2.1 and 3.2.3) were further refined according to the studies encountered in the second stage. Based on that, another team of three junior reviewers supervised by a senior team member (GB) determined the studies to be finally included. For the quantitative evidence studies, this required reviewing the articles retained after the second stage at full texts. For the qualitative evidence, title and abstract screening sufficed in many cases. Still, reviewers were generally rather over-inclusive and relied on full texts if doubts remained.

Any further uncertainties and discrepancies were resolved by discussion, further review of the respective studies and, where necessary, consultations with the senior team member. The third step was conducted in combination with data extraction.

3.4.2 Data extraction and management

Two junior reviewers supervised by a senior team member (GB) extracted data from included studies using a study coding form in Excel format. All data used for analysis were independently extracted and checked by a third junior reviewer. Information was pre-coded apart from the specific contextual and results features, which were classified by theme post hoc, i.e. during the coding process. The following describes the main study-level variables that were coded for each of the types of characteristics (a complete list can be found in Appendix 0):

- *general study information:* authors, year and type of publication, information on funding, type(s) of intervention (privatisation, etc.);
- *study context*: country, rural or urban setting, implementation period of intervention;
- *specific contextual and results features*: adverse or unintended effects, types

of moderators or mediators/ mechanisms discussed, types of subgroups assessed;
- r*isk of bias for quantitative causal studies and quality assessment of additional qualitative evidence*, described separately in the next section.

A separate section of the data extraction form covered data to be used for the quantitative synthesis addressing review question 1 on effectiveness:

- *data and methods*: unit of observation (e.g. household, utility, country), statistical method (difference-in-differences, etc.), numbers of treatment and control observations.

Similarly, a section of the data extraction form was dedicated for review question 2 on mechanisms:

- *mechanisms*: any type of information on factors that may explain the relationship between the interventions and the outcomes.

Finally, for review question 3, the data extraction form registered any information related to reform costs:

- *reform cost information:* any type of cost and cost estimate data.

3.4.3 Quality assessment and assessment of risk of bias in included studies

In order to account for differences in the validity of the applied approaches, we conducted a quality assessment of both the quantitative and qualitative evidence studies. For quantitative studies, we focused on their risk of bias (internal validity), for qualitative studies we assessed the quality of the research in more general terms (internal and external validity).

Quantitative evidence

Risk of bias was assessed using the Risk of Bias Tool proposed in Waddington and Hombrados (2012). We also considered the suggested risk of bias criteria for EPOC (Effective Practices and Organisation of Care) reviews (EPOC 2012), of which we added the criterion that the intervention can be considered as being independent of other changes. It was thus assessed whether the included studies might suffer from the following biases:

- *sample selection bias*: potential bias due to non-random assignment, non-exogenous source of quasi-experimental variation in assignment, no adjustment for confounders, e.g. differences in baseline measurements
- *motivation bias*: potential for Hawthorne or John Henry effects during the process of being observed for data collection
- *"incomplete data bias"*: non-compliance, non-response, attrition, or otherwise missing data (unavailable data falls under omitted variable bias)
- *spill-overs/ cross-overs/ contamination*: interference across intervention and non-intervention units

- *intervention independent of other changes*
- *selective outcome and analysis reporting*: potential for systematic differences between reported and unreported findings
- *incorrect confidence intervals or standard errors*: e.g. due to wrong distributional assumptions, fallacies in terms of the power of the study or a unit of analysis error (see Section 3.4.6)
- *other sources of bias*
  - simultaneous causality
  - omitted variable bias, misspecification of the functional form

Conflicts of interest can undermine the independence and thus the unbiasedness of research. Studies on reforms in the energy sector may be prone to such biases, since this sector tends to involve strong vested interests. To account for this further potential source of bias, we added the following signalling question to our risk of bias assessment along the lines of the Risk of Bias Tool:

- *Conflict of interest:* was the study produced in a context that guaranteed the unbiasedness of results related to vested interests?
  Score "NO" if:
  - study is funded by organizations that have a vested interest in the outcome of the research, e.g. as it is itself one of the principal subjects of the research
  - *or* authors have multiple potentially competing professional interests, which could impair the authors' ability to perform the research impartially.

  Score "YES" otherwise.

However, we eventually did not find any included study, for which suspicion was strong enough to code it as "No", which is why this criterion is not further discussed below.

While other systematic reviews propose an extensive catalogue of sub-criteria (see, for example, Brody et al. 2015), for the quantitative evidence studies we focused on few criteria related to the soundness of the methodology only. This means, we abstained from including criteria with regards to the quality and comprehensiveness of the presentation, since we considered them secondary for a judgement of potential biases.

If applicable, the relevant information was collected for each domain (e.g. sample selection bias) through the study coding form (Appendix 0). In line with the Risk of Bias Tool, this information was then translated into either "high risk of bias", "low risk" or "unclear risk". A summary judgment of the within-study risk of bias was carried out using the criteria provided in Higgins and Green (2011, Table 8.7.a).

Qualitative evidence

For the qualitative evidence studies, we used the guidance provided in the Critical Appraisal Skills Programme checklist (CASP 2006) and in IOB (2009) to assess the quality of included studies using the following criteria according to Table 3:

- explicit and convincing linkage to relevant literature and/ or theory
- clear and sound methodology
- appropriate, clear and comprehensive analysis
- conclusions consistent with the analysis
- conclusions accounting for limitations.

Table 3: Quality assessment roster of qualitative evidence studies

	Quality rating			
	high	**medium**	**low**	**n/a**
Explicit and convincing linkage to relevant literature?	Yes	Linkage to literature, but relevance unclear	No linkage at all	
Clear and sound methodology?	Yes	Non-standard, rather unclear approach	No systematic approach	
Appropriate, clear and comprehensive analysis, including triangulation?	Yes	Decent, but not well focused analysis that lacks some important aspects	Mismatching and unclear analysis	
Conclusions consistent with analysis?	Yes, at least mainly consistent	Only partly consistent	(Almost) no consistency	No conclusion
Conclusions accounting for limitations?	Yes	No (or limited) reference to transferability or limitations, but no obvious negligence	Obvious negligence of limitations, over-stretched transferability	

3.4.4 Data synthesis

We followed different approaches in synthesizing quantitative and qualitative data related to the two types of review questions, which are reported in the results Section 4.

Review question 1 on effectiveness

For the quantitative causal effect review question 1, we conducted a meta-analysis, i.e. an analysis that pools the findings from different studies. This analysis provides a single point estimate with increased statistical power, together with the likely range of

effects based on the associated confidence intervals (Cohn and Becker 2003). We separately synthesized data that were of the same construct (or "pool") along two dimensions: Intervention Type and Outcome Type (see Table 4).
First, data is synthesized for the Intervention Types presented in Section 3.2.4. Combined interventions involving multiple reform types are only synthesized in conjunction if they are treated as a single variable in the original studies. We refer to them as "Composite reforms". If they are estimated via multiple variables, we synthesize along Intervention Types as long as each Intervention Type only contributes one estimate (e.g. one privatisation dummy and one liberalisation dummy) or if the individual variables added up to the likely effect of the Intervention Type (e.g. one minority and one majority privatisation dummy in Cubbin and Stern 2006). Conversely, we excluded the complete estimation in the synthesis of the respective Intervention Type, if it included various variables of the same Intervention Type that, in sum, do not necessarily reflect the likely effect of the Intervention Type as a whole (e.g. *wholesale electricity market* and *unbundling* as Sub-Types of *Liberalisation* in Erdogdu 2011*a*).[6]

Second, certain Outcome Types among those listed in Table 2 of Section 3.2.5 were grouped together in the data synthesis. We did so given the limited sample of studies that were eventually included and for the sake of conciseness. This applies to the Outcome Type categories "Investment and Supply" as well as "Costs and Tariffs". Each pair, however, does not reflect exactly the same construct. Variations in costs, for example, not necessarily translate into changes in tariffs of a similar magnitude. The synthesis of results in Section 4.3 is therefore especially careful when it comes to these two pairs of Outcomes Types, though it has to be noted that considerable heterogeneity is also present among other Outcome Types, not least "Efficiency". Furthermore, the Outcome Types "Price ratios" and "Revenue" were not considered in the data synthesis. They were not assessed by a minimum number of three studies and could not be reasonably grouped with other Outcome Types.
We applied inverse-variance random effects meta-analysis. In comparison to fixed effect modelling, random effects produce pooled effect sizes with wider confidence intervals. For fixed effects, however, it has to be justifiable to assume that effect sizes come from a singular population (Borenstein et al. 2009*a*). Against this background, we opted for random-effects modelling since we considered effect sizes to differ too much across studies due to a range of factors including contextual variation (e.g. intervention design and implementation process and follow-up period) over and above the effects of chance alone on findings. This consideration is also supported by the statistics on heterogeneity presented in the results Section 4.3 .

[6] See also Step 2 of Appendix 0, the description of how estimates were dealt with in the calculation of pooled estimates, which is introduced in the next sub-Section 3.4.5.

Table 4: Dimensions used to pool effect sizes

Intervention Type	Outcome Type
1 | Privatisation	1 | Efficiency
2 | Liberalisation	2 | Labour force
3 | Private Sector Involvement	3 | Supply and investment
4 | Regulation	4 | Quality
5 | Composite reform	5 | Tariffs and costs
	6 | Household welfare

Note: See Section 3.2 for a definition of the different study types, intervention and outcome types. A study that did not differentiate between individual intervention types of a combined intervention and instead looked at the combined intervention reform as an aggregate is referred to as “Composite Reform”. As will be shown in the empirical results part of this review in Section 4, no primary studies could be found that address decentralisation as the fifth individual Intervention Type covered by this review.

Effect sizes are estimated with Stata software (Stata Corporation, College Station, TX, USA), irrespective of whether or not a pooled meta-analytic effect is estimable. We report the effect sizes using forest plots as long as at least three studies contribute to the respective pool. We decide case-specifically on whether it is appropriate to pool across studies given the heterogeneity of included outcomes – and thus on whether to show the overall pooled effect size in the forest plots. We consider effects as statistically significant if they have a *p*-value from a two-tailed test of less than .05. In addition, we conduct meta-regression analyses, which combine meta-analytical tools with the regression approach to assess different influencing factors on the magnitude of effect sizes in a multivariate manner. The Stata commands used are *metan* and *metareg*.

Review question 2 on mechanisms

The synthesis of the qualitative information on mechanisms is focused on the identification of themes that allow enriching the programme theory and its assumptions. We conducted an iterative logic model approach in which we used the hypothesized programme theory as our overall framework throughout. Specifically, we synthesized study findings on mechanisms according to all pairs of the four individual Intervention and six Outcome Types listed in Table 4. We thereby, for example, identified main mechanisms emerging from the primary studies that relate liberalisation measures with changes in efficiency.

Review question 3 on cost-effectiveness

Cost data was supposed to be synthesized in line with the Campbell Collaboration guidance provided by Shemilt et al. (2008). As will be shown in the results Section 1, cost data were, however, not retrievable.

3.4.5 Measures of treatment effect

Review question 1 on effectiveness

We calculated effect sizes to measure the magnitude of the reform intervention effects based on the quantitative evidence studies. The type of effect size calculated generally depends on the type of outcome and intervention being examined as well as the data available from the published studies. In our case, all included studies used continuous outcome data, e.g. installed generation capacity, cost estimates per customer, productivity per labour input and the price of electricity.[7]

Effect sizes were calculated for each estimation *i* imported from the included studies. β_i is defined as the *i*th treatment effect. It can either refer to the coefficient of the treatment variable in regression-based studies or, for matched-based strategies, to the difference in the mean outcome in the treatment group and comparison group, $\bar{X}_{i,t}$-$\bar{X}_{i,c}$. The standardized mean differences (SMD) as the key effect size measure is then given by $SMD_i = \beta_i/s_i$, where s_i is the standard deviation of the respective outcome variable at endline (post-treatment). Standardization proved to be necessary, since included studies measured outcomes in different ways (i.e. with different tools between studies). Due to data availability issues, we could not use the pooled post-treatment standard deviation as the generally preferred standard deviation but relied on a set of alternative standard deviations and newly developed standard deviation approximations outlined in Appendix 0.

All effect sizes have been computed in a way that positive effect sizes represent increases in the respective Outcome Type category. Inefficiency outcomes, such as occurrence of outages, have thus been inverted to be used in the Efficiency category, for example.

The standard error *SE* of SMD_i is the second main standardized measure to be calculated. It was approximated by $SE(SMD)_i = SMD_i/t_i$, where t_i is the Student *t*-statistic of the estimated β coefficient. Based on this information, we calculated 95 per cent confidence intervals (CI).

In a meta-analysis, the unit of analysis is the study. To maintain the assumption of statistical independence in the data, it is important that for each pool, for which pooled estimates are calculated, only one effect size is retrieved from a study (Borenstein et al. 2009*b*). This implies that in the presence of multiple dependent effect sizes within a study, these estimates may have to be hierarchized or combined. This was the case in all but one study (Yu and Pollitt 2009). Nagayama (2007), for example, assesses two outcomes of the same Outcome Type, residential and industrial electricity price. The author furthermore uses specifications with and without interaction terms, which he applies to a global dataset on developing countries as an aggregate and disaggregated by continent.

[7] For dichotomous data, we would have used summary odds ratios (RR) with 95 percent confidence intervals and converted them to SMDs as shown in Borenstein et al. (2009*a*: 47). For outcomes not measured numerically, we would have extracted them in a qualitative manner, e.g. indicating the direction of effect.

In a first step, we sought to select at most one effect size estimate per pool from each study. Studies that included multiple independent measurements based on non-overlapping samples were allowed to contribute one estimate *per sub-study* to each pooled effect size. If we encountered cases with multiple estimates for one pool within a study or sub-study, we gave preference according to a set of successively applied priority criteria outlined in Appendix 0. A clear preference could, however, not always be determined among the often still heterogeneous outcomes. For transparency, we chose the most standard outcome as default in these cases, generally the first one assessed by the original authors.

To test whether results are affected by this partly arbitrary choice, we additionally calculated "synthetic effect sizes". These synthetic effect sizes are meant to reflect the average effect size of the eligible study estimates that accounts for the dependence of the estimates coming from the same study. Borenstein et al. (2009*a*, chapter 24) suggest the sample-weighted average of the *m* estimates as single synthetic effect size point estimate of SMD_i:

$$SMD_i = \frac{1}{m} \times (\sum_{j=1}^{m} SMD_j)$$

and a formula that can be transformed to yield a "synthetic standard error" of the effect size:

$$SE(SMD)_i = \sqrt{\left(\frac{1}{m}\right)^2 \times (\sum_{j=1}^{m} SE(SMD)_j^2 + \sum_{j \neq k} (\rho_{jk} \times SE(SMD)_j \times SE(SMD)_k)}.$$

ρ_{jk} in this formula is the correlation coefficient between effect size estimates. This is unknown and can hardly be plausibly approximated for the included studies. We therefore assume ρ_{jk}=1, i.e. perfect correlation, since this is the most conservative option given that precision will likely be underestimated (with variance likely overestimated).

Review questions 2 and 3 on mechanisms and cost-effectiveness

The measuring of treatment effects is only required for the first review question on effectiveness. Similarly, the following sub-Sections 3.4.6 to 3.4.10 are only applicable for Review question 1 on effectiveness.

3.4.6 Unit of analysis issues

The unit of analysis of included studies is mostly a whole country, but may also be a sub-country region, a utility, power plant, electricity-generating unit (as part of a power plant), or a household. We accounted for this diversity of levels in the quantitative analysis in the sensitivity analysis (see Section 3.4.10).

Another main unit of analysis issue is the unit of analysis error. It is usually understood to occur when the analysed units, e.g. individuals, are different from the units of allocation to the treatment and comparison group, e.g. villages (Cochrane Community 2016). Most often, this type of error occurs with randomised controlled trials (RCTs), of which none are among our included studies. In a broader sense,

however, a unit of analysis error can be said to occur if the estimation of standard errors does not adequately account for clustering. The resulting problem is the same: either overly narrow confidence intervals, which increase the risk of Type-I error, or studies receiving inappropriately high weights in meta-analyses. This may well be the case for panel data, if studies do not use clustered standard errors to account for the fact that shocks may be correlated both cross-sectionally (e.g. in a given year) and longitudinally (e.g. in a given country). Alternatively, researchers can address one dimension parametrically (e.g. by including time dummies) and then estimate standard errors clustered on the other dimension when effects are present in both dimensions in the data as we assume for the included studies in this review (Petersen 2009).

We therefore included an assessment of the unit of analysis error as part of the risk of bias assessment (Section 3.4.3). Reviews based on sample data usually correct for this problem through adjusted standard errors, where the design effect of the study is used to reduce the sample size of each study to its 'effective sample size' (Higgins and Green 2011, section 16.3). In the present case with mostly non-sampled country-level data, where clustering is supposed to happen in two dimensions, this approach does not seem appropriate. We therefore use the information on potential unit of analysis error for our risk of bias assessment, but do not adjust standard errors in the analysis.

3.4.7 Dealing with missing data

Section 3.4.5 outlined how we treated situations in which certain data for the calculation of our measures of treatment effect were missing. We discuss potential implications of missing data in Section 5.2 for the rare cases where none of these approaches turned out to be feasible.

3.4.8 Assessment of reporting biases

The underlying hypothesis of reporting bias or publication selection is that negative or non-significant results will not be published as often as positive and significant results. What is generally perceived as positive is not necessarily equivalent to an increase in the respective outcome. Specifically, the general (still debatable) interpretation in the literature is that negative estimates for the two Outcome Types "Tariffs and Costs" and "Labour force" are positive signs of effective market reforms. We therefore recoded outcomes of these two types for the purpose of this reporting bias assessment. In this analysis, a positive sign thus does not indicate an increase in the respective outcome, but an "improvement" in the commonly understood sense.

Based on these partly recoded effect sizes, we generated funnel plots to assess potential reporting bias of included studies along the recommendations made by Sterne et al. (2011). Funnel plots are simple scatter plots of the effect estimates from individual studies against a measure of each study's precision, for which we use the standard error of the effect estimate. The presence of asymmetry of the funnel plots weakly suggest file-drawer effects, in which case we additionally performed the test proposed by Egger et al. (1997). This test regresses continuous outcomes on the

standard error of the effect size. A significant coefficient of this standard error can be interpreted as an indication of reporting bias. Both funnel plots and Egger's test are considered applicable if they are based on at least ten observations.[8]

3.4.9 Subgroup analysis and investigation of heterogeneity[9]

It was a priori not clear, which sub-groups of interest could be assessed as part of this systematic review, given the diversity of assessed groups, reform and outcome types as well as study levels in the included studies. Eventually, the data basis allowed to reasonably investigate – at least in parts – the following subgroups:

- *main Intervention Sub-Types*: part of the Intervention Types can be further disaggregated to assess the main intervention sub-types listed in Table 5.
- *main Outcomes*: in a similar vein, among the assessed outcome types, main outcomes as listed in the same table can be identified.
- *continents*: reform effects can be assessed on a geographically disaggregated level, i.e. differentiating between Latin America, Sub-Saharan Africa, and Asia (no studies included Eastern Europe which is also due to the exclusion criteria applied, see 3.2.2).

A subgroup division that was originally planned to be analysed but which eventually could not be undertaken for a lack of variation in this attribute is the differentiation between urban and rural populations.

For all meta-analyses, we assessed statistical heterogeneity (i.e. heterogeneity that goes beyond chance) by looking at three measures:

- *Tau-squared test statistic*: the between-study variance of effect sizes across studies in a random-effects meta-analysis. As such, it is an absolute measure of heterogeneity measured in the unit of the outcome and thus has to be interpreted in its size with reference to the outcome.
- *I-squared test statistic*: the percentage of total variation across studies that is due to unexplained heterogeneity rather than chance (Higgins et al. 2003). This relative measure of heterogeneity (or inconsistency) hints to substantive heterogeneity if higher than 50 percent (Higgins and Green 2011).
- *p-value chi square test for heterogeneity*: The chi square test tests whether one can reject that the true effect in all studies is the same. This is conventionally indicated by *p*-values lower than 5 or 10 percent.

[8] Note that there are further limitations of Egger's test as discussed in several letters in the issue of BMJ subsequent to Egger et al. (1997).
[9] This chapter incorporates the Section "3.4.7 Assessment of heterogeneity" of the Campbell Collaboration Systematic Review (Campbell Collaboration 2015) template.

Table 5: Subgroup analyses along main study dimensions

Intervention	
Intervention Type	**Main Intervention Sub-Type**
1 | Privatisation	-
2 | Liberalisation	Unbundling
3 | Private Sector Involvement	Independent Power Producers
4 | Regulation	-
5 | Composite reform	-
Outcome	
Outcome Type	**Main Outcome**
1 | Efficiency	Transmission and distribution losses (%)
2 | Labour force	Number of employees
3 | Supply and investment	(Net) electricity generation p.cap. Electricity gen. capacity p. cap. Residential electricity access (%)
4 | Quality	-
5 | Tariffs and costs	(Residential) electricity price
6 | Household welfare	-
Region	
1 | Global	Latin America Sub-Saharan Africa Asia

Note: See Section 3.2 for a definition of the different study types, intervention and outcome types.

3.4.10 Sensitivity analysis

The robustness of results is best tested along variations in moderator variables, methodological quality, and econometric specification details.

Too few of the included studies, however, included any potential moderators and moderators can neither be assessed ex post by the review team. Among others, this has to do with the fact that most studies conduct their assessments on an aggregated level that inhibits analysing country-specific moderators like specific regulatory schemes. Instead, the analysis of mechanisms that may drive observed findings is conducted based on the qualitative literature in Section 4.4 .

As will be shown in Section 4 on the results of the bias assessment, there is neither sufficient variation among included studies in order to test against fundamental study

quality differences. We rather seek to expose study-specific strengths and weaknesses in case exceptional results are found as part of the synthesis of results in Section 4.3 .

Lastly, to the degree possible we examined whether the following econometric specification details showed any systematic associations with effect size magnitude:

- *Study design*: The eligible study designs can simply be differentiated by whether they use panel methods (fixed or random effects models) or not (Difference-in-Differences, Ordinary Least Squares, Propensity Score Matching or probit).
- *Parametrization of intervention variable*: The reform concepts can be translated in different ways into quantitative variables. While most studies opt for simple dummy (yes/ no) intervention variables, others chose to define the reforms in different, not completely comparable ways. For regulatory reforms, for example, Zhang et al. (2008) constructed a four-component regulatory index and Sen and Jamasb (2012) assess the dummy variable “passing of tariff orders”. Further examples are listed in Table 7. We dealt with this diversity by conducting separate meta-analyses for estimates based on dummy definition and for estimates based on alternative variable definitions (see table).
- *units of data analysis*: Due to the paucity of studies, we are not able to separately assess all different levels of analysis but rather check whether analyses on micro (utility, electricity plant, electricity-generating unit, household) and macro (country, sub-country) level come to different results.
- *Study outcome used for pooling:* As outlined in Section 3.4.5, the most standard outcome of each study was used to calculate pooled effect sizes in case there were in multiple outcomes of the same Outcome Type eligible for pooling. Since it is not always straightforward to determine which outcome is most standard, we tested the sensitivity of this choice by calculating synthetic effect sizes (see also Section 3.4.5).

Table 6: Variable definitions of interventions included in this review

Intervention type or sub-type	Variable definitions (selected examples)
Privatisation	*Main dummy definitions* Privatisation Private ownership *Alternative variable definitions* Post Transition = at least two years after privatisation (dummy)
Liberalisation	
○ Unbundling	*Main dummy definitions* Unbundled Segments *Alternative variable definitions* Number of years after unbundling
○ Wholesale electricity market	*Main dummy definitions* Introduction of wholesale electric power market
○ Other competition-enhancing policies	*Main dummy definitions* Introduction of retail competition Open Access to network Generators allowed to compete to conclude supply contracts with distributors or large users
Private sector involvement	
○ Independent Power Producers (IPPs)	*Main dummy definitions* Independent power producers Introduction of foreign country IPPs *Alternative variable definitions* Share of privately-owned capacities in percent Post-Transition of private sector participation (dummy)
Regulation	*Main dummy definitions* Existence of independent regulatory agency *Alternative variable definitions* Electricity regulatory law (dummy) Four-component regulatory index
Decentralisation	-

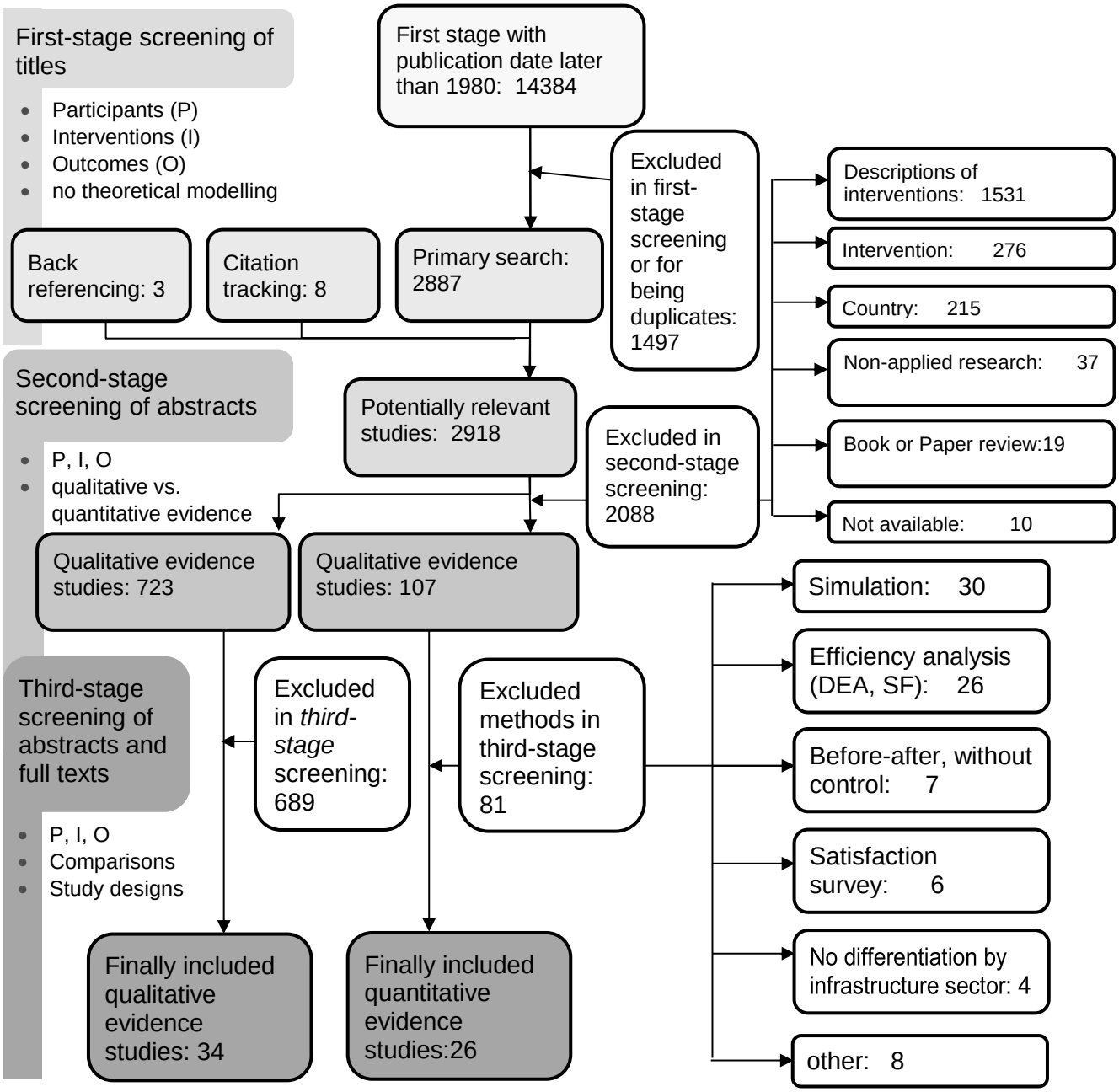
4. Results

4.1 Description of studies

Our systematic study search identified 14,384 search records that were subject to three screening and eligibility stages. At the first stage, the title or abstract stage, 11,497 records were discarded that did not meet the inclusion criteria (Figure 2). Together with 31 studies identified through back referencing and citation tracking, we reached a number of 2,918 potentially relevant studies. Among these, 107 qualified as impact evaluations and 723 as qualitative evidence studies, the remainder being descriptions of interventions or in fact not meeting the inclusion criteria. After the third round of full text and abstract screening for studies of interest, 26 quantitative and 34 qualitative evidence studies turned out to meet all requirements and were selected for analysis.

The reasons for exclusion of studies can also be taken from Figure 2. Most studies have been excluded in the second-stage screening of abstracts for not featuring research methods but solely being descriptive in nature about electricity sector reforms in developing countries (see, for example, Gelineau 1997 or Moffett 1998). A number of further studies turned out to not address market-based reforms as such or to study countries beyond the eligible participant pool, notably Turkey and Russia. For the 81 marginal quantitative evidence studies excluded in the third-stage screening full citations are available in the reference Section 0 and a full list of reasons for exclusion is available in Appendix 0. Main reason for exclusion of quantitative evidence studies was a lack of an empirical, factual counterfactual in the studies' impact assessments. These studies either used simulations or efficiency analysis methods. Qualitative evidence studies have mostly been excluded for not having a proper focus on electricity sector reforms and not addressing mechanisms such that they were not appropriate to respond to the review questions of this study (not reported in the figure, available on request from the authors). With regards to the language used to report findings, most original studies were in English. We also encountered articles in Farsi, French, Romanian, Russian, Spanish and Turkish. Eventually, however, only one non-English study remained in the pool of included studies, namely Murillo and Finchelstein (2004) written in Spanish.

Figure 2: Search result flow diagramme



Quantitative evidence

Table 7 presents main characteristics of the included quantitative evidence articles. All included studies were published after 2000. The vast majority has been published in peer-reviewed journals. Chile was the first country in the developing world that started a change of ownership and regulatory reforms in the electricity sector in 1978 and was soon followed by other countries in Latin America. This led to a better data quality for countries on the continent as compared to Asian or Sub-Saharan countries.

Thus, most of the 26 quantitative evidence studies are based on data from Latin America with twelve of them using data on the country level. They tend to cover more than only one country and rather compare results from different countries (e.g. Andres et al. 2009; Guasch et al. 2006; Pargal 2003; Wren-Lewis 2015). Few of these Latin America studies additionally cover a small number of Caribbean countries. The literature on Asia focuses on single countries, namely on China (Du et al. 2013 and 2009; Gao and Van Biesebroeck 2014), India (Malik et al. 2015; Panda 2002; Sen and Jamasb 2012) and Pakistan (Khan 2014). Sub-Saharan Africa, for its part, lacks any dedicated regional study. It is only covered in cross-regional studies, which mostly do not allow for a disaggregation of effect sizes. The same holds for Eastern Europe, which is also due to our exclusion criteria. This sample composition already suggests that the findings of this review shed particular light on Latin America and, to a lesser extent, Asia, with unclear transferability to Sub-Saharan African countries.

Only one quantitative study, Alcázar et al. (2007), makes a distinction between rural and urban areas by focussing on rural Peru. As indicated in Section 3.4.9, thus no urban-rural subgroup analysis can be performed in the study synthesis.

Table 7: Aggregated summary of included quantitative evidence articles

Publication Date		**Form of Publication**		**Regional Focus**			
1990 - 1999	0	Journal Article	17	Latin America	8	Urban & rural	25
2000 - 2004	2	Working Paper	5	Asia	7	Rural	1
2005 - 2009	12	Book Chapter	2	Sub-Saharan Africa	0		
2010 - mid-2015	12	Dissertation	1	Oceania	0		
		Report	1	Eastern Europe	0		
		Unpublished	0	Cross-Regions	11		
Total	26	Total	26	Total	26	Total	26

Three papers base their analysis on two independent samples with different units of observation (Gonzalez-Eiras & Rossi 2008, Malik et al. 2005 and Panda 2002). The units of observation in general are rather diverse and depend largely on data availability (Table 8). For cross-regional comparison, studies use country level data, whereas regional studies in Latin America and Asia can also rely on data ranging from the country level to the household level covering as well utilities, plants and sub-country regions such as provinces.

As can also be taken from Table 8, the techniques used in the articles are dominated by fixed or random effects panel estimation methods, which differ in the way they model unobserved heterogeneity (for details on these estimation methods and the choice between the two, refer to Panda 2002: 144ff).

Table 8: Aggregated summary of further quantitative evidence study characteristics

Unit of Analysis		Method of Analysis		Type of Reform/ Intervention	
Country	12	Ordinary Least Squares (OLS)	1	Privatisation	13
Sub-country region	1	Matching	1	Liberalisation	-
Sub-country region & power plant	1	Difference-in-Differences	4	- unbundling	9
Sub-country region & household	1	Difference-in-Differences & Instrumental Variables	1	- wholesale electricity market	3
Utility	6	Fixed and/ or Random Effects	16	- other competition-enhancing policies	6
Power plant	2	Fixed and/ or Random Effects & Instrumental Variables	2	Private Sector Involvement	7
Power plant & electricity-generating unit	1	Fixed and/ or Random Effects and GEE[10]	1	- independent power producers	5
Household	1			Regulation	14
Other	1			Change in tariff design	0
				Decentralisation	0
				Composite reform	3
Total	26	Total	26	Total	60

Note: See Section 3.2 for a definition of the different study and intervention types. The category “Type of Reform” allows for combined interventions with multiple reform types being assessed in a single study. If a study did not differentiate between intervention types and instead looked at a reform as an aggregate, this is referred to as “Composite Reform”. Difference-in-Differences analyses either rely on two waves of data or otherwise pool data from different waves into before and after without using fixed effects.

[10] Generalized Estimating Equations (GEE) are an extension of generalized linear models to the analysis of longitudinal data first proposed in Liang and Zeger (1986) and Zeger and Liang (1986). One of the included papers runs one of its estimations based on GEE.

Table 9 details the same as well as further characteristics such as sample sizes separately for each of the 26 articles. In virtually all cases interventions types were coupled to combined interventions indicating more profound electricity sector reforms. The types of interventions covered include those already specified in section 3.2.3, with privatisation and regulation being the two most often assessed types of interventions. They contribute half of the 60 reform type observations. Latin America and privatisation being the most common assessed combination is in fact also not surprising given that Latin America accounted for 55 percent of total privatisation revenues in the developing world in the 1990s (Chong et al. 2004). We followed the definitions of the original authors as reflected in the designation of intervention variables and scrutinize these designations as part of the sensitivity analysis. Cubbin and Stern (2006), for example, assess privatisation (through two dummies on minority and majority privatization), competition-enhancing policies (using a dummy for the legal right to generate electricity for resale), and regulation (among others relying on an independent regulator dummy).[11]

With reference to the causal chain, studies mostly assess direct outcomes. For example, around every third article discusses electricity prices and tariffs as an outcome. The array of analysed outcomes is vast and covers all outcome categories listed in Table 2 of Section 3.2.5, such as the supply of electricity (e.g. Andres et al. 2009) or the number of employees (Du et al. 2009). Most studies rely on secondary data – that is, data collected by others, usually official governmental and non-governmental bodies, outside of the context of an evaluation study. To a large extent the studies cover long time periods with time horizons of an average of 12 waves (i.e. rounds of data collection), typically being annual data. Since electricity sector reforms started in Latin America, the available data goes back the longest here with on average 15 waves covered by our included studies compared to on average 10 waves for Asian countries. The number of countries covered ranges between 9 and 19 for the Latin American cross-country analyses and between 22 and 86 for the global cross-regional studies.

The original authors mostly merged various secondary sources to conduct their analysis. These include general and electricity-related databases, respectively, such as the World Development Indicators Database (World Bank 2016), the Asia-Pacific Economic Cooperation (APEC) Energy Database (APERC 2016) and the Electricity Performance Benchmarking Database for the Latin American and Caribbean Region (World Bank 2007). Outcome information was, for example, retrieved from the Privatisation International Yearbooks by Privatisation International and the Private Participation in Infrastructure Database (World Bank and PPIAF 2016). In addition, authors used publications by firms, national regulatory bodies and bureaus of statistics as well as international organisations such as the International Energy

[11] Further examples of variables reflecting different Intervention Types can be taken from Table 6 in Section 3.4.10.

Association (IEA), World Energy Council (WEC), Latin American Energy Organization (OLADE), International Labour Organisation (ILO), International Monetary Fund (IMF), and the Economic Commission of Latin America and the Caribbean (ECLAC). In certain cases, authors requested particular information directly from firms or regulatory office (e.g. Guasch et al. 2006; Estache and Rossi 2005). In a few cases, authors based their studies on similar data, notably Andres et al. (2009) and Guasch et al. (2006), Zhang et al. (2008) and Zhang (2005), as well as Nagayama (2007; 2009; 2010). The studies, however, typically assess different Intervention and Outcome Types and use sufficiently distinct data sets as can be taken from Table 9. Dependency between different results of the same intervention-outcome combinations synthesized in Section 4.3 is therefore not an issue.

Table 9: Summary of included quantitative evidence studies

Study	Location	Type of Reform/ Intervention	Number of Waves	Sample Size	Unit of Analysis	Method of Analysis	Outcome Type
Alcázar et al. (2007)	Latin America (Peru)	Privatisation	1	2671	Household	Propensity Score Matching	Electricity price and/ or tariff Household welfare Quality
Andres et al. (2009)	Latin America and Caribbean (19 countries)	Private Sector Involvement Regulation	11	2000	Utility	Fixed Effects	Supply Electricity price and/ or tariff Electricity generation costs Inefficiencies Revenue or price and cost ratios Quality
Balza et al. (2013)	Latin America (18 countries)	Private Sector Involvement Regulation	40	684	Country	Fixed Effects	Supply Electricity price and/ or tariff Inefficiency
Cubbin & Stern (2006)	Cross-Regions (28 countries)	Privatisation Competition-enhancing pol. Regulation	22	585	Country	Fixed Effects	Supply

Study	Location	Type of Reform/ Intervention	Number of Waves	Sample Size	Unit of Analysis	Method of Analysis	Outcome Type
Du et al. (2013)	Asia (China)	Unbundling	2	2093	Utility	Difference-in-Differences	Technical efficiency
Du et al. (2009)	Asia (China)	Independent Power Producers	2	2161	Power Plant	Difference-in-Differences + IV	Inefficiency Number of employees
Erdogdu (2011*a*)	Cross-Regions (31 developing countries)	Privatisation Unbundling Wholesale electricity market Competition-enhancing pol. Independent Power Producers Regulation	28	1049	Country	Fixed and Random Effects	Revenue or price and cost ratios Industrial and residential price ratio
Erdogdu (2011*b*)	Cross-Regions (60 developing countries)	Composite reform	27	2046	Country	Fixed and Random Effects	Supply Inefficiencies Technical efficiency
Estache & Rossi (2005)	Latin America (14 countries)	Privatisation Regulation	8	535	Utility	Fixed Effects and OLS	Number of employees

Study	Location	Type of Reform/ Intervention	Number of Waves	Sample Size	Unit of Analysis	Method of Analysis	Outcome Type
Gao & Van Biesebroeck (2014)	Asia (China)	Unbundling	10	10792	Utility	Difference-in-Differences + IV	Electricity generation costs Number of employees
Gonzalez-Eiras & Rossi (2008)	Latin America (Argentina)	Private Sector Involvement	11	24432 (Household) 242 (Provinces)	Household and Subcountry Region (Provinces)	Difference-in-Differences and Probit	Household welfare
Guasch et al. (2006)	Latin America (10 countries)	Privatisation	Not Available	823	Utility	Fixed Effects	Supply Electricity price and / or tariff Inefficiencies Number of employees Quality
Khan (2014)	Asia (Pakistan)	Privatisation	6	356	Power Plant	OLS	Electricity generation costs
Koo et al. (2012)	Cross-Regions (35 developing countries)	Private Sector Involvement Regulation	11	385	Country	Random and Fixed Effects	Inefficiency
Malik et al.	Asia (India)	Unbundling	22	478 (Power	Power Plant	Difference-	Inefficiency

Study	Location	Type of Reform/ Intervention	Number of Waves	Sample Size	Unit of Analysis	Method of Analysis	Outcome Type
(2015)				Plants) 4298 (Electricity Generating Unit)	and Electricity Generating Unit	in-Differences	Technical efficiency
Nagayama (2010)	Cross-Regions (86 countries)	Privatisation Unbundling Wholesale electricity market Competition-enhancing pol. Independent Power Prod. Regulation	22	1652	Country	Fixed Effects	Supply Inefficiencies
Nagayama (2009)	Cross-Regions (78 countries)	Composite reform	19	1006	Country	Fixed and Random Effects + IV	Electricity price and / or tariff
Nagayama (2007)	Cross-Regions (83 countries)	Privatisation Unbundling Wholesale electricity market Competition-	18	906	Country	Fixed and Random Effects	Electricity price and/ or tariff

Study	Location	Type of Reform/ Intervention	Number of Waves	Sample Size	Unit of Analysis	Method of Analysis	Outcome Type
		enhancing pol. Independent Power Prod. Regulation					
Panda (2002)	Asia (India)	Privatisation Unbundling	13	756 (Utilities) 156 (State Electricity Boards)	Utility and Subcountry Region (State Electricity Boards)	Fixed and Random Effects	Electricity price and/or tariff Electricity generation costs Inefficiencies Technical efficiency Number of employees Revenue or price and cost ratios
Pargal (2003)	Latin America (9 countries)	Private Sector Involvement Regulation	19	693	Other (Infrastructure Sector x Country)	Fixed Effects	Investment
Sen & Jamasb (2012)	Asia (India)	Privatisation Unbundling Competition-enhancing pol. Independent Power	17	245	Subcountry Region (States)	Fixed Effects	Electricity price and/or tariff Inefficiencies Technical efficiency Industrial and

Study	Location	Type of Reform/ Intervention	Number of Waves	Sample Size	Unit of Analysis	Method of Analysis	Outcome Type
		Prod. Regulation					residential price ratio
Vagliasindi & Besant-Jones (2011)	Cross-Regions (22 countries)	Privatisation Unbundling Private Sector Involvement Regulation	21	271	Country	Fixed and Random Effects and GEE	Supply Electricity price and / or tariff
Wren-Lewis (2015)	Latin America and Caribbean (18 countries)	Privatisation Regulation	13	1359	Utility	Fixed Effects	Number of employees
Yu & Pollitt (2009)	Cross-Regions (69 countries)	Composite reform	10	120	Country	Random Effects	Quality
Zhang et al. (2008)	Cross-Regions (36 developing and transitional countries)	Private Sector Involvement Regulation	19	638	Country	Fixed Effects	Supply
Zhang (2005)	Cross-Regions (25 developing countries)	Privatisation Competition-enhancing pol. Regulation	17	374	Country	Fixed Effects	Supply

Qualitative evidence

Table 10 present main characteristics of the included qualitative studies. All studies have been published after 2000 and rather earlier than the quantitative evidence studies. 27 of the 34 studies are published in peer-reviewed journals. Similar to the regional and thematic focus of the quantitative studies, Latin American countries and privatisation received the most attention in qualitative evidence studies. In contrast to the quantitative studies, the qualitative literature usually does not restrict itself to a certain unit or method of analysis. In line with this flexibility, on average more than three types of interventions are explicitly studied in the articles and more studies can be found on Africa, for example. Karekezi and Kimani (2002), for example, review the status and challenges of ongoing power sector reforms in eastern and southern Africa with particular reference to privatisation, regulation and unbundling.

Table 10: Aggregated summary of included qualitative studies

Publication Date		**Form of Publication**		**Regional Focus**		**Type of Reform/ Intervention**	
1990 - 1999	0	Journal Article	27	Latin America	12	Privatisation	27
2000 - 2004	10	Working Paper	2	Asia	9	Liberalisation	8
2005 - 2009	13	Book Chapter	5	Sub-Saharan Africa	6	- unbundling	23
2010 - mid-2015	11	Dissertation	0	Oceania	1	- other competition-enhancing policies	11
		Report	0	Eastern Europe	0	Private Sector Involvement	12
		Unpublished	0	Cross-Regions	6	Regulation	27
						Change in tariff design	8
						Decentralisation	3
Total	34	Total	34	Total	34	Total	119

Note: The category “Type of Reform” allows for combined interventions with multiple reform types being assessed in a single study.

Review question 3 on cost-effectiveness

One explicit goal of this review was to gather information on reform costs to conduct cost-effectiveness analyses. Yet, all quantitative and qualitative evidence studies remain silent about concrete cost information. This is in line with observations from the literature stating that published articles rarely provide enough specific and complete cost data to undertake cost-effectiveness analyses in the framework of a systematic review (Levin 2001; Levin and McEwan 2001; Baird et al. 2013). We therefore have to abstain from further cost analyses and confine ourselves to mentioning this critical knowledge gap in our conclusions.

4.2 Assessment of study validity

4.2.1 Risk of bias of quantitative evidence studies

Data extraction revealed that the risk of bias categories proved to be either non-applicable or to yield basically no differentiation across studies due to the nature of the underlying (mostly panel) data and the study selection process focussing on higher-quality studies:

- *sample selection bias*: Sample selection is inherent to all included studies considering that the decision to reform the electricity sector is likely influenced by unobserved factors which simultaneously affect outcomes.[12] This endogeneity arises on all levels of analysis (see Du et al. 2009). To remove endogeneity in such a context and as long as only one variable is affected, Wooldridge (2010) suggests using a two-stage least square estimation with an instrumental variable (IV). However, identifying an IV for large scale infrastructure projects is very challenging to impossible (Jamasb et al. 2005). In fact, only three of the included studies applied an IV approach (see Table 9), with different degrees of persuasiveness. Still, all studies except one can be said to reasonably address this potential bias through their analysis method and the (regression- or matching-based) adjustment for confounders. They are thus assigned a medium risk of *sample selection bias*. The only exception is Khan (2014), who conducted a less rigorous pooled OLS study that was rated as having a high risk of bias.
- *motivation bias*: None of the datasets has been collected in a context where subjects were observed for data collection. This category is therefore not applicable.
- *"incomplete data bias"*: The core data basis of all articles are existing secondary data sets. Non-compliance, non-response, and attrition again do not apply, since data has not been collected as part of a survey among

[12] This may actually happen in both directions: Sectors in worse conditions may be more pressured to reform. If this is not adequately controlled for, it would cause impacts to be biased downwards. Conversely, better managed and performing sectors may find it easier to be reformed. This positive selection into reforms may lead to an upward bias. In any case, the sector performance changes found in the studies may not necessarily reflect reform impacts but may also be driven by underlying factors that could not be controlled for by the studies.

participants. Nonetheless, panel data are in practice often unbalanced, i.e. data are missing for certain observations in certain years, as it is the case for all of our studies. It poses a problem as long as the missings are not random but due to systematic reasons (e.g. crises). Since a conclusive answer cannot be given, all studies are assigned a medium risk of bias.

- *spill-overs, cross-overs, contamination*: Cross-overs and contamination are hardly imaginable for the case of regionally clearly demarcated reforms. Spill-overs are somewhat more likely (e.g. through competitive pressure among utilities or knowledge spillovers across countries), but the risk of a biasing effect is in all cases low.
- *intervention independent of other changes:* It can generally be concluded for all assessed reform types that they are to some degree intertwined with more general economic and societal changes. This issue can, hence, not completely be ruled out implying a medium risk of bias.
- *selective outcome and analysis reporting*: All assessed outcomes are standard measures given that they have been retrieved from databases that compile key electricity sector variables. There are also no indications for selective variable omissions. Similarly, methods used in the analysis are, in principle, 'common' as understood by the Risk of Bias tool, which also reflects the selection of included studies based on considerations of the method quality. For this category, all studies are therefore considered to have a medium risk of bias.
- *incorrect confidence intervals or standard errors*: Some differences in methodological quality can be observed in this category. Only three studies use clustered errors meaning they are clustering both cross-sectionally and longitudinally (Gonzalez-Eiras and Rossi 2008; Estache and Rossi 2005; Wren-Lewis 2015). One further study follows the second approach considered appropriate as outlined in Section 3.4.6 on unit of analysis issues: Malik et al. (2015) address one dimension parametrically through time dummies and estimate standard errors clustered at state level. For the remaining studies, it is unclear whether they do apply appropriate clustering. A high risk of bias is conservatively attributed to these studies.
- *simultaneous causality:* It is highly likely that not only the reform interventions affect outcomes but also the other way around. Zhang et al. (2008) provide the example of generators with poor performance which may be privatized first because governments are keen to get rid of them, while better performing generators are sold off more slowly leaving time to introduce prior changes to the regulatory and competitive environment. Since this issue holds consistently for all Intervention and Outcome Types, there is a high risk of bias for this criterion.
- *omitted variable bias, misspecification of the functional form*: One main issue is that the considered reform interventions may be correlated with each other. In case of combined interventions with multiple reform variables included in one regression, one of the variables may be a linear combination of the others. In this situation, which is known as multicollinearity, the regression

coefficient estimates may change erratically in response to small changes in the model or the data. 15 of the 23 studies using fixed or random effects models apply estimations with multiple reform dummies and are thus candidates for multicollinearity issues. Only 7 of these studies discuss multicollinearity and related potential problems at all, with three of them taking some action (Pargal 2003; Sen and Jamasb 2012; Vagliasindi and Besant-Jones 2011). These studies either tested for multicollinearity and found it to be no problem or excluded regressions with risk of multicollinearity. On the other hand, studies that only included one intervention variable may suffer from omitted variable biases. More generally, omitted variable biases seem to be a severe problem for all studies. Data on a number of decisive variables such as institutional factors or corruption levels is lacking. Du et al. (2009) point out that even studies conducted at utility or plant level with somewhat more precise data lack information to control for operational characteristics relevant for the assessed outcomes. To conclude, we assign the three abovementioned studies a medium risk of bias and all others (fixed effects or not) a high risk.

Table 11 summarizes this extensive discussion of the individual risk of bias categories. It can be concluded that a discrimination of studies by risk of bias would be inappropriate in the present case. All of our included studies tend to be within the same risk of bias category, which can best be subsumed under an overall medium risk of bias. Thus, a specific risk of bias analysis is unnecessary.

Table 11: Summary risk of bias assessment of quantitative evidence studies

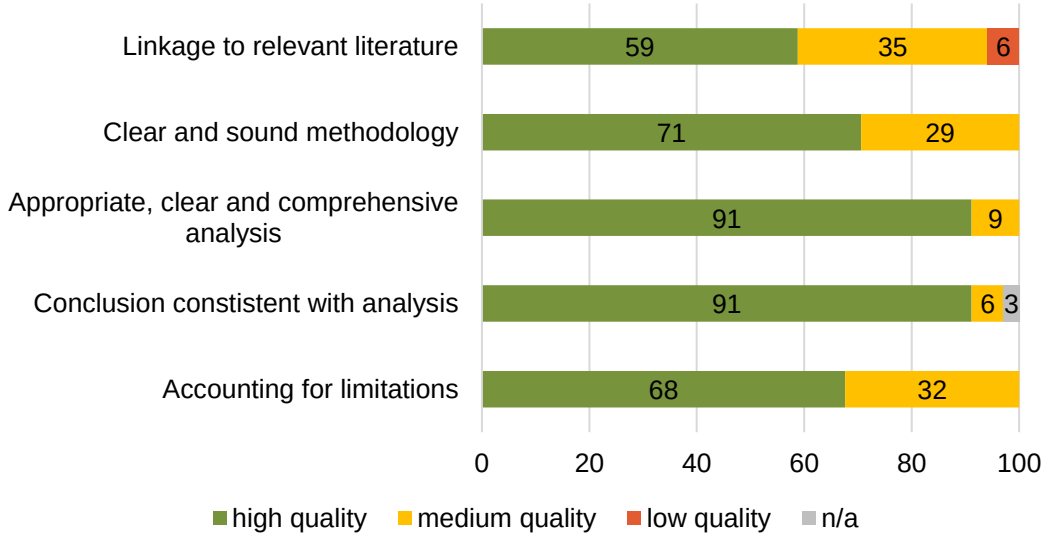
Risk of bias category	Risk of bias rating			
	low	medium	high	n/a
sample selection bias		25	1 Khan (2014)	
motivation bias				all 26
"incomplete data bias"		all 26		
spill-overs, cross-overs, contamination	all 26			
intervention independent of other changes		all 26		
selective outcome and analysis reporting	all 26			
incorrect confidence intervals or standard errors	4 Gonzalez-Eiras & Rossi (2008); Estache & Rossi (2005); Wren-Lewis (2015); Malik et al. (2015)		22	
other: simultaneous causality			all 26	
other: omitted variable bias, misspecification of the functional form		3 (Pargal 2003; Sen & Jamasb 2012; Vagliasindi & Besant-Jones 2011)	23	

4.2.2 Quality appraisal of qualitative evidence studies

We used critical appraisal to determine eligibility for qualitative evidence studies to be included in this review (see 3.2.1), hence there is relatively little variation in study quality among them. Particular emphasis has been put on the methodology and analysis in the selection process, which is also reflected in Figure 3 summarizing our

five evaluation criteria. Note that the rating now relates to a positive scale on quality (high = high quality), which is thus different from the negative risk of bias scale for quantitative studies. Encouragingly, almost all authors complete their study with a conclusion that is consistent with their analysis. Low ratings have only been attributed in the “linkage to relevant literature” category, which was considered acceptable. A list of the appraisal of each individual study can be found in Appendix 0.

Figure 3: Summary quality appraisal of qualitative studies



Note: If a study did not have a concluding section, the fourth criterion was coded as not applicable (n/a).

4.2.3 Publication bias assessment

Another step in the assessment of study validity is a publication bias assessment. This assessment is meant to inform about the reliability of the synthesized results in terms of one crucial aspect: are there indications for negative or insignificant results not having been published so that the results of the review reflect a rather favourable estimate of the true effect?

Funnel plots provide a first indicative picture on the potential of publication bias (see Section 3.4.8). We plot Standardized Mean Differences (SMDs) and their standard errors for all Intervention Types with at least ten independent studies irrespective of the specific Outcome Type. This is the case for Privatisation, Private Sector Involvement, and Regulation. The number of studies focusing on Liberalisation was not sufficient to determine the potential for publication bias related to this topic. The SMD is adjusted by what is considered the generally desired outcome direction (again see the methods Section 3.4.8).

Figure 4: Funnel plot of privatisation estimates

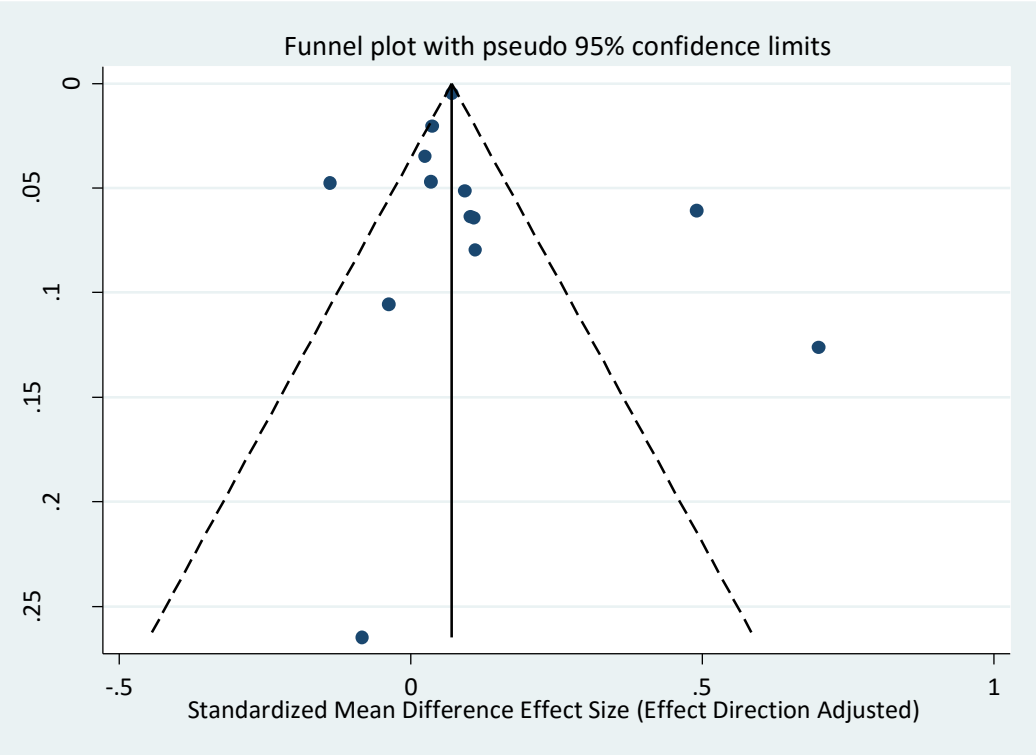
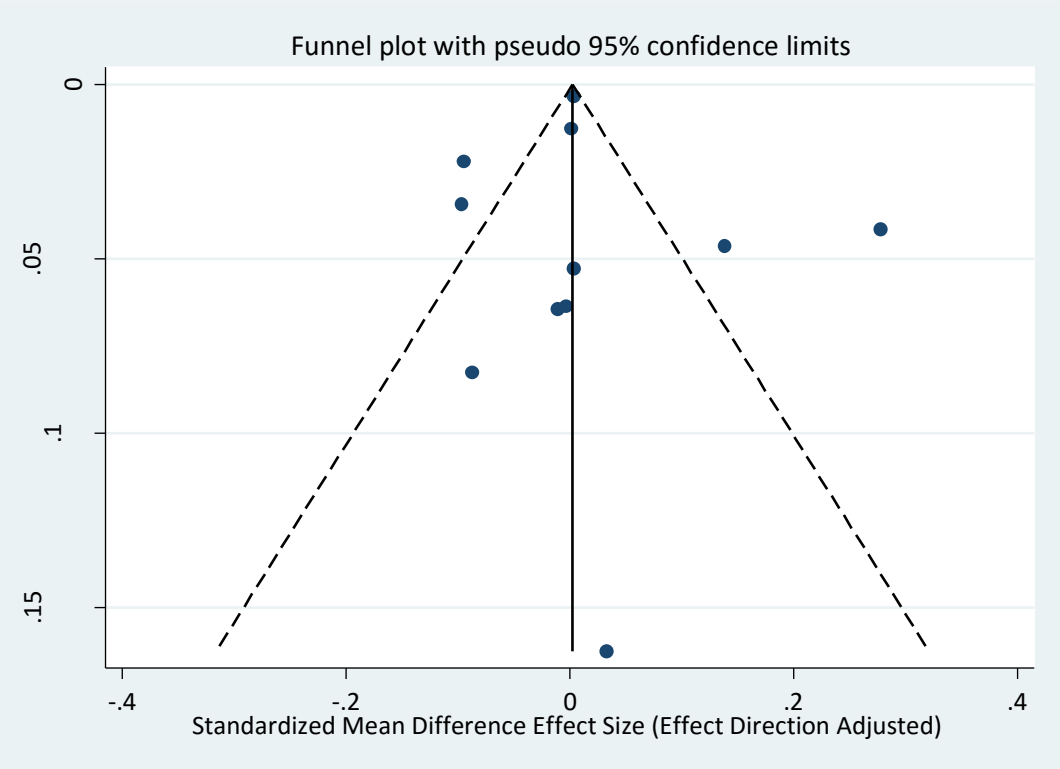
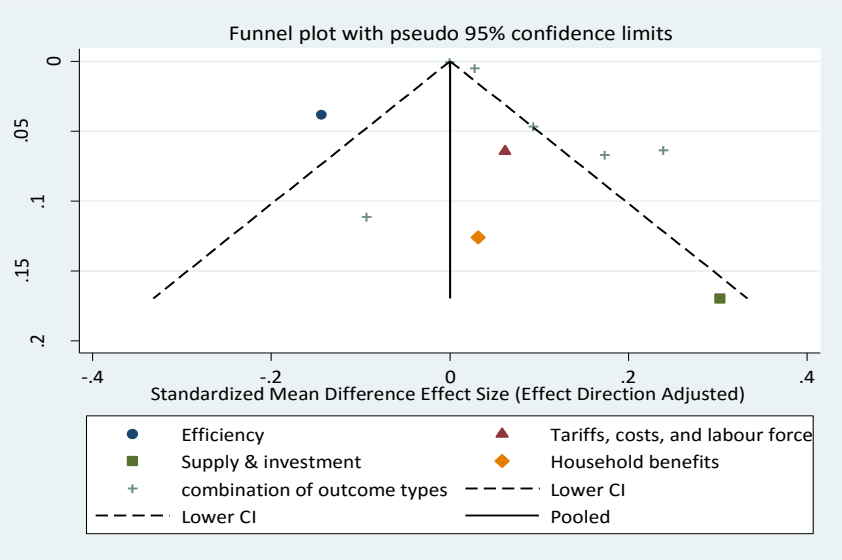


Figure 5: Funnel plot of regulation estimates



The basic idea of a funnel plot is that publication bias is most likely when the effect sizes of studies do not follow a normal distribution or, put differently, are asymmetrically spread across the plot. **Error! Reference source not found.** and REF _Ref442122444 \h * MERGEFORMAT **Error! Reference source not found.** indicate that studies focusing on Privatisation and Regulation are less prone to such a bias. On the contrary, results from Private Sector Involvement studies are skewed to the right (Figure 6). Differentiating by the outcomes that have been assessed in the studies as done in the figure does not provide further insights into the determinants of the potential bias. Still, the limited number of observations and variety of Outcome Types depicted in the figure makes it even more evident that these graphs provide limited straightforward information on potential publication bias.

Figure 6: Funnel plot of private sector participation estimates



At least to some degree, this problem is attenuated when formally testing for publication bias using Egger's test. The results are presented in Table 12. For Privatisation and Regulation the test supports the impression gleaned from the funnel plots that there is no relevant bias. For Private Sector Participation Egger's test point estimate is positive and statistically insignificant (*p*-values between 0.34 and 0.84). Interestingly, the additional control variable for whether the study was published in a peer-reviewed journal (columns 2 and 3) has a negative, borderline significant coefficient. We thus observe that published studies tend to report lower effects. This, however, does not seem to reveal any kind of bias. It may rather reflect that the peer-review process incentivises authors to work harder on the strength and robustness of their methodology and results, which tends to have an attenuating effect on the reported results. The negative coefficient is hence likely to reflect a normal process that also applies to two (and probably more) of the included studies, Gao and Biesebroeck (2014) and Estache and Rossi (2005), as compared to previous discussion paper versions (Gao and Biesebroeck 2011 as well as Estache and Rossi 2004). It can thus rather be concluded that discussion papers may need to be treated with more care.

Table 12: Meta-regression analysis of small study effects (Egger's test)

	Private Sector Participation			Privatisation	Regulation
	(1)	**(2)**	**(3)**	**(5)**	**(6)**
Standard error of effect size	0.94	0.78	0.22	0.71	0.09
(Egger's test)	(0.93)	(0.92)	(1.01)	(1.35)	(1.22)
	[0.34]	[0.43]	[0.84]	[0.61]	[0.94]
Published in journal (1=yes)		-0.10	-0.18		
		(0.08)	(0.11)		
		[0.29]	[0.14]		
Intervention sub-type: IPP (1=yes)			0.13		
			(0.11)		
			[0.27]		
Constant	0.00	0.08	0.11	0.07	0.02
	(0.06)	(0.09)	(0.09)	(0.11)	(0.07)
	[0.96]	[0.42]	[0.27]	[0.52]	[0.83]
Tau-sq	0.01	0.01	0.01	0.04	0.01
I-squared res	86%	80%	81%	90%	91%
Adjusted R-sq	0.02	0.04	0.14	-0.01	-0.10
Sample size	10	10	10	12	10

Note: Standard errors in parentheses and *p*-values in squared brackets that indicate the statistical significance of coefficients.

4.3 Synthesis of quantitative evidence results

This section presents the results from meta-analysis along the lines of the different Intervention Types Privatisation, Liberalisation, Private Sector Involvement and Regulation. As found in Section 1, no primary studies could be identified that address decentralisation as the fifth Intervention Type covered by this review (see 3.2.3). In all cases, the Outcome Types discussed in Table 4 of Section 3.4.4 are examined.

For each Intervention Type, the presentation starts with effects on efficiency and the labour force and continues with the effects on supply indicators, quality, tariffs, and costs, before household welfare are examined. While many of these factors influence each other in both directions, this sequence is supposed to represent the most likely

causal chain: reforms affect the technical and financial efficiency of the electricity sector, which may go along with adjustment measures in the labour force. Generation capacity and investments in generation capacities may be either directly affected by reforms (e.g. the opening of the market to new, private investors) or indirectly though efficiency gains in the previous step. This, in turn, may or may not affect quality, costs and tariffs and eventually the welfare of electricity consumers.

No single study provides results for all of the outcomes and interventions. We neither have enough studies at hand to meaningfully assess the results for each intervention and each outcome with a forest plot. Forest plots are only presented for those outcomes that have been assessed by at least three studies. In each case, we assess whether individual results are sufficiently homogeneous to allow pooling. This is partly a contentious exercise in light of the limited number of studies and the large variety of approaches of these studies. If studies are pooled, we use random effects estimation techniques and weight the result by their inverse variance meaning the higher the variance in a study is the less weight is put on the study in the meta-analysis. Standardized outcome measures of studies not shown with a forest plot are, nevertheless, shown in a table at the end of each paragraph, complemented by results of meta-regressions for the respective outcome. To the extent possible, the table and the meta-regressions also feature subgroup and sensitivity analyses. Given the lack of studies that consider these subgroups, a differentiation between rural and urban populations, for example, is not possible at all.

The analysis of isolated Intervention Type effects helps to address their distinct features and impact channels. Still, they are typically considered and implemented in conjunction. In a subsequent sub-section, the interventions are therefore also assessed from an aggregate reform perspective.

In all sub-section, particularities in the underlying data or studies are highlighted and explanations for certain patterns across studies are provided. For transparency, we provide at least the overall conclusions of primary study authors related to impact findings in Appendix 0. A general discussion of impacts pathways and mechanisms underlying these results follows in Section 4.4 that relies on the qualitative evidence as the quantitative evidence studies mostly lack a detailed discussion of these aspects.

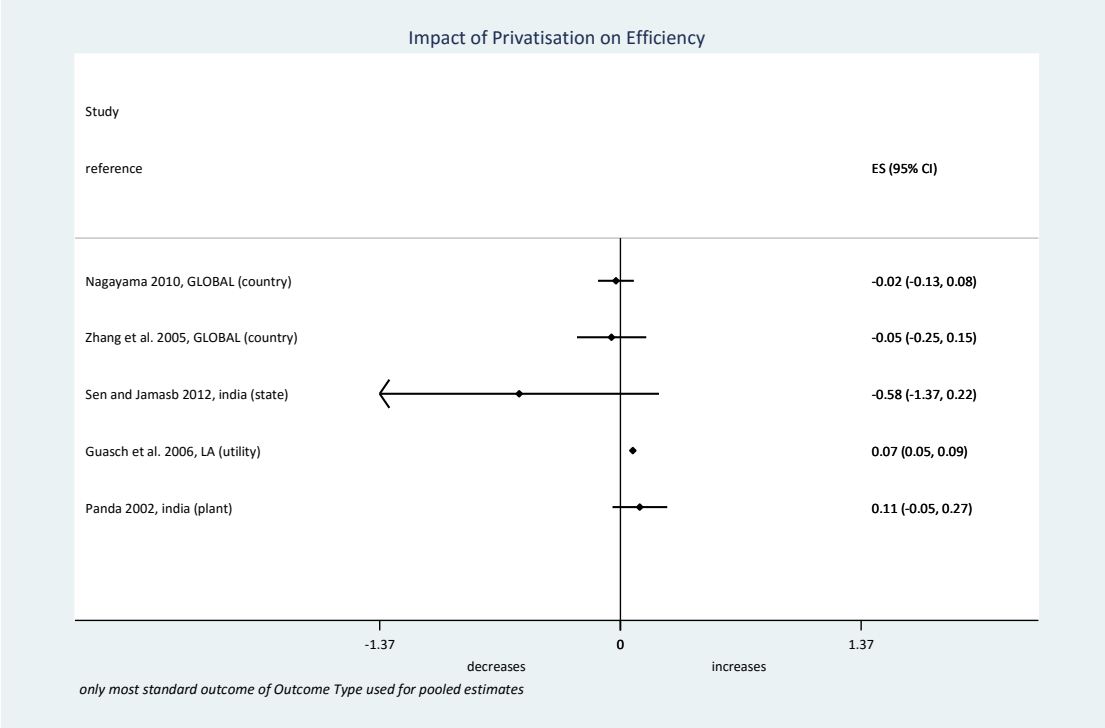
4.3.1 Privatisation

In general, we find few and rather heterogeneous studies that explore the link between privatisation and different outcome measures. Results are also mixed with weak indications for an attenuating impact of privatisation on tariffs and costs.

We are able to calculate privatisation results for five studies on the efficiency outcome using meta-analysis as presented in Figure 7. In the forest plots, studies are ordered according to the unit of analysis, from the macro (country) down to the micro (household) level. Efficiency measures and units of analyses are quite diverse, which is why we abstain from calculating an overall pooled effect estimate. Three studies conduct cross-country or cross-state analyses. The efficiency measures of

Nagayama (2010) and Sen and Jamasb (2012) relates to the inverse of transmission and distribution losses. Zhang et al. (2005) use the net overall electricity generation per average installed capacity (capacity utilisation). Sen and Jamasb (2012) find a significantly negative effect (ES=-0.59, CI=-1.22 - 0.04), which they explain with flaws in the underlying data: prior to the reform, the State Electricity Boards in India would often include transmission losses in agricultural consumption data to hide the true levels of losses. As a consequence, reform measures tended to reveal previously hidden information and caused an artefactual increase in loss figures (i.e. reduction in efficiency). The estimates of the other two studies are only marginally, but also negatively different from zero. On the contrary, studies based on disaggregated utility and plant data find weakly positive effects in terms of reductions of transmission and distribution losses and increases in plant availability (Panda 2002). Even the more pronounced improvement observed by Panda (2002) though merely translates to an increase in 2.3 percentage points in plant availability from a baseline level of around 70%. As also noted by Zhang et al. (2005), it can thus at least be concluded that privatisation on its own is not sufficient to affect efficiency performance significantly – a circumstance that is likely to hold for other Intervention Types as well.

Figure 7: Impact of privatisation on efficiency

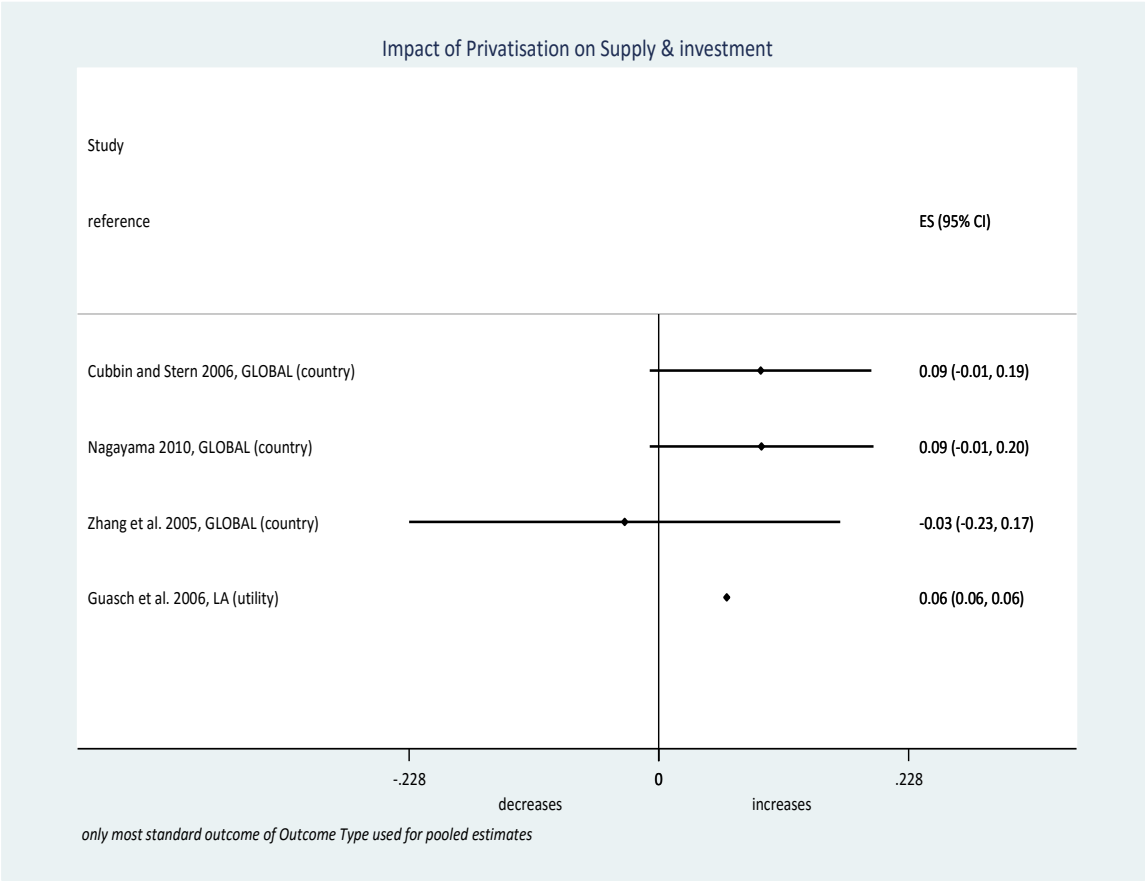


Notes: On the left side of the graph, study references are noted together with the respective sample and unit of analysis in parentheses. Cross-country samples are written in capital letters. LA stands for Latin America.

Four studies examine the relationship between privatisation and supply and investment outcomes (Figure 8). They tend to find positive effects on electricity generation capacity per capita (Cubbin and Stern 2006; Nagayama 2010) and on the

number of electricity connections (Guasch et al. 2006). Zhang et al. (2005) also investigate electricity generation capacity per capita with rather imprecise findings and a weakly negative point estimate.

Figure 8: Impact of privatisation on supply and investment

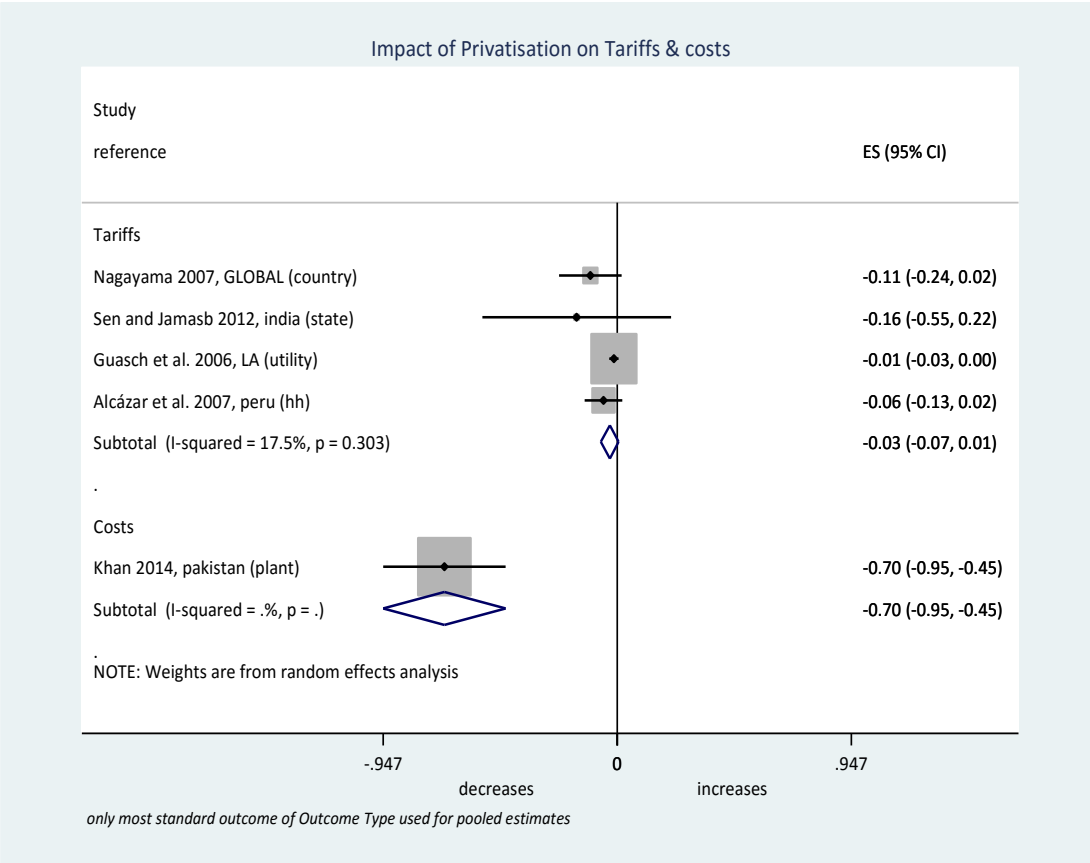


Notes: On the left side of the graph, study references are noted together with the respective sample and unit of analysis in parentheses. Cross-country samples are written in capital letters. LA stands for Latin America.

Tariffs and Costs is the third outcome category for which at least three studies could be retrieved related to privatisation impacts. The study results presented in Figure 9 provide indications on whether privatisation reform effects trickle down to the micro level in form of impacts on tariffs or at least electricity generation costs. We see that (residential and average) tariffs are used as outcomes across all levels; Khan (2014) examines this aspect from a more direct perspective by using the unit costs of production at power plant level. The unit costs of production are not as rigid as residential or industrical prices, which may be the explanation for the higher effect size we find in this study compared to the other studies on tariffs. Even though the latter are conducted on different levels, it does make sense to pool them as they all measure the same outcome. We find a basically neutral overall pooled effect size of -0.03 (95% CI=-0.17 – 0.01, I-squared=18%, 4 observations). This is also interesting to observe as reforms were sometimes taken as an opportunity to introduce cost-

reflective pricing in the short term. Prices were raised to lower negative price-cost margins (or increase weakly positive price-cost margins) and thus to strengthen the financial sustainability of the electricity sector.

Figure 9: Impact of privatisation on tariffs and costs



Notes: On the left side of the graph, study references are noted together with the respective sample and unit of analysis in parentheses. Cross-country samples are written in capital letters. LA refers to Latin America and hh to households.

The results for the outcomes presented above are substantiated by those provided in Table 13, which includes the Main Outcomes and results on Outcome Types studied by less than three articles. The table reproduces the same data as the forest plots: the Standardized Mean Difference (SMD) as the measure of the effect size (ES), its 95% confidence interval, the I-squared test static, and the *p*-value of the chi-squared heterogeneity test. In addition, it shows the *p*-value indicating whether the effect size is significantly different from zero and the Tau-squared test statistic as another heterogeneity measure (see also Sections 3.4.5 and 3.4.9 on these different measures). Most notably, two studies find significant decreases in the labour force.

Further subgroup and sensitivity analyses along continents, study designs and econometric specifications are only conducted through multivariate meta-regressions. Obviously, such analyses are not immune against the analytical limitations introduced by study heterogeneity and small sample sizes. Coefficients

should therefore not be taken at face value. Still, they can help exposing patterns inherent in the data. For that purpose, some measures are recoded as it was done for the publication bias assessment to make coefficient signs comparable across studies. Specifically, we inverted the signs of two Outcome Types “Tariffs and Costs” and “Labour force”. As such, a positive sign does not anymore necessarily indicate an outcome increase, but an “improvement” in the sense commonly understood in the literature.

Table 13: Subgroup analysis for privatisation outcomes

	Effect Size				Heterogeneity tests			
	SMD	**95% confidence interval**		***p*-value** (ES=0)	**Tau-sq**	**I-sq**	***p*-value** (chi-sq)	**Sample size**
Other outcome types								
Labour force	-0.31	-0.66	0.04	0.08	0.06	97%	0.00	2
Quality	0.10	-0.03	0.23	0.13	0.01	90%	0.00	2
Household welfare	-0.04	-0.12	0.04	0.32	-	-	-	1
Main outcomes								
Transmission and Distribution losses (%)	0.03	-0.13	0.18	0.71	0.01	82%	0.00	3
Number of employees	-0.31	-0.66	0.04	0.08	0.06	97%	0.00	2
Electricity gen. capacity p. cap.	0.09	0.02	0.17	0.01	0.00	0%	0.99	2
(Net) electricity generation p.cap.	-0.03	-0.26	0.20	0.79	-	-	-	1
(Residential) electricity price	-0.03	-0.06	0.00	0.10	0.00	10%	0.34	4
Residential electricity access (%)	0.06	0.05	0.06	0.00	-	-	-	1

We also tested whether results are sensitive to the study outcomes used in pooling. As described in Section 3.4.10 and 3.4.5, instead of using the estimate related to the most standard outcome per Outcome Type, we also pooled all outcomes of the same Outcome Type within a study to determine a synthetic effect size point estimate. Similar to the following Intervention Types, we did not find substantive differences and therefore do not further delve into this distinction.

Table 14 shows three different random effects meta-regression analyses, each one with a limited and wider set of covariates, respectively. In the first two columns, we do not only pool across outcomes of a particular Outcome Type but across all outcomes. The third and fourth columns allow studies on privatisation to contribute pooled effect sizes of multiple outcomes. Finally, column (5) and (6) focus on pooled estimates for only those studies which applied a main privatisation dummy considering that the parametrization of the variable of interest may be a critical technical detail further explaining heterogeneity among studies. Other relevant study details are included as control variables: the sample, method and unit of analysis used in the individual studies.

The regressions basically support the previous findings: no clear distinction can be made between the performance in Latin American and Asian countries and studies;ro level show clearly higher outcomes. The methods studies apply (*panel method m*nd the choice of the intervention variable (*last two columns of the table*) seem to have little impact. Still, coefficients are rather sensitive to the concrete specification and caution is warranted when interpreting the results.

Table 14: Privatisation meta-regression results, pooled across outcome types

Dependant variable: Effect Size	Pooled effect sizes across outcomes		Pooled effect sizes of multiple outcomes per study allowed		Pooled effect sizes across outcomes, only main reform dummy	
	(1)	(2)	(3)	(4)	(5)	(6)
Study sample						
Global	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Latin America	0.16	-0.46	0.15	-0.37	0.24	-0.40
	(0.83)	(1.10)	(1.23)	(1.48)	(0.88)	(0.79)
Asia	0.20	-0.29	0.23	-0.23***	0.21	-0.28
	(0.98)	(0.83)	(1.15)	(8.21)	(0.81)	(0.67)
Study characteristics						
Panel methods (=1)		-0.09		-0.05		-0.05
		(0.41)		(0.22)		(0.17)
Unit of analysis (1= utility, plant, EGU or hh)		0.58		0.50**		0.61
		(1.50)		(2.26)		(1.34)
Constant	0.05	0.14	0.06*	0.11	0.04	0.09
	(0.42)	(0.58)	(2.23)	(0.46)	(0.22)	(0.26)
Number of observations	10	10	19	19	8	8
Number of sub-samples/ studies	10/10	10/10	10/10	10/10	8/8	8/8
Tau-squared	0.05	0.05	-	-	0.07	0.08
I-squared	89%	92%	-	-	91%	93%
Adjusted R-squared	-	-	0.08	0.14	-	-
F-tests	0.60	1.07	-	-	0.50	0.80

Notes: The SMD signs of the Outcome Types “Tariffs and Costs” and “Labour force” have been inverted to make coefficient signs comparable across studies, in all cases reflecting “improvements” in the sense commonly understood by the literature. Specifically, we inverted. The regressions in column (3) and (4) are weighted by the inverse of the number of observations that came from the same study over and above the standard inverse variance weighting. Standard errors clustered at the study level. Ref. refers to the reference category of the respective covariate. * p<0.1; ** p<0.05; *** p<0.01.

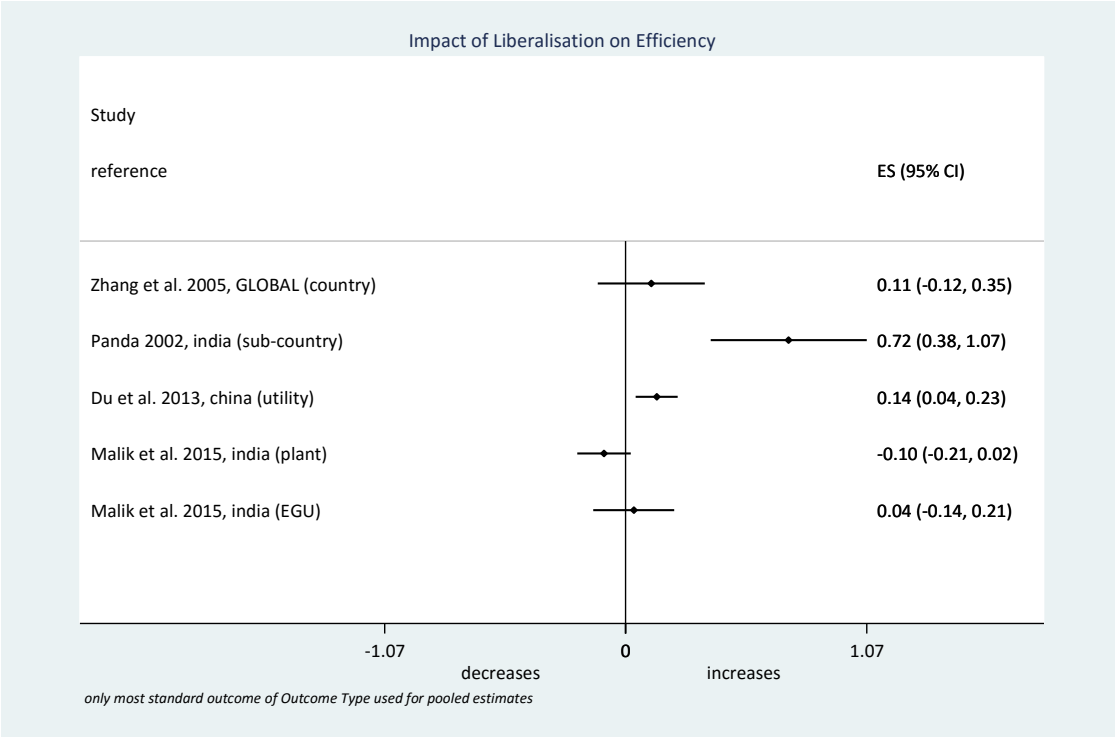
4.3.2 Liberalisation

A limited number of estimations included in the results synthesis addresses liberalisation reform activities, mostly looking at efficiency outcomes.[13] The five observations included in the forest plot in Figure 10 cover a relatively wide range of units of analysis and outcome measures (see also figure note). Malik et al. (2015) contribute two estimates using two different samples, one finding a weakly positive and the other a weakly negative impact of liberalisation on efficiency. Panda (2002) uses data from India as well, but reaches a different conclusion in that he finds a distinct increase in plant availability of 13.7 percentage points, again from a baseline level of around 70%. Having a closer look at the studies, this may be explained by the different time frame and. In fact, Malik et al. (2015) find heterogeneous effects across dates of reform. Plants that underwent reform longer time ago observe increases in efficiency, those that have been reformed more recently significant decreases. The authors find indications that these decreases are likely due to short-term and idiosyncratic factors.[14] To conclude, all studies tend to find efficiency increases after liberalisation activities.

[13] Note that this also has to do with the exclusion of four papers from the analysis of Liberalisation, namely Erdogdu (2011*a*), Nagayama (2007; 2010), and Sen and Jamasb (2012). These articles included various Sub-Types of the Intervention Type Liberalisation that, in sum, do not necessarily reflect the likely effect of the Intervention Type as a whole. See also PCa11 in Appendix 9.8.

[14] On the one hand, EGU availability seemed to have gone down because of increased restoration and maintenance shortly after reform. On the other hand, plant efficiency decreases (expressed as increasing operating heat rates) may have been triggered by shocks to the quality of coal in terms of ash and moisture content in two major states of India.

Figure 10: Impact of liberalisation on efficiency



Notes: EGU refers to electricity-generating unit. Zhang et al. (2005) use capacity utilisation as outcome measure, Panda (2002) plant availability, Du et al. (2013) labour productivity, and Malik et al. (2015) operating heat rate as well as EGU availability.

In addition, it has to be noted that sub-intervention types are more diverse than for the other interventions. They include unbundling as the most discussed sub-intervention, the introduction of a wholesale electricity market, and other competition-enhancing policies as listed in Table 15. Estimates, however, do not seem to differ substantially across these sub-types. It is not possible to further discern our results.

Table 15: Other competition-enhancing policy variables assessed in the included studies

Other competition-enhancing policies	Reference
Legal right to generate electricity for resale	Cubbin & Stern (2006)
Choice of supplier	Erdogdu (2011)
Introduction of retail competition	Nagayama (2007) & (2010)
Open Access to network	Sen & Jamasb (2012)
Wholesale market introduced or generators allowed to compete to conclude supply contracts with distributors or large users)	Zhang et al. (2005)

Table 16: Subgroup and sensitivity analyses for liberalisation outcomes

	Effect Size				Heterogeneity tests			
	SMD	**95% confidence interval**		***p*-value** (ES=0)	**Tau-sq**	**I-sq**	***p*-value** (chi-sq)	**Sample size**
Other Outcome Types								
Labour force	0.07	-0.21	0.35	0.63	0.03	66%	0.09	2
Supply & investment	-0.19	-0.04	0.43	0.10	0.02	67%	0.08	2
Quality	-	-	-	-	-	-	-	-
Price & costs	-0.05	-0.09	-0.01	0.02	0.00	0%	0.38	2
Household welfare	-	-	-	-	-	-	-	-
Main Outcomes								
Transmission and Distribution losses (%)	-	-	-	-	-	-	-	-
Number of employees	-0.03	-0.07	0.01	0.12	-	-	-	-
Electricity gen. capacity p. cap.	0.30	0.11	0.48	0.00	-	-	-	-
(Net) electricity generation p.cap.	0.05	-0.18	0.29	0.66	-	-	-	-
(Residential) electricity price	-	-	-	-	-	-	-	-
Residential electricity access (%)	-	-	-	-	-	-	-	-

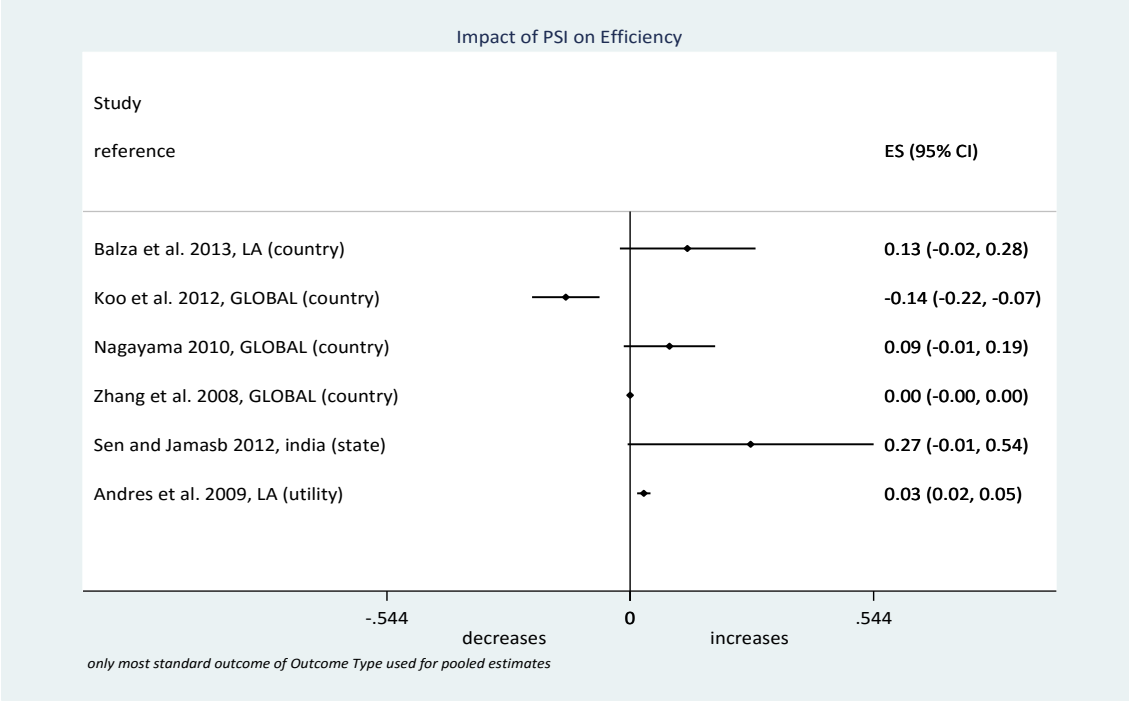
4.3.3 Private sector involvement

Overall our meta-analysis results provide no strong evidence related to reforms that foster private sector involvement. If at all, we find weak indications of positive Private Sector Involvement effects, which are, however, consistent across outcomes.

Regarding the impact of private sector involvement on efficiency, forest plot analysis indicates a weakly positive effect size. Five of the six studies use transmission and distribution losses as outcome measure; the only exception is Zhang et al. (2005)

who explore capacity utilisation. The effect size for all studies but one is positive (Figure 11). Koo et al. (2012) find a negative effect. The authors, however, note that an interaction term of regulation and private sector involvement, something which is not included in our estimation, is positive meaning that the effect of private sector involvement on efficiency improves as the level of government regulation increases (Koo et al. 2012). The point estimate obtained by Sen and Jamasb (2012) using state-level data is large, but it is likely imprecise and has a very large confidence interval.

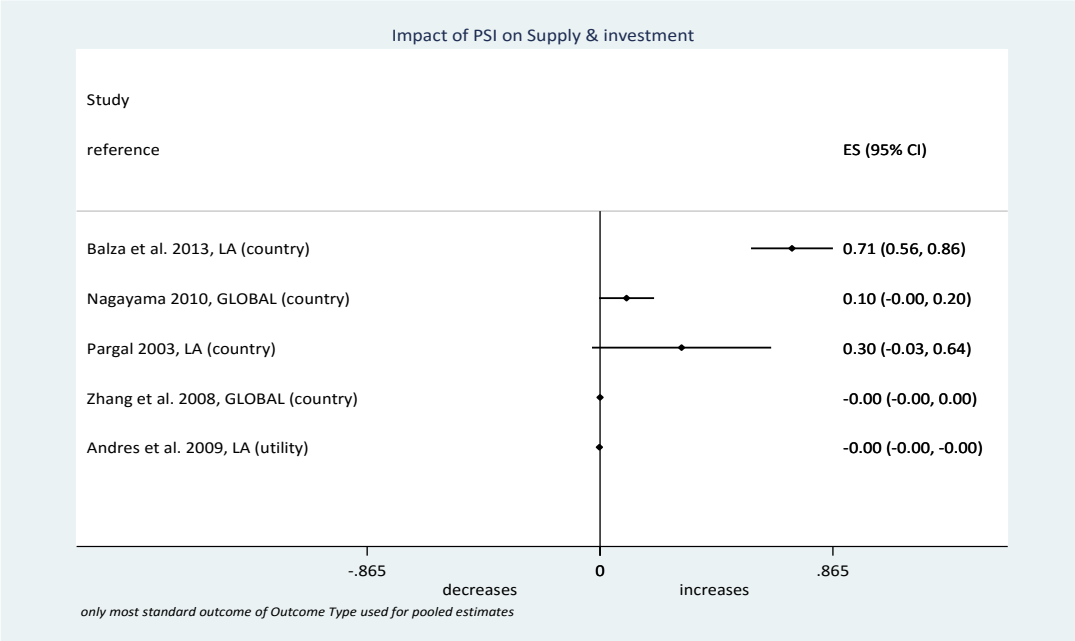
Figure 11: Impact of private sector investment on efficiency



Note: LA refers to Latin America.

Figure 12 depicts results on five private sector investment studies that include estimations on supply and investment. Pargal (2003) assesses whether real private investment is affected in the first place and, not too surprisingly, finds a positive effect. The other four studies assess residential electricity access (Balza et al. 2013; Andres et al. 2009), electricity generation per capita (Zhang et al. 2008) and electricity generation *capacity* per capita (Nagayama 2010). Interestingly, Balza et al. (2013) find a larger effect on country level than Andres et al. (2009) on utility level. Balza et al.'s result would imply that an increase of 1% in cumulative private investment is statistically significantly associated with a 0.11% increase in access to electricity services. Yet, it is likely that the estimations by Andres et al. (2009), which account for utility-specific time trends, are more precise. To conclude, while we may see increased private investment triggered by private sector involvement measures, there is no substantive evidence that this translates into impacts on aggregate electricity supply.

Figure 12: Impact of private sector involvement on supply and investment



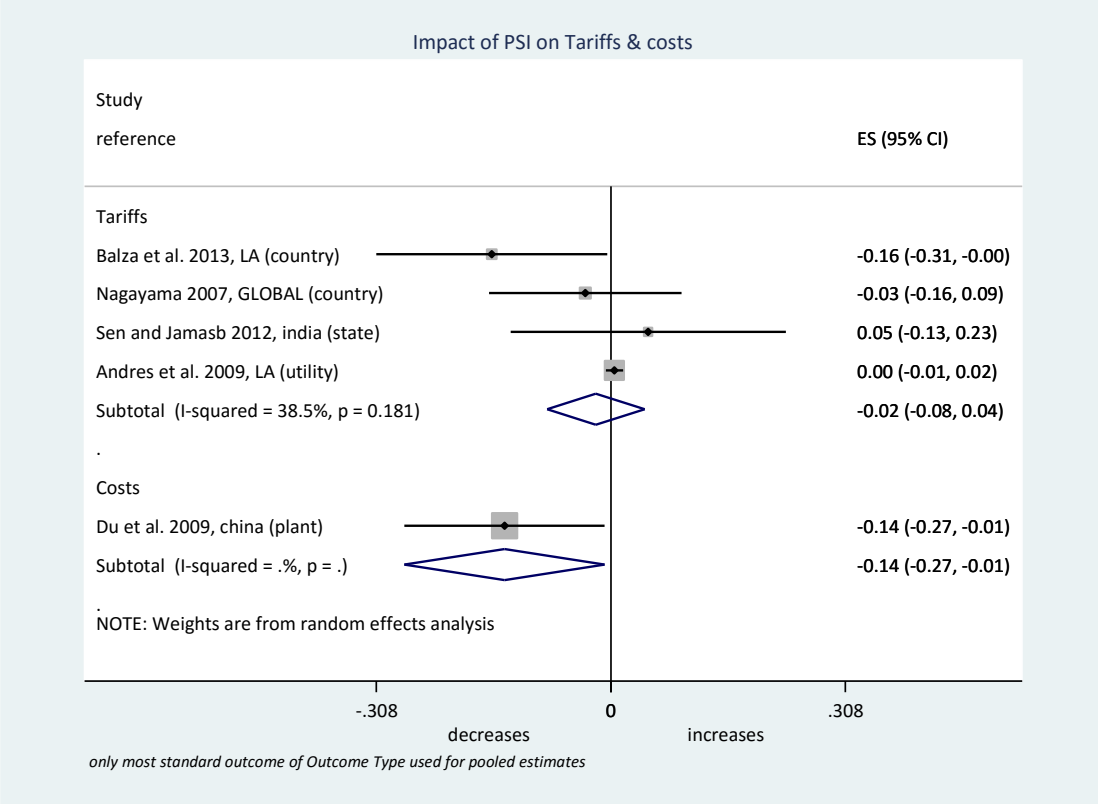
Note: LA refers to Latin America. Pargal (2003) uses interaction terms of infrastructure sectors and countries as unit of observations. However, only estimations restricted to the power sector entered the pooled estimates. Thus, the unit of observation is the country as well in this case.

The forest plot in Figure 13 has some resemblance to the previous one for supply and investment, mirrored vertically due to the reverse implied impact direction of tariffs and costs: costs in the first place seem to be negatively affected (Du et al. 2009), but for various conflicting reasons as already mentioned under privatisation, the overall pooled effect is insignificant and, if at all, merely weakly negative (SMD=-0.02, 95% CI=-0.08 - 0.04, I-squared=39%, 4 observations). Again, the utility-level analysis of Andres et al. (2009) finds basically no effect as opposed to the negative estimate in Balza et al. (2013) based on country data. Compared to the impact of privatisation on tariffs and costs, there is more heterogeneity between studies as indicated by the I-square shown in the forest plot. While the variety of samples and units of analysis is similar in both studies, this heterogeneity may be alternatively due to other methodological particularities of the studies or a larger diversity in the implementation of concrete Private Sector Involvement measures.

Table 17 summarizes the remaining Outcome Types and looks specifically into Main Outcomes. Though effects continue to be rather weak, outcomes are consistently showing into directions generally considered as improvements: higher quality, household welfare, and electricity access on the one hand and lower transmission and distribution losses, prices and workforce on the other. The meta-regressions in

Table 18 underpin that effects are rather subtle with a slightly better performance in Latin America. The relative low adjusted R-squared and F-test values indicate that – similar to the privatisation data –the assessed covariates can explain rather little of the variation in the data.

Figure 13: Impact of private sector involvement on tariffs and costs



Note: LA refers to Latin America.

Table 17: Subgroup analysis for private sector involvement outcomes

	Effect Size				Heterogeneity tests			
	SMD	**95% confidence interval**		***p*-value** (ES=0)	**Tau-sq**	**I-sq**	***p*-value** (chi-sq)	**Sample size**
Other Outcome Types								
Labour force	-0.19	-0.32	-0.06	0.00	-	-	-	1
Quality	0.08	0.06	0.10	0.00	-	-	-	1
Household welfare	0.03	-0.22	0.28	0.80	-	-	-	1
Main Outcomes								
Transmission and Distribution losses (%)	-0.04	-0.14	0.06	0.72	0.01	85%	0.00	5
Number of employees	-0.19	-0.32	-0.06	0.72	-	-	-	1
Electricity gen. capacity p. cap.	0.10	0.00	0.20	0.72	-	-	-	1
(Net) electricity generation p.cap.	0.00	0.00	0.00	0.72	-	-	-	1
(Residential) electricity price	-0.02	-0.08	0.04	0.72	0.00	39%	0.18	4
Residential electricity access (%)	0.35	-0.35	1.05	0.72	0.25	99%	0.00	2

Table 18: Private Sector Involvement meta-regression results

Dependant variable: Effect Size	Pooled effect sizes across outcomes		Pooled effect sizes of multiple outcomes per study allowed		Pooled effect sizes across outcomes, only main reform dummy	
	(1)	(2)	(3)	(4)	(5)	(6)
Study sample						
Global	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Latin America	0.18	0.22*	0.18*	0.20*	0.10	0.31
	(1.87)	(2.09)	(1.98)	(2.02)	(0.82)	(1.41)
Asia	0.13	0.17	0.09	0.10	0.05	0.05
	(1.07)	(1.10)	(0.97)	(0.68)	(0.26)	(0.26)
Study characteristics						
Panel methods (=1)		-0.07		-0.08		0.15
		(0.47)		(0.66)		(0.57)
Unit of analysis (1= utility, plant, EGU or hh)		-0.14		-0.10		-0.31
		(1.15)		(0.98)		(1.31)
Constant	-0.01	0.06	-0.00	0.08	-0.01	-0.16
	(0.09)	(0.40)	(0.05)	(0.59)	(0.10)	(0.57)
Number of observations	10	10	19	19	7	7
Number of sub-samples/ studies	10/10	10/10	10/10	10/10	7/7	7/7
Tau-squared	0.01	0.01	-	-	0.01	0.01
I-squared	83%	78%	-	-	79%	86%
Adjusted R-squared	-	-	0.18	0.14	-	-
F-tests	1.86	1.33	-	-	0.34	0.65

Notes: The SMD signs of the Outcome Types “Tariffs and Costs” and “Labour force” have been inverted to make coefficient signs comparable across studies, in all cases reflecting “improvements” in the sense commonly understood by the literature. The regressions in column (3) and (4) are weighted by the inverse of the number of observations that came from the same study over and above the standard inverse variance weighting. Standard errors clustered at the study level. Ref. refers to the reference category of the respective covariate. * p<0.1; ** p<0.05; *** p<0.01.

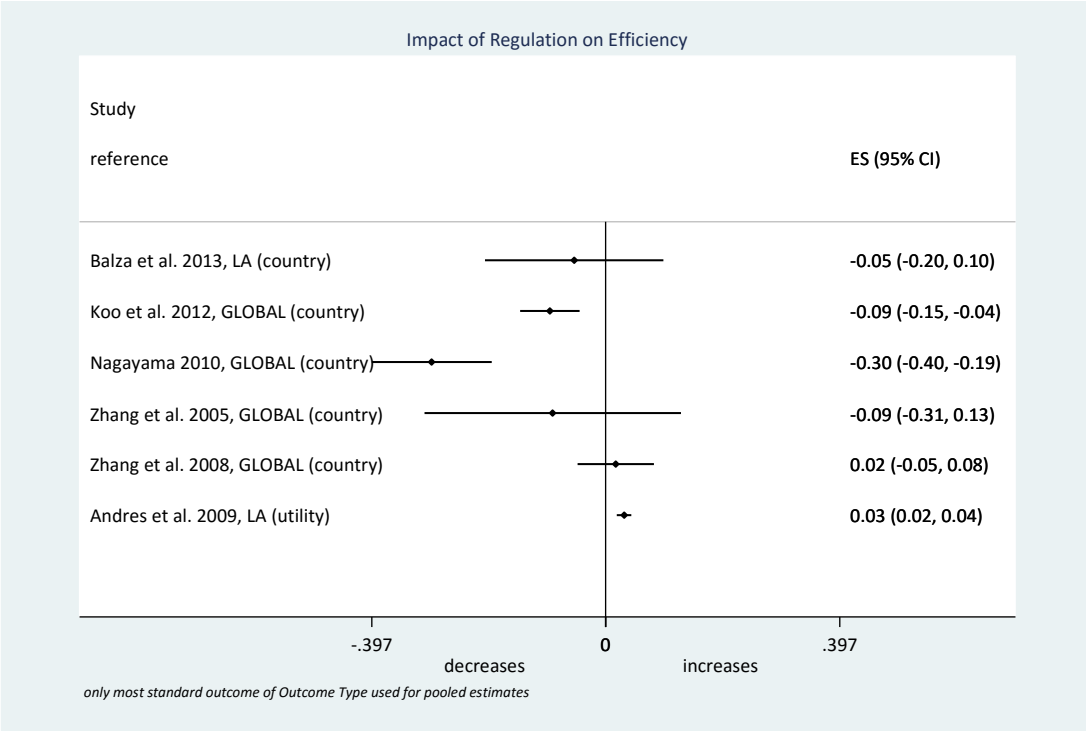
4.3.4 Regulation

Regulation is generally understood by the primary study authors as the existence of a regulatory body that usually goes along with the presence of an electricity (or energy) regulatory law. While most authors create dummy variables out of the information on the respective regulatory framework, Balza et al. (2013), Cubbin and Stern (2006) and Zhang et al. (2008), for example, use additive indices with four dimensions including a sub-index on whether the regulator is an autonomous agency or the sector ministry.[15] Regulation is inevitably linked with any of the other reform interventions. Concerns about combined interventions and the robustness of their estimates, as they have briefly been discussed in 4, therefore particularly apply for this intervention type.

In general, meta-analysis findings again suggest mixed impacts. Closer examining the results for the different outcomes, we first find a rather unclear picture for efficiency as measured through transmission and distribution losses or, as in the case of Zhang et al. (2005; 2008), through capacity utilisation. There is only one study that finds a positive impact on efficiency (Andres et al. 2009), with Zhang et al. (2008) basically finding no effect at all. Nagayama finds the highest efficiency decrease (i.e. the highest increase in transmission and distribution losses) among the included studies and explains this by expansion periods of the electricity sector: a higher share of the generated electricity got lost simply because reform countries simultaneously extended transmission and distribution grids to more remote areas. The negative sign thus not necessarily reflects inefficiencies but rather the inability to control for electricity network sizes in the analysis. More fundamentally, regulation may not have yielded efficiency gains since regulation often seemed to have favoured cost pass-through by utilities leaving little incentive to cut inefficiencies. At the same time, it is worth translating these standardized figures into economic terms, which makes clear that Balza et al. (2013), for example, merely find an increase in losses of on average 0.28%.

[15] Note that a few papers have been excluded from the analysis in this section, namely Erdogdu (2011a), Nagayama (2007), and Sen and Jamasb (2012). In the same way as for liberalisation, these articles included various Sub-Types of the Intervention Type Regulation that, in sum, do not necessarily reflect the likely effect of the Intervention Type as a whole. See also PCa11 in Appendix 9.8.

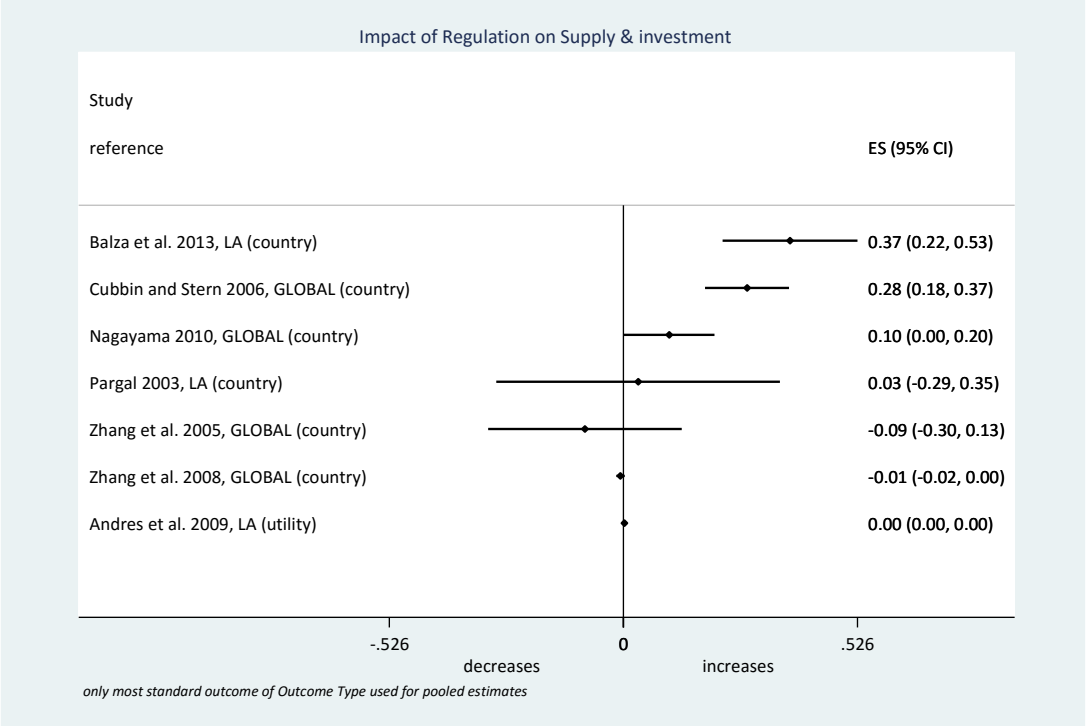
Figure 14: Impact of regulation on efficiency



Note: LA refers to Latin America.

We are able to calculate effect sizes and confidence intervals for seven studies with supply and investment outcomes. Figure 15 presents the forest plot of these results. For this Intervention Type, Pargal (2003) basically finds no effect on investment levels. Supply outcomes are the same as presented in the previous sub-section (Figure 12), with Cubbin and Stern (2006) and Zhang et al. (2005) additionally assessing electricity generation capacity per capita. Hence, the assessed outcomes do not seem to dictate the heterogeneity of results depicted in the graph. A more relevant aspect may be that Balza et al. (2013) and Cubbin and Stern (2006) better succeed in disentangling regulation from other Intervention Types by using a more precise measure for regulation (though it has to be noted that Zhang et al. 2008 use a similar measure). Hence, the literature provides little clear clues for this intervention-outcome combination, though stronger evidence can be found for a positive effect of a robust regulatory framework on electricity generation.

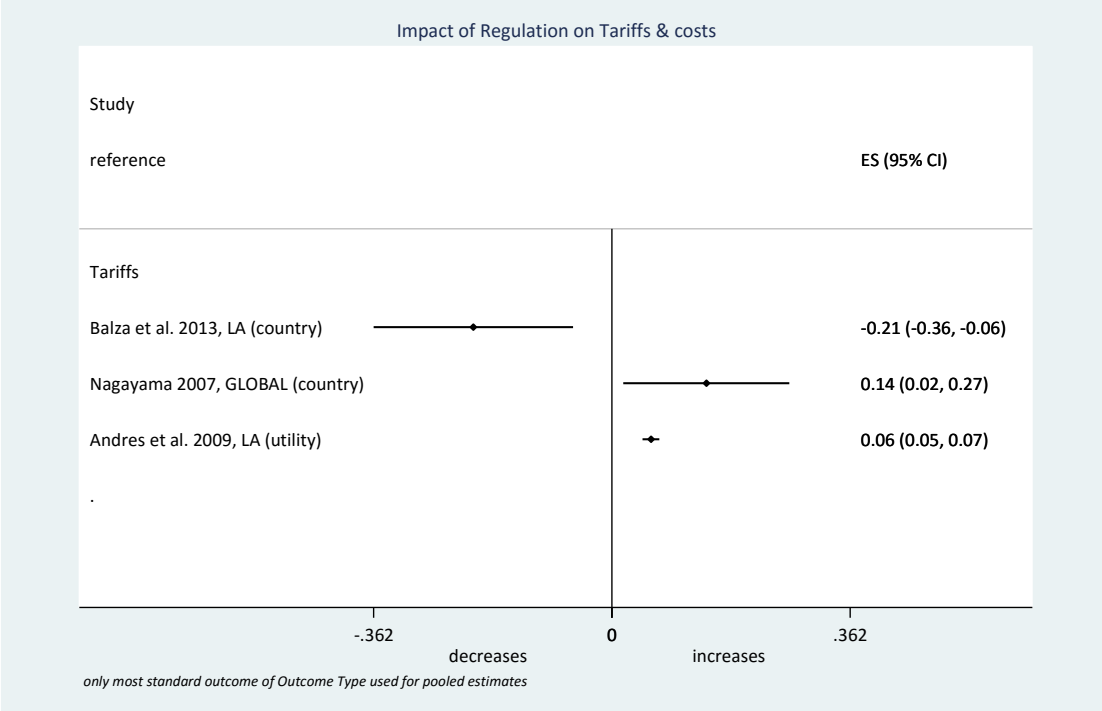
Figure 15: Impact of regulation on supply and investment



Note: Pargal (2003) uses interaction terms of infrastructure sectors and countries as unit of observations. However, only estimations restricted to the power sector entered the pooled estimates. Thus, the unit of observation is the country as well in this case.

Even less conclusive are results for Tariffs and Costs. The three studies that examine the impact of regulation on electricity prices shown in Figure 16 come to quite distinct conclusions. Balza et al. (2013) find significant reductions in end-user prices, while Nagayama (2010) finds clear increases in prices. The more focused analysis by Andres et al. (2009) on utilities in Latin America gives an idea for why this heterogeneity can be observed, substantiating a claim made earlier in this review: they find a 14% increase in residential tariffs under the presence of a regulatory agency, while industrial ones presented a 5% reduction and the cost-recovery ratio rose significantly by 13%. Cost recovery and the overall tariff structure are thus important co-determinants of impact directions related to reform endeavours including regulatory interventions.

Figure 16: Impact of regulation on tariffs and costs



Note: LA refers to Latin America.

Table 19: Subgroup and sensitivity analyses for regulation outcomes

	Effect Size				Heterogeneity tests			
	SMD	**95% confidence interval**		***p*-value** (ES=0)	**Tau-sq**	**I-sq**	***p*-value** (chi-sq)	**Sample size**
Other Outcome Types								
Labour force	0.00	-0.12	0.12	0.95	-	-	-	1
Quality	0.11	0.08	0.13	0.00	-	-	-	1
Household welfare	-	-	-	-	-	-	-	-
Main Outcomes								
Transmission and Distribution losses (%)	0.10	-0.03	0.23	0.13	0.01	95%	0.00	4
Number of employees	0.00	-0.12	0.12	0.95	-	-	-	1
Electricity gen. capacity p. cap.	0.19	0.02	0.36	0.03	0.01	84%	0.01	2
(Net) electricity generation p.cap.	-0.01	-0.02	0.00	0.16	0.00	0%	0.47	2
(Residential) electricity price	0.01	-0.14	0.16	0.91	0.01	86%	0.00	3
Residential electricity access (%)	0.18	-0.18	0.54	0.33	0.07	96%	0.00	2

The more comprehensive look at regulation impacts in Table 19 and Table 20 provide little additional evidence. One notable result is the higher, though still insignificant coefficient for residential electricity access. Residential electricity access as one key outcome of this review will be further assessed in the next sub-section.

Table 20: Regulation meta-regression results

Dependant variable: Effect Size	Pooled effect sizes across outcomes		Pooled effect sizes of multiple outcomes per study allowed		Pooled effect sizes across outcomes, only main reform dummy	
	(1)	(2)	(3)	(4)	(5)	(6)
Study sample						
Global	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Latin America	0.07	0.15	0.07	0.14	0.11**	0.13
	(0.86)	(1.26)	(1.00)	(1.77)	(3.30)	(0.76)
Asia	-	-	-	-	-	-
Study characteristics						
Panel methods (=1)		-				-
Unit of analysis (1= utility, plant, EGU or hh)		-0.13		-0.11*		-0.02
		(0.92)		(2.13)		(0.12)
Constant	-0.01	-0.01	-0.01	-0.01	-0.09**	-0.09*
	(0.28)	(0.29)	(0.15)	(0.15)	(2.93)	(2.93)
Number of observations	10	10	18	18	6	6
Number of sub-samples/ studies	10/10	10/10	10/10	10/10	6/6	6/6
Tau-squared	0.01	0.01	-	-	0.00	0.00
I-squared	85%	84%	-	-	-	-
Adjusted R-squared	-	-	-0.01	-0.02	-	-
F-tests	0.75	0.80	-	-	10.90	5.45

Notes: The SMD signs of the Outcome Types “Tariffs and Costs” and “Labour force” have been inverted to make coefficient signs comparable across studies, in all cases reflecting “improvements” in the sense commonly understood by the literature. The regressions in column (3) and (4) are weighted by the inverse of the number of observations that came from the same study over and above the standard inverse variance weighting. Standard errors clustered at the study level. Ref. refers to the reference category of the respective covariate. * p<0.1; ** p<0.05; *** p<0.01.

4.3.5 Impact synthesis across Intervention Types

To conclude the synthesis of reform intervention impacts, we take a look at three aspects across Intervention Types: first, we show results of studies that analyse electricity sector reforms as one aggregate, composite concept. Second, we depict forest plots for the Main Outcome residential electricity access, since this review was supposed to particularly focus at this outcome. Thirdly, we present results of a regression that pools the meta-regression results of the four individual Intervention Types.

Electricity sector reforms as a composite Intervention Type

Regrettably, there are only three studies looking at electricity sector reforms in an aggregate manner, with in total merely four Outcome Type results (Table 21). Though we mostly see small positive impacts (including price reductions), the largest coefficient is negative: Erdogdu (2011*b*) finds considerable increases in transmission and distribution losses, which may add up to 10% depending on the extent of reforms undertaken. Interestingly, the author's main reasoning for efficiency reductions relate to reduced economies of scope due to liberalisation in the form of unbundling, the Intervention Type for which we found indications of positive effects on efficiency. According to Erdogdu, integrated utilities take potential transmission losses into account when deciding on the location of power generation, which is not anymore the case once the sector is unbundled. This may thwart performance improvements achieved by the reforms and thus lead to higher net inefficiencies. Though the argument is in line with the theoretical economic literature, it seems debatable to which degree it can bring about such strong effects in practice.

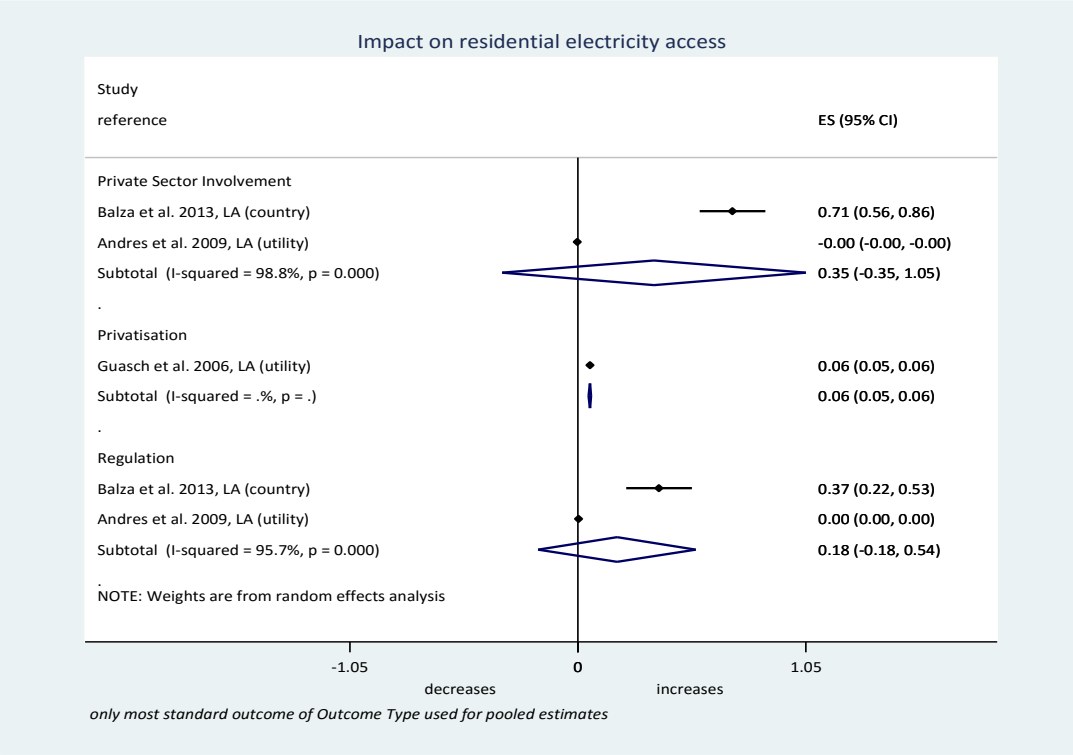
Table 21: Composite reform outcomes by outcome type

	Effect Size				**Heterogeneity tests**			
	SMD	**95% confidence interval**		***p*-value** (ES=0)	**Tau-sq**	**I-sq**	***p*-value** (chi-sq)	**Sample size**
Outcome Types								
Efficiency	-0.25	-0.28	-0.21	0.00	-	-	-	1
Supply & investment	0.02	0.01	0.03	0.00	-	-	-	1
Quality	0.14	-0.08	0.36	0.22				1
Price & costs	-0.09	-0.20	0.02	0.12	-	-	-	1

Electricity access as main outcome

Figure 17 brings together the results on residential electricity access across the different Intervention Types mentioned in the graph. All have been retrieved from Latin American countries and may thus not inform about the situation on other continents. Since results partly come from the same study, we abstain from calculating pooled effect sizes. Still, it can be concluded that all results are at least non-negative.

Figure 17: Forest plots for the residential electricity access outcome



Regression pooling the meta-regression results across intervention types

The pooling of all meta-regression results from the previous sub-sections yields the results presented in Table 22. Since we pool across outcomes, results should be read carefully. Having said that, the results suggest impacts are weak, most pronounced for Privatisation and least pronounced for Regulation, to show little overall difference between Latin America and Asia, and to have the strongest effect on supply indicators. It would have been desirable to further look at interaction terms, in particular between Intervention Types and Outcomes, but this clearly overstrains the degrees of freedom determined by the sample size of these regressions.

Table 22: Regression results on reform impacts across intervention types

	Effect Size	
	(1)	(2)
Intervention Types		
Composite reform	Ref.	Ref.
Privatisation	0.00 (0.03)	0.04 (0.57)
Liberalisation	-0.13 (1.11)	-0.11 (1.00)
Private Sector Involvement	-0.08 (1.47)	-0.08** (2.08)
Regulation	-0.12*** (2.29)	-0.11** (2.27)
Study sample		
Global	Ref.	Ref.
Latin America	0.09 (1.57)	0.18** (2.32)
Asia	0.13 (1.19)	0.25* (1.79)
Study characteristics		
Panel methods (=1)		-0.03 (0.25)
Unit of analysis (1= utility, plant, EGU or hh)		-0.15* (1.76)
Outcomes		
Efficiency (=1)		Ref.
Labour force (=1)		0.11 (1.40)
Supply & investment (=1)		0.12* (1.89)
Quality (=1)		0.07 (1.46)
Tariffs & costs (=1)		0.08 (1.47)
Household welfare (=1)		-0.02 (0.24)
Constant	0.10*** (4.51)	0.05 (0.52)
Number of observations	71	71
Number of sub-samples/ studies	25/23	25/23
Adjusted R-squared	0.15	0.28

4.4 Synthesis of qualitative evidence literature

In order to understand the mechanisms behind electricity sector reform successes and failures, it is crucial to understand the drivers of electricity sector reform in the first place. Since the quantitative evidence literature is largely silent about these mechanisms, we rely on qualitative evidence for this synthesis. These studies and their main findings used in this synthesis are listed in Annex 0. They generally rest on deep contextual knowledge to sketch likely relationships between reform measures and outcomes.

Reforms are highly endogenous in the sense that driving factors of reforms at the same time co-determine outcomes. This holds true for many of the drivers listed in Table 23. The table differentiates between national electricity sector drivers, national policy drivers and external drivers. This difference is critical in order to be able to anticipate in how far reform measures may be interpreted as being dictated from certain internal or external circumstances or entities.

Table 23: Drivers of electricity sector reform

National electricity sector drivers	National policy drivers	External drivers
Lack of public sector financial, human and technical resources (resource endowment, electricity market structure and size, and institutional strength) Poor electricity sector performance ○ institutional inefficiency, including corruption ○ low service quality ○ high energy losses, including power theft ○ poor service coverage ○ capacity shortage Rapidly growing demand Burden of energy subsidies Energy sector investment constraints in general	Political and economic ideology: faith on the forces of market, competition and privatisation Capital raising options: privatisation of state-owned energy assets Demonstrations effects from neighbouring countries, notably in Latin America from Chile and Argentina Political clientelism	Macroeconomic events: notably the Latin American debt crisis (1980s), Asian financial crisis (1997-1998) and post-Soviet economic transition (1989) Lending policies of donors: such as those of the World Bank and IMF with strings attached, structural adjustment programmes OECD energy deregulation: creation of new energy multinationals looking for investment opportunities Technological innovation: such as the development of high-efficiency thermal power plants (CCGT)

Source: adapted from Jamasb et al. (2015) based on a review of the entirety of the included qualitative evidence literature.

In this regard, scepticism by main stakeholders like employee unions has been identified as one main barrier to reforms in Asian countries such as Thailand, Indonesia and Sri Lanka (Bhattacharyya 2007; Nagayama and Kashiwagi 2007). In Sub-Saharan Africa, particular resistance from labour unions has been observed in French-speaking countries in West Africa (Karekezi and Kimani (2002). In privatising its state-owned electric utilities, Argentina worked to minimise such resistance through limited employee layoffs, employee-protection measures and the use of privatisation proceeds for allowance to retirees (Nagayama and Kashiwagi 2007). Other main reform barriers identified in the literature are not specific to the power sector either, most notably political instability (see, for example, Bhattacharyya 2007; Nair 2008; Srivastava and Kathuria 2014 and Dornan 2014).

Some stylized-fact lessons can be drawn from the qualitative evidence literature when it comes to the mechanisms that can be related to the cause-effect relationship introduced in Section 1.3 between reforms and the impacts identified in the previous sub-section. In general, the literature is quite unanimous in their interpretation of what is conducive to successful electricity sector reforms: (i) a commercial approach, (ii) competitive arrangements, (iii) cost-reflective pricing, and (iv) independent, empowered and efficient regulation. The matrix in Table 24 on electricity policy drivers of reform impacts highlights these four issues at the intersection of the Intervention Types Privatisation, Private Sector Involvement, Liberalisation, and Regulation. The table also relates these and other secondary drivers to the Outcome Types assessed in this review. The interventions and outcomes partly tend to be related directly with each other, partly indirectly. The latter is particularly true for household welfare, which mostly reflect the second-round effects of effects on other intermediary outcomes. Reliability and prices of electricity supply affect households' access to electricity service, which in turn may affect their well-being.
In how far the outcomes are effectively affected in a positive way is essentially attributed to how serious, timely and complementarily these mechanisms are implemented by reform actors and in how far negative side effects are mitigated. Note that the following summary of the four abovementioned topics refers to countries or continents for illustrative purposes only. Some examples may not represent the current status quo but rather explain certain mechanisms from a historic perspective:

- a *commercial approach* that properly establishes commercial corporate governance structures including decision-making and accountability. In Table 24, it is located at the intersection of Privatisation and Private Sector Involvement on the one hand and Efficiency and Labour force on the other. The prevalence of non-commercial practises has been found in the early years of electricity sector reforms in Pakistan and India, for example (Malik et al. 2009; Nair 2008). They go along with low billing and collection efficiencies and high technical and commercial losses, in particular. The transition to commercial entities has to account for the social welfare functions previously

fulfilled by the electricity utilities to mitigate disruptive negative effects on certain consumer segments (Karekezi and Kimani 2002). For certain functions, this may be achieved through regulatory measures, e.g. with regards to disconnection and pricing policies.

- *cost-reflective pricing* remains “at the heart of the success or failure” of reforms (Jamasb et al. 2015). It mainly relates to the Outcome Price and Costs and the Intervention Types Liberalisation and Regulation (Table 24). As compared to actual costs, Han et al. (2005), for example, find that from a social welfare perspective prices in China tended to be too low for central government owned utilities and too high or regional or foreign invested ones. Determining and – at least in an early reform phase – regulating cost-reflective tariff structures, however, is an economically and technically complex and not always straightforward task (Meher and Sahu 2013). Eberhard et al. (2011) further stress that insufficient cost recovery is not only a function of low tariffs but also of high costs. This implies that measures to increase cost recovery should always be accompanied by regulatory measures to incentivize cost-minimization. Finally, the question of adequate price signals extends to transmission network expansion and use. In Latin America, disputes regularly arose among market players about the appropriate allocation of transmission payments (Rudnick and Zolezzi 2001). Increases in prices obviously have negative effects on household welfare by lowering disposable incomes. Whether these effects are regressive in nature, i.e. affecting poorer segments stronger than richer ones, depends largely on prevailing electrification rates. In Sub-Saharan Africa with mostly low electrification rates, this has therefore been found to be less an issue than in Latin America (Karekezi and Kimani 2002; Kozulj and Di Sbroiavacca 2004).
- *competitive arrangements* that yield a functioning electricity market with a sufficient number of players. They primarily link the Intervention Types Private Sector Involvement, Liberalisation, and Regulation with the Outcomes Efficiency and Labour force (Table 24). According to Von der Fehr and Millán (2003), economic, technological and institutional conditions have to be conducive to competitive outcomes, which can be qualified based on the reviewed literature as follows:

Table 24: Electricity policy drivers of reform impacts

	Efficiency	Labour force	Supply & investment	Price & costs	Household welfare and quality
Privatisation	-	-	-	higher electricity price-cost mark-ups	(indirect effects) availability of privatisation proceeds for social purposes
	commercial approach availability of new financial resources for system maintenance		availability of new financial resources for system expansion	increased revenue collection (indirect effects from changes in efficiency and supply)	limited focus on unprofit-able areas (indirect effects)
Private Sector Involvement	-	-	-	-	-
Liberalisation	***competitive arrangements*** availability of more financial resources for system maintenance		availability of more financial resources for system expansion	(indirect effects from changes in efficiency and supply)	(indirect effects)
	higher flexibility in planning		-	-	-
	new skills and capabilities introduced by new players fragmentation of electricity industry inducing losses of economies of scale and scope and increased transaction costs		clear, transparent and basically non-discriminatory entry and exit as well as network access rules	***cost-reflective pricing***	-

Regulation	promotion of appropriate technologies through supportive pricing arrangements	-	fair and optimal costs for consumers	balancing interests of consumers, utility and government
	Independent, empowered and efficient regulation			

Source: own illustration

- technological conditions: the main primary energy sources have to be competitive, since monopolists can otherwise extract all rents from downstream activities (Estache and Rodriguez-Pardina 2000). Nepal and Jamasb (2012) give the example of Nepal, where large hydropower determines a high minimum efficient scale of power generation that leaves the market with few competitors. Additionally, the initial technological endowment of the electricity sector plays a relatively strong role given the more pronounced path dependency of electricity infrastructure systems. Finally, the technical infrastructure (e.g. load dispatch centres) may simply create constraints to the sourcing from different electricity suppliers (Kodwani 2009).
- institutional conditions: the literature first of all highlights the need to address the full range of competition areas, which also requires institutional coordination between regulatory and competition policies. Beyond head-to-head competition, this comprises market and yardstick competition, including competitive tendering for monopoly concessions, mergers and acquisitions in regulated sectors, competitive advocacy, and clear third-party access regulation (Estache and Rodriguez-Pardina 2000; Greco et al. 2011). In Argentina, for example, the obligation of all new public transmission investments above $2 m to be competitively tendered led to significantly reduced construction costs (Pollitt 2008). The early reform process in Chile missed restrictions on ownership concentration. In consequence, the electricity sector remained a highly oligopolistic, vertically integrated industry acting in a very imperfect competitive context (Gabriele 2004). Room for discriminatory third-party network access and its adverse effects were observed in Nepal (Nepal and Jamsb 2012).

As noted by Gabriele (2004), the maximum achievable degree of competition considering these various challenges remains limited for most developing countries. As a consequence, efficiency gains achieved through sector reforms in some Latin American countries have not necessarily reached the consumers but remained within the mono- or oligopolies (Rudnick and Zolezzi (2001). In any case, the opening of the electricity sector to competition is best implemented in a coordinated and step-wise approach, in which competitive arrangements are progressively introduced in the generation, wholesale and retail level, respectively (Nepal and Jamasb 2015, Figure 1). Joskow (2008) adds that such arrangements proofed to be preferably dealt with structurally ex ante rather than ex post.

- more broadly speaking about regulatory oversight, the literature stresses the importance of *independent, empowered and efficient regulation*. The lack of autonomy and professional expertise has been stressed in the case of Pakistan (Malik et al. 2009). More fundamentally, Kayo (2002) stressed the lack of an enabling legal and regulatory framework related to stalling electricity sector reforms in Zimbabwe; Karekezi and Kimani (2002) observed some reluctance to establish independent regulatory agencies in various African countries. Similarly, Pineau (2005; 2007) determined the absence of transparency and accountability mechanisms as one of twelve policy incoherencies in the Cameroonian electricity reforms around the year 2000. Nair (2008) further pointed out that even if the necessary powers and enforcing instruments are in place, the state of the sector that is regulated may inhibit the application of these instruments. He gives the example of India, where the regulator was largely seized with regulating 'negativities', i.e. supply shortages, revenue deficits of utilities and technical and commercial losses.

This synthesis underscores that the mechanisms mostly link the interventions with intermediate outcomes. Table 24 mentions another separate channel through which households may benefit from privatisation reforms: privatisation proceeds to the government – either from the transfer of ownership to private operators or for the concession of electricity services – may be reinvested for social purposes (Rosillo-Calle et al. 2002). Other authors like Kozulj and Di Sbroiavacca (2004) point out that indirect impacts of energy sector reforms may affect household welfare even stronger than these direct effects. They hold electricity sector reforms responsible for increased foreign indebtedness, monetary appreciation, growing unemployment and ultimately higher poverty levels in Latin America. Such statements, however, lack sufficient evidence and require alternative economy-wide assessments such as general equilibrium approaches applied in Benitez, Chisari and Estache (2003), which are not covered by this systematic review.

5. Discussion

5.1 Summary of main results

Review questions 1 and 2 on effectiveness and mechanisms

This systematic review examined the effects of different market-based reforms in developing countries and the mechanisms that help explain them. Table 25 summarizes the synthesis of results of the primary quantitative evidence studies included in this review. Outcome Types listed in the table are mostly intermediate indicators, since only very few studies embrace the whole results chain from market-based reform activities to electricity access. The overall message transpiring from this table is that there is not sufficient evidence for a general trend in any relevant outcome triggered by market-based electricity sector reforms. Despite a careful

separate pooling by Intervention and Outcome Types, the quantitative synthesis has been plagued by substantive heterogeneity among primary studies in terms of study designs, units of analyses and applied outcome variables. The whole set of meta-analytical instruments could thus in many cases not be applied. This is also true for the few studies that jointly assessed reforms as combined interventions. In half the cases, we even lack a minimum number of three studies dedicated to specific Intervention-Outcome Type combinations depicted in Table 25. The evidence base neither allowed embarking on relevant participant sub-group analyses, for example in order to assess claims as made in Argentina that reforms failed to provide equitable benefits to poorer segments of the society (Haselip et al. 2005).

Table 25: Summary results of reform intervention impacts on main outcome types

	Efficiency	Labour force	Supply & investment	Quality	Price & costs	Household welfare
Privatisation	o		(+)		o	
Liberalisation	(+)					
Private Sector Involvement	(+)		(+)		o	
Regulation	?		(+)		?	

Note: The symbols “o” and “?” refer to neutral and unclear and the “+” and “-“ to positive or negative impacts, respectively; if put in brackets meaning weakly positive/ negative. If left blank, there was not sufficient evidence (less than three studies) to assess this Intervention-Outcome combination.

In sum, the existing literature thus does not allow making any robust statements about the aptness of market-based reforms as a means to foster electricity access effort in developing countries. There are merely weak indications that ownership (i.e. privatisation) plays less of a role than other market-based interventions and that regulation can show mixed results depending on how it is designed as part of a broader reform agenda. Among outcomes, supply and investment indicators are the only ones that coherently present positive, though weak, impacts.

The synthesis of the qualitative evidence illustrated that four factors linking the individual interventions and outcomes at the heart of the underlying theory of change are critical to increase the likelihood of positive effects of electricity sector reforms: (i) a commercial approach, (ii) competitive arrangements, (iii) cost-reflective pricing, and (iv) independent, empowered and efficient regulation. Beyond that the synthesis rather exposed the complexity of market-based reforms and the various technical, economic and political factors that need to come into play in order to reach desired outcomes. As will be outlined in more detail in the following section, the existing quantitative literature mostly fails to account for these factors.

Review question 3 on cost-effectiveness

Neither quantitative nor qualitative included primary studies provided any information on reform costs so that cost-effectiveness of reform measures could not be assessed in this review.

5.2 Quality of the evidence including its overall completeness and applicability

Quantitative evidence

The findings of a systematic review evidently have to be judged with regards to the quality of the primary studies upon which the review is based.

Overall, the quality of the studies covered by this review is decent and quite comparable across studies as found in the risk of bias assessment. A major strength of the included studies is that they almost exclusively rely on relatively large panels of official data. This allows a methodologically sound application of panel methods based on data with supposedly less measurement error, though it may have its own flaws in the presence of political economy issues as in the case of manipulated transmission loss data cited in Sen and Jamasb (2012).

23 out of the 26 included studies use a fixed effects (FE) approach to quantify the effects of electricity sector reforms. The downside of the use of basic indicators on aggregated level is that little can be said about moderating factors to uncover some of the mechanisms underlying reform impacts. At the same time, the likelihood of important *omitted variable bias* is high. The list of potential confounders for which limited data is available covers technical engineering factors related to the fleet of generation plants and the electricity system as a whole, to economic factors (incl. corruption levels) and extends to political institutional and governance factors.

Fixed effects approaches further have the advantage to control for stable unobservable characteristics over time, but require that the variable to be analysed shows some variation over time because its effect cannot be detected otherwise. In other words: Only countries in which a reform took place and where the respective data is available can be included in the analysis. This leads to a selected sample of countries in which reforms took place during the study period. This is likely not representative for all developing countries worldwide. Thus, the *generalizability* of results from studies in the assessed countries to other developing countries where reforms have not yet taken place, particularly in Sub-Saharan Africa, is difficult.

Any meta-analysis requires that *pooling* always encompasses sufficiently comparable interventions and outcomes. Electricity sector reforms, however, comprise several steps, whose sequencing and interaction may matter for the success or failure of a reform. In this context, Sen and Jamasb (2012) maintain that substantial changes begin to occur only once a baseline level of reform has been undertaken. The practical implementation of the different steps may as well differ significantly across countries, e.g. due to differences in the quality of governance of electricity sector agencies (Cubbin and Stern 2005). In a stricter sense one may only

retrieve an unbiased treatment effect if those steps are undertaken in a comparable manner, order and timing. Similarly, effect sizes are only strictly comparable in studies employing same estimation methods and a common model, meaning that proxies for the same constructs are included in all the studies being synthesized due to likely collinearity between intervention variable and commonly used covariates (Becker and Wu, 2007; Keef and Roberts, 2004; Waddington et al. 2014). As pointed out at several parts of this review, despite the careful pooling this is not necessarily the case for all intervention-outcome pools used to synthesize data in this review.

Related to that, *definitions* of reform Intervention Types are not always clear-cut. Intervention Types are sometimes not even definable from each other. Vagliasindi and Besant-Jones (2011), for example, use the term privatization for what we define as private sector involvement. Alcázar et al. (2007) assess privatisation, but implicitly regulation and unbundling as well. Du et al. (2009) frame their paper as assessing regulation and unbundling, while essentially looking at Independent Power Producers (i.e. Private Sector Involvement) in their estimations. For other studies, it did not become obvious whether definitions coherent with those used in this review were applied. While this does not affect the overall synthesis of electricity sector reforms, it makes clear that the distinction of Intervention Types and their impacts as done in Section 4.3 should be read carefully. It is important to keep in mind that electricity sector reforms usually work as complex interventions.

On the other side of the equations, most *outcomes* assessed by the included studies are intermediate ones, even though we allowed for any type of outcome in our study search process. A main challenge of market-based reforms that cannot be captured by average tariff outcome indicators is to guarantee that tariffs structures ensure an average tariff level that minimizes the fiscal burden while dealing with any social concern governments may have. Relatedly, it can be argued that average impacts miss to account for the particular dynamics of the assessed reform types, where supply, prices and labour force may observe changes in one direction in early years and a subsequent trend towards the other direction in later years.

Publication bias is another limitation typically encountered with systematic reviews. We find mixed and rather weak evidence that partly even hints towards a negative publication bias: published articles present smaller outcome coefficients compared to unpublished papers, which seems to rather reflect improvements in the methodological approaches made during peer-review revision processes or incentives to produce better data and use better methods in the first place that make an acceptance with a peer-reviewed journal more likely. This suggests taking the results of not-yet-published working papers with care, of which there are six in our review.

Missing information may as well blur the clarity of the encountered quantitative results. In that regard, we managed to minimize the number of missing information through a meticulous process of approximating lacking data. These approximations seemed to have been successful in providing plausible figures (see also Appendix 0).

Qualitative evidence

A similarly decent strand of the literature approaches the question of electricity sector reform impacts in a qualitative manner. This literature presented in Section 4.4 provides important clues with respect to the possible mediators and underlying drivers of the effectiveness of reform interventions. However, the possibility to discern these findings by specific Intervention and Outcome Type is often limited and the studies generally have to rely rather on plausibility than strong empirical evidence for their claims.

5.3 Agreements and disagreements with other studies or reviews

Two studies already introduced in Section 1.4 focus on at least partly the same type of studies as the present systematic review. First, John et al. (2015), the journal-published version of the systematic review on private sector participation by Annamalai et al. (2013). This review uses meta-regressions with non-standardized coefficients. Based on that, it finds that the effects of private sector participation on electricity access and quality in developing countries are slightly positive but not significant. The outcomes the authors include in the electricity access category are partly the same as in our supply and investment category. Our results in this category are as well positive with unclear significance. Similarly, John et al. (2015) find similar results for electricity quality measured, among others, by the duration and frequency of power outages and energy losses in distribution: there is a positive but non-significant impact of private sector involvement on these outcomes.

Jamasb et al. (2015) summarize and review the existing literature on power sector reforms in developing countries aimed at economic and technical efficiency, as well as poverty reductions. Their approach differs from ours since they neither assess the results systematically nor conduct any sort of meta-analysis. Using a sample that includes simulation studies and European developing countries, Jamasb et al. (2015) conclude that reforms improved efficiency and productivity. However, these efficiency gains did not necessarily benefit end consumers. Closely comparing Jamasb et al.'s results to ours, the authors find a positive impact of privatisation on efficiency, whereas this systematic review revealed that the rigorous quantitative literature does not (yet) allow for bolder statements on this relationship. Analysing the impact of liberalisation, the authors find an increase in efficiency and mixed evidence on tariffs and costs as do we. Private sector involvement, argue Jamasb et al. (2015), decreases the electricity losses and yields improvements in electricity coverage. This is basically in line with our results as we find an increase in efficiency and a positive impact of private sector involvement on supply and investment. According to Jamasb et al. (2015), regulation has a slightly positive impact on electricity prices in Latin America but not in Asian countries. At the same time, it increases the losses from transmission and distribution. Our results also suggest some weakly negative effects of regulation on efficiency.

In sum, our results mostly corroborate the results obtained in other reviews. Any differences are on a subtle level and may stem from a different sample of studies, for

example including European countries or simulation studies, or from a different definition of outcome variables, as in the case of John et al. (2015). Most notably, our review complements the other studies as we are able to assess the impact of power sector reforms systematically and quantitatively with a particular focus on developing countries.

6. Authors' conclusions

6.1 Implications for practice and policy

This systematic review had the ambitious goal to collect evidence on the effectiveness and cost-effectiveness of electricity sector reforms in achieving wider electricity access in developing countries. For both questions, insufficient evidence is at hand to provide guidance for practice and policy. Findings merely suggest that electricity sector reforms are no panacea on their own. To make bolder statements, a systematic review requires clear indications emerging from the primary studies, which is not the case for our review questions.

Both the quantitative and qualitative evidence demonstrated that there was much heterogeneity across reform designs and implementation as well as the effectiveness of reforms. These findings can be read in two competing ways: first, that the concrete context matters and that, as put by Millán (2006), "reforms and institutional conditions should conform" advocating for an evolutionary approach towards reforms (see also Von der Fehr and Millán 2003). Second, that reforms have simply been implemented in an incomplete or inept manner. From this perspective, textbook models provide a sound general guidance to be followed. Reforms would merely require some additional anticipatory measures before reform implementation to deal with two major threats to the success and acceptance of reform, i.e. anti-competitive market power and distorted prices. Which reading is more appropriate can again be hardly said based on the compiled evidence.

In any case, it is worth highlighting that electricity sector reforms are "complex interventions" taking place at the intersection of the technological, economic and political sphere meaning they are complicated techno-economic and political economy matters that require strong collaboration between these fields of expertise.

6.2 Implications for research

This systematic review made clear that there are considerable knowledge gaps – in terms of absolute and relative reform costs as well as reform effectiveness. This paucity of quantitative evidence seems to be less a problem of lacking attention by the research community. It can rather be traced back to a combination of two factors: first, the lack of sufficiently detailed and internationally comparable data. And, second, the methodological challenge to develop a convincing rigorous framework to empirically isolate reform effects from confounding factors.

Improvements in both regards are possible. On the one hand, research could more clearly articulate its data needs. Potentially with the support of international

organisations, regulators and ministries around the world can then be motivated to provide this data necessary for effectiveness and cost-effectiveness studies. Moreover, more effort may be made to also cover indicators on potential key technical, economic, and political mechanisms and ultimately relevant indicators such as electricity access rates. On the other hand, researchers would do good to consistently apply best practise in panel estimations, including appropriate clustering of standard errors. Instrumental variables may represent a workaround for the remaining endogeneity problems, but possibilities for their application are very limited in the given context. It is likely that they rather increase the bias of estimated impact coefficients for being weak or non-exogenous instruments thus representing a cure that is worse than the disease. A more promising avenue seems to be a greater consideration of mixed methods. Thereby, not only solid evidence can be generated but, even more importantly, this evidence is then supposed to be linked to the underlying mechanisms of reform successes and failures to the extent possible.

Acknowledgements

We would like to thank the Canadian Department of Foreign Affairs, Trade and Development (DFATD, formerly CIDA) for funding this study and the International Initiative for Impact Evaluation (3ie) in the person of Hugh Waddington and Phil Davies. Their very thoughtful, constructive and proficient comments and suggestions on earlier versions of this review are highly appreciated. We would also like to warmly acknowledge our advisory group including Dr. Eva Rehfuess from Ludwig-Maximilians-University Munich, Prof. Antonio Estache from the European Centre for Advanced Research in Economics and Statistics (ECARES) of the Université Libre de Bruxelles (ULB), Prof. Michael Grimm from the University of Passau and Institute of Social Sciences in The Hague and Prof. Subhrendu Pattanayak from Duke University. Similarly, our thanks go to two external reviewers for useful comments and suggestions. Furthermore, we would like to thank Kyra Eusemann, Sophie Wannemacher, Friederike Blönningen, Ann-Kristin Reitmann and Sebastian Mertesacker for valuable research assistance and Jonathan Stöterau for helpful methodological discussions.

Appendices

World Bank list of economies

	Low-income economies ($1,025 or less)	Lower-middle income economies ($1,026 to $4,035)	Upper-middle-income economies ($4,036 to $12,475)
Europe and Central Asia	Kyrgyz Republic, Tajikistan	Albania, Armenia, Georgia, Kosovo, Moldova, Ukraine, Uzbekistan	Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Macedonia, FYR, Kazakhstan, Latvia, Lithuania, Russian Federation, Romania, Serbia, Turkey, Turkmenistan
South Asia	Afghanistan, Bangladesh, Nepal	Bhutan, India, Pakistan, Sri Lanka	Maldives
Middle East and North Africa		Djibouti, Egypt, Morocco, Syrian Arab Republic, West Bank and Gaza, Yemen	Algeria, Iran, Islamic Rep., Jordan, Lebanon, Libya, Tunisia
East Asia and Pacific	Cambodia, Democratic Republic of Korea, Myanmar	Fiji, Indonesia, Kiribati, Lao PDR, Marshall Islands, Micronesia, Mongolia, Papua New Guinea, Philippines, Samoa, Solomon Islands, Timor-Leste, Tonga, Vanuatu, Vietnam	American Samoa, China, Malaysia, Palau, Thailand, Tuvalu

	Low-income economies ($1,025 or less)	Lower-middle income economies ($1,026 to $4,035)	Upper-middle-income economies ($4,036 to $12,475)
Sub Saharan Africa	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Eritrea, Ethiopia, The Gambia, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, Tanzania, Togo, Uganda, Zimbabwe	Cameroon, Cape Verde, Republic of Congo, Côte d'Ivoire (Ivory Coast), Ghana, Lesotho, Nigeria, São Tomé and Principe, Senegal, South Sudan, Sudan, Swaziland, Zambia	Angola, Botswana, Gabon, Mauritius, Seychelles, South Africa
Latin America and Caribbean	Haiti	Belize, Bolivia, El Salvador, Guatemala, Guyana, Honduras, Nicaragua, Paraguay	Antigua and Barbuda, Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Grenada, Jamaica, Mexico, Panama, Peru, St. Lucia, St. Vincent and the Grenadines, Suriname

Note: As of June 2013. The current list of countries can be taken from http://data.worldbank.org/about/ country-and-lending-groups. In the meantime, some countries moved to a higher category (Albania, Antigua and Barbuda, Argentina, Belize, Chile, Fiji, Iraq and Mauritania, Marshall Islands, Mongolia, Paraguay, Russian Federation, Seychelles, Tonga) while others are ranked in a lower category (South Sudan).

Global electricity sector reform timeline

	Privatisation		Liberalisation						Private Sector Participation		Regulation	
			Unbundling		Introduction of retail competition		Establishment of wholesale electricity market		Introduction of foreign capital		Establishment of regulatory body	
Year	Latin America	Others	Latin America	Others	Latin America	Others	Latin America	Others	Latin America	Others	Latin America	Others
1978											CL	
1982	CL, CO											
1984										CN		
1985			CL				CL					
1990		MY										MY
1991		TH								ID, PH		
1992	AR, PE		AR, PE		AR		AR		AR, CO, DO, GT		AR, PE	
1993									CL, EC, HN			
1994	BO	IN	BO, CO				BO		BO, SV, JM, MX, TT	TH, MY	BO, CO, HN	
1995	BR		BR				CO		BR, PE, VE	IN, PK	MX, NI	
1996			GT	IN			GT		NI	LA	BR, CR, SV, GT, PA	ZA
1997				MY					PA	LK, VN, BD, KH	UY	

Year	Privatisation		Liberalisation						Private Sector Participation		Regulation	
			Unbundling		Introduction of retail competition		Establishment of wholesale electricity market		Introduction of foreign capital		Establishment of regulatory body	
	Latin America	Others	Latin America	Others	Latin America	Others	Latin America	Others	Latin America	Others	Latin America	Others
1998	SV, GT, PA		DO, SV, PA		SV		BR, DO, EC, SV, NI				DO, EC	IN
1999	DO		EC, NI					IN			VE	
2000	NI											
2001	JM			PH								PH, KH
2002				CN	PA		PA					LK
2003												CN
2004		PH										
2005												

Source: Nagayama and Kashiwagi (2007)

Note: Country Codes are the following: AR (Argentina), BD (Bangladesh), BO (Bolivia), BR (Brazil), KH (Cambodia), CL (Chile), CN (China), CO (Colombia), CR (Costa Rica), EC (Ecuador), SV (El Salvador), GT (Guatemala), HT (Haiti), HN (Honduras), IN (India), ID (Indonesia), JM (Jamaica), LA (Lao PDR), MY(Malaysia), MX(Mexico), NI (Nicaragua), PK (Pakistan), PA (Panama), PY (Paraguay), PE (Peru), PH (Philippines), ZA (South Africa), LK (Sri Lanka), TH (Thailand), TT (Trinidad and Tobago), UG (Uganda), UY (Uruguay), VE (Venezuela), VN (Vietnam).

Database-specific search strategies

Sub-intervention	ABI/INFORM Global PAIS International World Wide Political Sciences Abstracts	British Libr. for Dev. Studies Google Scholar	Energy Citations Database	Business Source Complete Econlit
Market based reform	all("electricity reform") OR all("electricity sector reform") OR all("power market reform") OR all("power system reform") OR all("power sector reform") OR all("power reform")	"electricity reform" OR "electricity sector reform" OR "power market reform" OR "power system reform" OR "power sector reform" OR "power reform"		boolean: "electricity reform*" OR "electricity sector reform*" OR "power market reform*" OR "power system reform*" OR "power sector reform*" OR "power reform*"
Privatisation	all(electricity) AND all((privatisation OR "private sector engagement" OR "private sector participation" OR "private sector investment" OR "private sector involvement"))	(privatisation OR privatization OR private sector) AND electri*	(privatization or privatisation) AND electricity	boolean: (privatisation or "private sector") AND electricity

Sub-intervention	ABI/INFORM Global PAIS International World Wide Political Sciences Abstracts	British Libr. for Dev. Studies Google Scholar	Energy Citations Database	Business Source Complete Econlit
Private sector involvement			("private sector engagement" OR "private sector participation" OR "private sector investment" OR "private sector involvement") AND electricity	
Decen-tralisation/liberali-sation	(all(liberalisation) OR all(decentralization)) AND all(electricity)	electri* and (liberalization OR liberalisation OR decentralization OR decentralisation)		boolean: electricity and (liberalisation OR decentralisation)
Electricity tariff design	all("electricity tariff")	"electricity tariff"	"electricity tariff"	boolean: electricity tariff

Note: Detailed search strategies, together with the number of hits for each database, can be provided by the authors on request. The same information can also be provided on the second and third intervention category introduced in Section 1.2, Interventions to reduce technical and non-technical system losses and Governance and accountability arrangements, which have been screened as part of the original scoping phase.

Electronic search databases and websites

Organisation	Website
3ie Impact Evaluation database	www.3ieimpact.org/evidence/impact-evaluations
3ie Systematic Reviews database	www.3ieimpact.org/evidence/systematic-reviews
African Development Bank	www.afdb.org
Asian Development Bank	www.adb.org
Australian Aid Agency	www.ausaid.gov.au
Canadian International Development Agency	www.acdi-cida.gc.ca
Danish Development Agency	www.um.dk
Department for International Development	www.dfid.gov.org
European Commission	ec.europa.eu/index_en
European Environment Agency (EEA) Datasets	www.eea.europa.eu/publications
Gesellschaft für International Zusammenarbeit (GIZ)	www.giz.de
Inter-American Development Bank	www.iadb.org
Intergovernmental Panel on Climate Change (IPCC) Data Distribution Centre	www.ipcc-data.org
Japan International Cooperation Agency and Japan Bank for international Cooperation	www.jica.go.jp/english
Kreditanstalt für Wiederaufbau (KfW)	www.kfw.de/Internationale-Finanzierung
Swedish development agency	www.sida.org
The World Bank + Office of Evaluation and Development	www.worldbank.org
UN: UNICEF UNEP UNDP UN-HABITAT	www.un.org
US Agency for International Development	www.usaid.gov

Inclusion decision form

Article	Exclusion Criteria									Decision	Article category		Reviewer
	Study is on middle or low-income countries?			Study is on intervention of interest?			Study is applied research, not theoretical modelling						
Author (year) Title	yes	no	maybe	yes	no	maybe	yes	no	maybe	include / exclude	qualitative	quantitative	

Note: A study is excluded if any of the three exclusion criteria is met.

Data extraction form

The following table lists the main variables retrieved from data extraction. In the code sheet, each estimation from the original studies represented one observation with the first estimation additionally containing study level information. Accordingly, variables starting with *s* are variables on study level (e.g. authors) and variables starting with *e* vary on estimation level, such as the specific dependant (outcome) variable used in the respective estimation.

Variable name	Description
Coding information	
s1	ID in Citavi database
e2	Running number of estimation, by study
s3a	Forward or backward citation tracking
s3b	Forward or backward citation tracking – Citavi ID of source
s4	Citavi ID of duplicate in Citavi database
s5	Name of coder
s6	Date(s) of coding
General study information	
s11	Title
s12_x	Author x (Last Name, Name)
s13	Year of publication
s14	Corresponding author's affiliation
s15	Funding Organisation
s16	Note
s17	Type of publication (journal article, book chapter, working paper, report, unpublished work)
s17b	Journal (if s17=journal article)
Sub-intervention design	
s21_x	sub-intervention type (privatisation, private sector involvement, decentralisation, liberalisation and changes in the electricity tariff design, regulation, introduction of competition, unbundling, other)
s22	brief description of sub-intervention/ treatment
s24	information on reform costs
Study context	
s31	Country ID(s)

Variable name	Description
s32	Setting (rural, urban)
s33	Stage of electricity supply at which sub-intervention takes place (generation, transmission, distribution)
s34_1a	Start of first intervention (month)
s34_1b	Start of first intervention (year)
s34_2a	Start of last intervention (month)
s34_2b	Start of last intervention (year)
s35	Baseline conditions
General eligibility	
s41	eligible population
s42	eligible intervention
s43	eligible publication date
s44	study is quantitative
Eligibility of quantitative impact evaluation studies	
s51	use of a valid and reliable comparison
s52	eligible outcome measures
s53	eligible study design
Eligibility of qualitative evidence studies	
s56	study approach (analysis of implementation and outcomes or impacts of intervention qualitatively and/or using descriptive statistics)
s57	macro-perspective analysis
s58	focus on previous or ongoing market-based electricity sector reforms in developing countries
Data	

Variable name	Description
s61	Unit of observation, by study (household, enterprise, utility, country)
e61b	Unit of observation, by estimation
s62	Method for estimation, by study
e62b	Method for estimation, by estimation
e62c	IV estimation
e62d	Preferred estimation method (=1, if competitive)
s62e	Note on method for data analysis or unit of observation
s62f	Note on choice between fixed and random effects modelling
s63	Data source (primary or secondary data)
s63b	Dataset (if s63=secondary data)
s64	Reference on data quality
s65	Data structure (cross-sectional, time-series, panel)
e66_1	Number of treatment observations
e66_2	Number of control observations
e66_3	Number of independent observations
e66_4	Total number of observations
treat_N_imp	Imputed number of treatment observations
treat_N_imp	Imputed number of control observations
imp_obs_ref1	Reference to page in original study for observation imputation
imp_obs_ref2	Reference to table in original study for observation imputation
imp_obs_comment	Comment on observation imputation
e67a	Year in which first wave of data has been collected
e67b	Year in which last wave of data has been collected
e67c	Number of waves
Standard deviation	
e71	Descriptive statistics table available
e72a	Table number of descriptives table

Variable name	Description
e72b	Page of descriptives table
e72c	Metric of standard deviation
e73	Standard deviation: total pre-treatment
e74	Standard deviation: total post-treatment
e75	Standard deviation: total cross-panel
e76	Raw mean of outcome variable required for SD approximation
Dependant variable	
e81_1	Dependent variable (text)
e81_2	Sub-Type of Dependent Variable (code)
e81_3	Dependent Variable (running no. by type of Dependent Varaible)
e81_4	Dependent Variable (running code by study)
e81_5	Dependent Variable (running no. by Dependent Variable)
e81_6	Dependent Variable (metric)
e81_7	Dependent Variable (note)
Specification characteristics	
s82_1	Specifications with fixed effects
s82_1b	Type of fixed effects
s82_2	If diff-in-diff, treatment dummy (=1) or fixed effects (=2)
s82_3	Year dummy/ fixed effects
s82_4	Specifications with time trend
e82_5	Preferred specification (if competitive)
e82_6	Particular subgroup/ sensitivity analysis (note)
s82b	Note on preferred specification
Independent variables	

Variable name	Description
e83_xa	xth Intervention/ Variable of Interest (text)
e83_xb	Sub-Type of xth Intervention/ Variable of Interest (code)
e83_xc	xth VoI: coefficient
e83_xd	xth VoI: standard error
e83_xe	xth VoI: *t*-statistic
e83_xf	xth VoI: 95% confidence interval
e83_xg	xth VoI: significance level
e83_xh	xth VoI (scale)
e84_xa	xth Control Variable (text)
e84_xb	xth CV: coefficient
e84_xc	xth CV: standard error
e84_xd	xth CV: *t*-statistic
e84_xe	xth CV: 95% confidence interval
e84_xf	xth CV: significance level
Other effects, moderators and mediators, subgroups	
s91	Adverse effects
s92	Unintended effects
s93	Reference to adverse or unintended effects
s94	Moderators
s95	Mediators (mechanisms)
s96	Subgroups
Risk of Bias assessment	
s101	Sample selection bias
s101b	Endogeneity discussed (=1 if yes)
s102	Motivation bias

Variable name	Description
s103	“Incomplete data bias”
s104	Spill-overs/ cross-overs/ contamination
s105	Selective outcome and analysis reporting:
s106	Incorrect confidence intervals or standard errors
s106_1	Number of clustered dimensions (if use of clustered standard errors)
s106_2	Type of clustered standard errors used
s107	Intervention independent of other changes
s108	Other sources of bias
s108_1a	Multicollinearity addressed (=1 if yes)
s108_1b	How multicollinearity is addressed
Conclusions	
s111	Conclusion on reform success
s111b	Reference to conclusion on reform success
s112	Conclusion on mechanisms
s112b	Reference to conclusion on mechanisms

Types of standard deviations used for effect size calculation

Due to data availability, we had to rely on different standard deviations $s_{i,j,t}$, where *i* refers to each individual estimation imported from the included studies, *j* to the respective sample with *j*={control, treatment, pooled} and *t* to the point in time where data has been retrieved, with *t*={baseline, endline}. The generally preferred standard deviation is the pooled post-treatment standard deviation $s_{i,p,e}$ of the outcome variable (Waddington et al. 2012). It is based on the treatment and control group standard deviations as defined by Hedges (1981) for matched-based studies and the standard deviation of the error term in the regression $s_i(\varepsilon)$ for regression-based studies.

Alternative standard deviations used in this review are – in order of preference – the following (see also the Table below): first, the standard deviation of the post-treatment control group $s_{i,c,e}$ (Glass 1976). As an approximation of this standard deviation, we use, second, the total post-treatment standard deviation $s_{i,e}$, third, the total cross-panel standard deviation s_i or, fourth, the total pre-treatment standard deviation $s_{i,b}$, in particular for panel data, which lacks the differentiation between

treatment and control. Through information on the dates of reform implementation, subsample sizes for treatment and control $\check{n}_{i,t}$ and $\check{n}_{i,c}$ can, however, be approximated. These can then be plugged into equation 4.3 of Borenstein (2009*a*) that can be transformed to, fifth, yet another approximation of the pooled standard deviation $s_{i,\check{p}} = \sqrt{((\check{n}_{i,t} * \check{n}_{i,c})/(\check{n}_{i,t} + \check{n}_{i,c})) * \beta_i / t_i}$, which is technically only applicable for bivariate effect sizes. t_i in this equation is the Student *t*-statistic of the estimated coefficient β_i. Finally, there are several papers with treatment effects in log-transformed scale, for which the total cross-panel standard deviation on the log-transformed scale can be approximated based on Higgins et al. (2008: 6075) $s_i' = \sqrt{(ln(s_i^2/\bar{Y}_i^2) + 1)}$ with s_i^2 and $\bar{Y}_i^2$ being the squared standard deviation (i.e. variance) and mean of the raw outcome measurement, respectively.

Standard deviations of outcome variable used for effect size calculation

Hierarchy	symbol	Description of type of standard deviation (sd)	reference
	$s_{i,p,e}$	pooled post-treatment sd	Hedges (1981)
=	$s_i(\varepsilon)$	sd of the error term	Keef & Roberts (2004)
>	$s_{i,c,e}$	sd of the post-treatment control group	Glass (1976)
>	$s_{i,e}$	total post-treatment standard deviation	-
>	s_i	total cross-panel standard deviation	-
>	$s_{i,b}$	total pre-treatment standard deviation	-
>	$s_{i,\check{p}}$	Borenstein approximation of pooled sd	based on Borenstein et al. (2009*a*: 22)
>	s_i'	total cross-panel standard deviation on the log-transformed scale	based on Higgins et al. (2008: 6075)

Hierarchisation of estimations for contributing to pooled effect estimates

We identified the relevant study characteristics that potentially required hierarchisation of estimations for the pooling of effect estimates in three steps:

Step 1: If same Intervention Sub-Type, same Outcome, or same Sample were assessed in multiple estimations per article, we checked the applied definitions, methods, and specifications along the following priority criteria:

preference could be established		no priority	
PCa1	standard definition of intervention variable > alternative definition	PCb1	equally appropriate intervention variables for same Intervention Sub-Type
PCa2	average effects > heterogeneous effects/ particular subgroup/ sensitivity analysis > robustness checks	PCb2	equally appropriate methods
PCa3	power sector estimations > cross-sector estimations (e.g. including telecommunication)	PCb3	equally appropriate estimators
PCa4	IV > non-IV or vice versa, depending on the appropriateness of the IV	PCb4	equally appropriate sets of controls
PCa5	fixed effects panel > OLS		
PCa6	fixed effects panel > random effects panel or vice versa, depending on the tests and assessment conducted by the original authors		
PCa7	without interaction term > with interaction term		
PCa8	with controls > without controls		
PCa9	estimations excluding a few strong outliers (as determined by authors) > estimations including the strong outliers		
PCa10	only one aggregate intervention variable per Intervention Sub-Type > multiple intervention variables per Intervention Sub-Type		

Step 2: A few estimations selected in Step 1 included multiple variables of the same Intervention Type or Sub-Type (e.g. a privatisation transition period dummy and a privatisation post-transition dummy in Guasch et al. 2006). We decided to include all estimates in the pooling if the individual variables added up to the likely effect of the Intervention Type or Sub-Type as a whole (e.g. minority and majority privatisation in Cubbin and Stern 2006). Conversely, we excluded the complete estimation in the synthesis of the respective Intervention Type, if it included various Sub-Types of the same Intervention Type that, in sum, do not necessarily reflect the likely effect of the

Intervention Type as a whole (e.g. *wholesale electricity market* and *unbundling* as Sub-Types of *Liberalisation* in Erdogdu 2011*a*). The latter implied the exclusion of estimations with multiple variables of the Intervention Types *Liberalisation* and *Regulation*:

preference could be established		**no priority**	
PCa11	exclusion of estimations with multiple intervention variables per Intervention Type or Sub-Type for the for the Intervention Types *Liberalisation* and *Regulation* and their Sub-Types (if no aggregate intervention variable per Intervention Type or Sub-Type, respectively; cf. PCa10)	PCb5	inclusion of all estimates from estimations with multiple intervention variables per Intervention Type or Sub-Type for the for the Intervention Types *Privatisation, Private Sector Involvement* and *Composite Reform* (if no aggregate intervention variable per Intervention Type; cf. PCa10)

Step 3: The estimations selected in Step 1 and 2 were then aggregated along the three dimensions intervention, outcome, and sample as outlined in the following table:

Pooling	**Intervention**	**Outcome**	**Unit of observation in sample**
Level at which effects are estimated in estimations selected in Step 1 and 2	Intervention Sub-Type (e.g. unbundling)	Individual Outcome (e.g. Residential electricity access)	Any unit of observation (e.g. Latin America)
□ aggregation	*no priority*	*no priority (alternatively: most standard outcome selected)*	*if countries: highest aggregated geographic area selected*
Default used for pooling effect sizes	Intervention Type (e.g. Privatisation)	Outcome Type (e.g. Supply and Investment)	Analysis at highest aggregated geographic level
□ aggregation	-	*no priority*	-
Pooled effect sizes used for sensitivity analysis, meta-regressions and publication bias assessment	Intervention Type	No differentiation by Outcome Type	Analysis at highest aggregated geographic level

Subgroup analysis of main Intervention Sub-Type, main Outcomes, and Continents (see Section 3.4.9) used information on the disaggregated level and the aggregation approaches shown in the table above as follows:

Pooling for Subgroup analysis	Intervention	Outcome	Unit of observation in sample
… of main Intervention Sub-Type (e.g. unbundling)	*Intervention Sub-Type*	No differentiation by Outcome Type	Analysis at highest aggregated geographic level
… of main Outcomes (e.g. Residential electricity access)	Intervention Type	*Individual Outcome*	Analysis at highest aggregated geographic level
… of Continents (e.g. Latin America)	Intervention Type	No differentiation by Outcome Type	*Any unit of observation*

Note: The cells in italic highlight the dimension that has been changed for the purpose of the respective Subgroup analysis.

Reasons for third-stage exclusion of quantitative evidence studies

The following methods have been excluded in the third stage of study screening:

Abbreviation	Description
SIM	Simulation
EFF	Efficiency analysis (DEA, SF)
BAw	before-after, without statistical control
SaS	Satisfaction survey
INFR	no differentiation by infrastructure sector

Study	SIM	EFF	BAw	SaS	INFR	other
Anaya (2010)	X					
Angel-Urdinola, Cosgrove-Davies & Wodon (2006)	X					
Arndt et al. (2014)		X				
Babatunde, Opawole & Akinsiku (2012)				X		
Balachandra (2006)	X					
Barja & Urquiola (2001)			X			
Belyaev et al. (2010)	X					
Benitez, Chisari & Estache (2003)	X					
Boccanfuso, D., Estache, A., & Savard, L. (2009*a*)	X					
Boccanfuso, Estache & Savard (2009*b*)	X					
Bonifaz & José (2001)		X				
Checchi, Florio & Carrera (2009)					X	
Chen & He (2013)	X					
Chisari, Estache & Romero (1999)	X					
Chong & López-de-Silanes (2003)					X	
Chong et al. (2004)					X	
Delfino & Casarin (2003)	X					
Domah, Pollitt & Stern (2002)						Cross-country analysis of post-reform cost functions
Estache & Iimi (2008)						Analysis of effect of number of bidders on bid amounts for procurement auctions

Study	SIM	EFF	BAw	SaS	INFR	other
Estache, Tovar & Trujillo (2008)		X				
Fainboim Yaker (2000)	X					
Fatima & Barik (2012)		X				
Ferreira (2002)	X					
Fuentes-Bracamontes (2012)	X					
Galán & Pollitt (2014)		X				
Galiani et al. (2003)					X	
Gnansounou & Dong (2004)	X					
Hofman & Plane (2001)		X				
Hossain (1993)	X					
Hwang & Lee (2015)	X					
Iimi (2003)		X				
Khanna, Mundra & Ullah (1999)		X				
Kundu & Mishra (2011*a*)				X		
Kundu & Mishra (2011*b*)				X		
Kundu & Mishra (2012)				X		
Lin & Liu (2013)	X					
Ma et al. (2011)		X				
McKenzie & Mookherjee (2003)			X			
Moita (2006)						Post-reform analysis of factors potentially affecting electricity generation market entry
Monari (2002)	X					
Mota (2003)	X					

Study	SIM	EFF	BAw	SaS	INFR	other
Mota (2004)		X				
Mukherjee (2008a)		X				
Mukherjee (2008b)						Before-after comparison of composite index based on Principal-component Analysis
Ninan (2012)			X			
Ochugudu & Onodugo (2013)				X		
Ogbuagu & Ubi (2009)						Comparison of separate pre- and post-reform OLS regressions with controls; additional integrated OLS regression but without reform dummy
Perera (2000)	X					
Perez-Reyes & Tovar (2009)		X				
Pérez-Reyes & Tovar (2010)		X				
Plane (1999)		X				
Pombo & Taborda (2006)		X				
Qudrat-Ullah & Davidsen (2001)	X					
Reneses et al. (2011)	X					
Rodríguez & Rivas (2005)						Engel curves visually assessed for the reform transition period
Ruangrong (1992)	X					
Sá Ferreira et al. (2013)		X				
Salarzehi, Ebrahimi & Mazandarani (2011)				X		
Saleem (2007)		X				

Study	SIM	EFF	BAw	SaS	INFR	other
Saxena & Thakur (2011)		X				
See & Coelli (2012)		X				
Sharma & Kumar (2012)			X			
Shukla & Thampy (2011)			X			
Siddiqui (1998)		X				
Siddiqui (2005)			X			
Silva (2007)						Event-study approach
Silvestre et al. (2010)			X			
Simpson & Mon Abraham (2012)						vector error correction (VECM) and vector autoregressive (VAR) model
Sirasoontorn (2004a)	X					
Sirasoontorn (2004b)		X				
Sirasoontorn (2008)	X					
Sirtaine et al. (2005)	X					
Sokhanvar et al. (2012)		X				
Sugianto (2014)	X					
Toba (2007)	X					
Torero & Pasco-Font (2003)	X					
Vélez et al. (2011).	X					
Wattana & Sharma (2011)		X				
Yadav, Padhy & Gupta (2014)		X				
Zhao & Ma (2013)		X				
Ziba (2008)		X				

Quality assessment of qualitative studies

Study	Linkage to relevant literature	Clear and sound methodology	Appropriate, clear and comprehensive analysis	Conclusion consistent with analysis	Conclusions accounting for limitations
Babatunde (2011)	low	high	high	high	medium
Bhattacharyya (2007)	medium	high	high	high	medium
Dornan (2014)	high	high	high	high	high
Eberhard et al. (2011)	high	high	high	n/a	high
Estache & Rodriguez-Pardina (2000)	high	high	high	high	high
Gabriele (2004)	high	high	high	high	high
Greco & Petrecolla, Romero (2011)	medium	high	high	high	medium
Haanyika (2006)	high	medium	high	high	high
Han, Jiang & Fan (2005)	medium	medium	high	high	medium
Haselip, Dyner & Cherni (2005)	high	high	high	high	high
Jamasb et al. (2015)	high	high	high	high	high
Joskow (2008)	high	medium	high	high	high
Kapika & Eberhard (2013)	high	high	high	high	high

Study	Linkage to relevant literature	Clear and sound methodology	Appropriate, clear and comprehensive analysis	Conclusion consistent with analysis	Conclusions accounting for limitations
Karekezi & Kimani (2002)	high	high	high	high	high
Kayo (2002)	medium	high	high	high	medium
Kodwani (2009)	high	high	medium	high	high
Kozulj & Di Sbroiavacca (2004)	high	high	medium	high	high
Malgas & Eberhard (2011)	medium	medium	high	high	high
Malik, Mahmood & Ahmed (2009)	high	high	high	high	high
Meher & Sahu (2013)	high	high	high	high	medium
Millán (2006)	low	high	high	high	medium
Murillo & Finchelstein (2004)	high	medium	high	medium	medium
Nagayama & Kashiwagi (2007)	medium	high	high	high	high
Nair (2008)	medium	medium	high	high	high
Nepal & Jamasb (2012)	medium	medium	high	high	high
Nepal & Jamasb (2015)	medium	medium	high	high	high
Pineau (2005)	high	high	high	high	high
Pineau (2007)	high	high	high	high	high

Study	Linkage to relevant literature	Clear and sound methodology	Appropriate, clear and comprehensive analysis	Conclusion consistent with analysis	Conclusions accounting for limitations
Pollitt (2008)	high	high	high	high	medium
Pollitt (2004)	high	high	high	high	medium
Rosillo-Calle et al. (2002)	medium	medium	high	high	medium
Rudnick & Zolezzi (2001)	medium	medium	high	medium	high
Srivastava & Kathuria (2014)	high	high	medium	high	high
Von der Fehr & Millán (2003)	medium	high	high	high	high

Conclusions of authors of quantitative evidence studies on reform impacts

The following table reproduces the original conclusions of the authors of primary studies in the quantitative evidence category related to reform impacts. Discussed Intervention Types are highlighted in bold.

Study	Region	Conclusions
Alcázar et al. (2007)	Latin America, rural Peru	Our results can be summarized as follows: first, there is a significant improvement in the quality of the provision of electricity when **distribution firms** are **managed by the private sector**. This result is consistent with solid work that supports the proposition that privatization improves the operating and financial performance of firms (Galal et al., 1994; La Porta and López-de-Silanes, 1999; and the studies summarized in D'Souza and Megginson, 1999) Secondly, improvements in the quality and supply of electricity provision yield some efficiency gains in terms of the time allocation of the working labor force that can be directly linked to the use of electricity. Rural households **under private provision of electricity** had more opportunities to work in non-farm activities, and as a result, the share of non-farm activities increased, indicating both a substitution effect and a potential price

		effect. The substitution effect implies a reduction of hours spent on farm activities in favor of non-farm activities and the price effect implies that households will receive higher salaries and therefore will need to work fewer hours in total. As a result, the increase in time spent on non-farm activities was accompanied by a reduction of hours spent on farm activities and an increase in the hours spent on leisure.
Andres et al. (2008)	Latin America	In summary, we have shown that regulation matters for sector performance, on three aspects. We have shown that the existence of a regulatory agency matters, that the experience of the regulatory agency matters and that its governance matters as well. The results are consistent with the literature on the impact of private sector participation and show the relevance of the existence of a regulatory agency and its governance, defined as the agency's institutional design and structure that allows it to carry its functions as an independent regulator. Our results indicate a significant improvement in utility performance through **the involvement of a regulatory agency** even in the case of state owned enterprises. The results strongly support that the highest achievements are reached **with the combination of private sector participation** regulated through a regulatory agency that exhibits good governance.
Balza et al. (2013)	Latin America	In line with empirical literature, the econometric analysis suggests that **the privatization process** is statistically associated with improvements in efficiency and quality of the sector through reduction of electricity losses and expansion of generation capacity. However, no robust results were found in terms of whether privatization improves accessibility of electricity services in terms of coverage or electricity prices. In contrast, a strong and robust association was found between **regulatory quality** and generation capacity, coverage, and end-user-prices. Thus, regardless of the country characteristics and level of private participation, an efficient and well-designed institutional and regulatory setting is key to the sound performance of the electricity industry.
Cubbin & Stern (2006)	Cross-Regions	This article concentrated on **the role of regulatory quality** for capacity and investment in the electricity industry. The results are very similar in type to those previously found for telecommunications, and similar

		approaches could likely be used to examine the institutional underpinnings for investment in other infrastructure. This article presented evidence suggesting that good regulatory governance does have a positive and statistically significant effect on some electricity industry outcomes in developing economies—notably per capita generation capacity levels. For electricity supply industries an index of regulatory governance is a consistently positive and statistically significant determinant of per capita generation. On **privatization and competition**, there was some evidence of the effects on generation capacity of majority privatization and of competition (its legal introduction). But the effects of competition are almost certainly more a reflection of a country's commitment to electricity reform than of a genuine market effect. A positive and well-determined impact of majority privatization was found in the dynamic modeling. The results here are consistent with the literature on the role of institutions in economic growth and with good country governance. Indeed, the evidence suggests that good country governance and specific regulatory effectiveness are mutually reinforcing. Both the quality of the electricity regulatory framework and the quality of country governance (as measured by a political risk indicator) are strongly associated with higher capacity, but as one might expect, the sectoral variables have a markedly larger impact.
Du et al. (2013)	Asia	Empirical results show that electricity reforms have significantly improved labor and capital productivities of China's generation plants, of which, labor productivity has improved by roughly 26% and capital productivity has improved by roughly 45%, while the improvement of fuel productivity is only weakly significant because of the factor substitution and the influence of fuel price. The TFP estimation also shows that the electricity reforms have significant positive impact on the technical efficiency of the generation plants when the substitution effect between labor and capital is considered. When fuel expense is further included in the TFP analysis, the effect of the electricity reforms becomes weakly significant. Again, this result is possibly related to the factor substitution and the influence of fuel price. Positive effects of the electricity reforms on productivities and efficiencies are expected if fuel input is measured in

		physical quantity. Our results unambiguously show that though **the electricity deregulation reform** in China is far from completion, the positive effects of the reforms on productivity and efficiency of the generation plants are still significant.
Du et al. (2009)	Asia	Our results show that **the regulatory reforms** between 1995 and 2004 have improved the generation plants' production efficiency in labor and nonfuel material inputs greatly. The net efficiency improvement in labor input associated with the regulatory reforms is roughly 29% and the gains in nonfuel materials are about 35%, while there is no evidence of efficiency gains in fuel input associated with the electricity reforms.
Erdogdu (2011*a*)	Cross-Regions	This study focuses on observing the impact of **electricity sector reforms** on price-cost margins and cross-subsidy levels. As a result of the study, we could not detect a uniform pattern for the impact of reform processes as a whole. Our results suggest that each individual reform step has different impact on price-cost margins and cross-subsidy levels for each consumer and country group. Our findings imply that similar reform steps may have different impacts in different countries.
Erdogdu (2011*b*)	Cross-Regions	The study is looking at the impact of **reform steps** on electricity industry efficiency. We found that reform process causes efficiency in the industry to go up but its effect is limited. Moreover, our findings showed that reform process has a negative impact on the efforts to reduce network losses.
Estache & Rossi (2005)	Latin America	The paper provides three major results: (i) that **privatized firms** operating **under price-cap and hybrid schemes** are more efficient in their use of labor than both public firms and **privatized firms under rate-of-return regulation**; (ii) that firms regulated under hybrid regimes have intermediate labor productivity levels; and (iii) that privatized firms operating under rate-of-return regulation have, at most, similar labor efficiency as public firms. Results (i) and (ii) are consistent with the expectation from theory and with those of similar studies conducted for electricity distribution and other sectors.
Gao & Van Biesebroeck (2014)	Asia	We have investigated the impact of **regulatory reforms** and the vertical unbundling of the dominant integrated firm in China in 2002 on the performance of electricity

		generation companies. The results strongly indicate a positive impact on both labor and material input efficiency. We find that it did take a few years for the effects to materialize, which explains the weaker evidence in Du et al. [2008] who only had data until 2004. The benchmark estimates suggest that the average firm that was state-owned in 2002 reduced employment by 7 per cent more than the control firms and material input by an additional 5 per cent. The magnitudes of these reform-related input reductions are plausible in light of the estimated reductions in factor use experienced by all firms between 2002 and 2007, respectively 5 and 20 per cent for employment and materials. Firms that are expected to be less productive initially—those located in the West or Central regions, older, and smaller firms—show stronger improvements in labor productivity, but weaker change in material productivity. One possible explanation is that competitive pressure is sufficient to reduce excessive employment, but technological and/or managerial innovations are needed to improve material (fuel) efficiency. Restructuring effects are less pronounced when they are identified from a broader group of firms with majority state-ownership of equity, rather than from the official state versus non-state categorization. Subsidiaries of the Big 5 generation firms that were created from the breakup of the State Power Company, which include many firms of mixed ownership type, on average did not experience a comparable decline in employment.
Gonzalez-Eiras & Rossi (2008)	Latin America	The central hypothesis of this chapter is that service expansions and quality improvements associated with **the privatization of electric companies** in Argentina have had a positive effect on health outcomes. In order to test the main hypothesis, it is first shown that access to electricity service increased more in those provinces that privatized their electricity distribution networks than in provinces where distribution remained public. Also presented is evidence supporting the idea that private firms have better quality indicators than public firms.
Guasch et al. (2006)	Latin America	This paper presents the analysis of the changes, as a **result of private participation**, in the performance of indicators in output, employment, labor productivity, efficiency, coverage and prices for 116 electricity distribution firms in Latin America. The results suggest

		that **changes in ownership** caused significant improvements in labor productivity, efficiency, and product/service quality in the near term. However, the improvements do not appear as remarkable two years after the change in ownership. This suggests that the change in ownership has the strongest effect on firms during the transition period. Finally, although it was found that change in ownership matters, there seems to be some heterogeneity across firms regarding its impact.
Khan (2014)	Asia	The study's estimation of a cost function for power plants is an attempt to compare plant performance according to **plant ownership** in Pakistan's electricity industry. Our results show that public plants are less efficient than private plants, both technically and economically. This does not, however, imply that the latter perform better on other dimensions of cost, including wage bills and maintenance, because this exercise was based on the limited information available, particularly for private plants.
Koo et al. (2012)	Cross-Regions	We examined the effects of **private participation** on efficiency in the power service sector in developing countries. The results of the proposed models suggest that private participation is in fact negatively associated with the efficiency of the power service. However, the results also show that the overall effects of private participation on efficiency are positively augmented according to the level of government regulations. Empirical data prove that the effects of private participation are channeled through **government regulations**. In addition, the results also suggest that hidden costs of regulations are outweighed by efficiency gains from controlling private parties' potential misbehaviors.
Malik et al. (2015)	Asia	This paper has examined the impact of **unbundling reforms** in the Indian electricity sector on the generation performance of state-owned power plants. Specifically, we have focused on the impact of unbundling of generation on the operating reliability and thermal efficiency of coal-fired power plants. We find that the impacts of unbundling differ greatly between states that restructured their SEBs prior to the Electricity Act of 2003 (Phase 1 unbundlers), which made unbundling mandatory, and those that restructured in 2005 or later

		(Phase 2 unbundlers). Our results show that unbundling resulted in a statistically significant increase in the average availability of EGUs in states that unbundled between 1996 and 2002.We find that the increase in availability at these EGUs is mainly driven by a corresponding reduction in forced outages. There is no evidence of an impact of restructuring on average capacity utilization or improvements in thermal efficiency.
Nagayama (2010)	Cross-Regions	In this study, we could assume that, firstly, different electric industry's reform policies/measures have different impact on geographically and economically diverse countries. In the developed countries, **unbundling with regulatory agencies**, and **introduction of retail competition** works in increasing generation per capita, and **unbundling and introduction of wholesale power market with regulatory agencies** work on decreasing T&D loss. On the other hand, in the developing countries, introduction of **foreign IPPs** work most in increasing generation capacity per capita and reducing T&D loss. Secondly, different stages of economic development have different impacts on policy effects of reforms. Increases in T&D loss outweigh the reform effects on reducing T&D loss in the countries with developing stages. Thirdly, **coexistent with independent regulatory agencies**, reform policy becomes more powerful in realizing sector performances. The number of coefficiencies increases at the interacting terms with establishment of regulatory agencies. Regulatory agencies, for example, can contribute to reducing T&D loss by setting up caps of T&D loss to incentivize efforts of reducing loss of the utilities. The role of regulators is also important to expand capacity of electric power facilities. They send a long-term signal for investors to various business firms, which try to minimize risk and maximize profits.
Nagayama (2009)	Cross-Regions	We estimated the effect of electric power prices on electric sector liberalization models and the effect of the **selected liberalization models** on electric power prices of each country. The development of liberalization models in the power sector does not necessarily reduce electricity prices. In fact, contrary to expectations prices had a tendency to rise. Therefore, when the selection of a liberalization model is discussed in developing countries, careful consideration should be given to the types of

		reforms that would best suit the economic development stage of each country.
Nagayama (2007)	Cross-Regions	The empirical results presented in this study seem to be consistent with the findings of the studies by Steiner (2001), Hattori and Tsutsui (2004), and Zhang et al. (2002). The research findings suggest that neither **unbundling** on its own nor the introduction of a **wholesale pool market** on its own necessarily reduces the electric power price. Contrary to what was expected, the price tends to go up. However, coexistent with an **independent regulator**, the unbundling may work to reduce electricity prices. The introduction of **Foreign IPPs, privatization, and introducing retail competition** will lower the electricity prices in some regions, but not all. The results shows that the effects of coexistence with establishment of independent regulator with reform valuables were ambiguous. In developing countries, in addition to those indicated above there are other problems arising from the lack of substance in the formality of liberalization. Some examples are as follows: (1) **Unbundling** Even if unbundling is formally carried out, electricity prices may not go down due to lack of governance in the sector.5 (2) **Establishment of a regulatory agency** If the regulatory institution is not independent, politics may influence decisions on electricity prices and prices may not be reflective of actual costs. (3) The **wholesale electric power spot market/exchange introduction** Our results show that the introduction of a wholesale electric power spot market and exchange increases electricity prices in developed countries, which is contrary to expectations. This may support the future apprehension that the introduction of wholesale electric power markets to the countries where transmission infrastructures are not sufficiently prepared, such as Asian Developing countries, may lead to the price hikes since exercise of the market power take place.
Panda (2002)	Asia	**Restructuring** of the vertically integrated state electricity boards seems to initiate beneficial changes in such plant performance indicators as plant availability, plant load factor and forced outage. It creates independent action-

		centers with accountability, and brings competition into erstwhile vertically integrated structures. As far as plant performance is concerned, restructuring has significant positive effects, even after controlling for ownership. Second, as far as labor efficiency indicators are concerned, we have found mixed results. Restructuring is negatively and significantly associated with the number of employees per thousand consumers served, implying an increase in labor efficiency in this regard. Third, as our study shows, restructuring appears to entail a reduction in the extent of cross-subsidization. This has been one of the objectives of the reform legislation. Fourth, the cost of supply seems to be unaffected by restructuring. This finding is also significant, especially in the face of some skepticism that restructuring may result in a significant increase in the cost of supply due to loss of economies of scale and scope. Fifth, as the results reveal, restructuring has positive effects on some crucially important indicators of financial performance such as tariff collection, and sales revenue as a ratio of cost. The state electricity boards (SEBs) in India have fared poorly, especially in these areas. Finally, as far as the effect of **ownership** on the performance indicators of the thermal power plants is concerned, we find interesting results. State ownership is associated with relatively worse plant performance. This is evident in all three areas: plant availability, plant load factor and forced outage. Federal ownership is found to be significantly and positively different from other forms of ownership, as far as plant load factor is concerned. However, it is not so in areas like plant availability and forced outage. Thus, the effects of ownership on plant performance are somewhat mixed.
Pargal (2003)	Latin America	This paper has presented findings on institutional factors that affect the investment climate for infrastructure using recent data from the nine largest Latin American countries. We find that the most significant determinant of private investment volumes overall (after lagged GDP) is the passage of legislation liberalizing the investment regime. We also find that the general relationship of private to public investment is one of substitutability. The results on regulatory structure underline investors' need for stability and predictability and reflect the historical existence of strong executive branches in most Latin

		American countries. A particularly intuitive result is that **private investment** is positively associated with the independence and credibility of the regulator, particularly its ability to commit. Private investment in power was relatively higher than in the other sectors.
Sen & Jamasb (2012)	Asia	This analysis has empirically demonstrated that electricity reforms result in visible changes in key economic variables related to the electricity sector. Substantial changes begin to occur only once a *baseline level* of **reform** has been undertaken.
Vagliasindi & Besant-Jones (2011)	Cross-Regions	The level of access is positively linked to **full vertical unbundling**, even if not significantly so. **Partial unbundling** is negatively and significantly associated with lower levels of access. The **introduction of an autonomous regulator** is significantly positively associated with higher access, confirming that regulators can also play an important role in ensuring that contracts were effectively designed. The **introduction of private sector participation** in generation also is significantly linked to access expansions, proving that IPPs and divestiture of formerly state-owned generators can deliver positive results. The introduction of private sector participation also helped to significantly enhance operational efficiency and labor productivity in distribution.
Wren-Lewis (2015)	Latin America	This paper analyzes the relationship between corruption and **regulated firms**' productivity and the way in which this relationship interacts with policy reforms. The econometric analysis shows that corruption at the national level is negatively associated with firm productivity. This result adds to the increasing evidence that corruption can be detrimental to the performance of utilities. The association between corruption and productivity is smaller for **private firms** than for public ones.
Yu & Pollitt (2009)	Cross-Regions	Despite the interest of media in reporting **liberalization** as a major cause of blackouts, we do not find any statistically significant evidence of a connection between the frequency of small blackouts and the degree of sector liberalization. The relations between liberalization and regional factors are not statistically significant between the European and Latin American regions. However, Asia, which is the least liberalized region, shows more blackout incidents than Latin America. There is no

		evidence of a statistical difference in the mean of blackout incidents before and after liberalization in the European and Asian regions. Latin American region is an exception. Liberalization itself does not directly contribute to the cause of blackout incidents.
Zhang et al. (2008)	Cross-Regions	The empirical results presented show consistently that **competition** in electricity generation is more important than **privatization or the establishment of independent regulation** in bringing about performance improvements. Reviewing our findings in more detail, we did not find that privatization leads to improved labor productivity or to higher capital utilization or to more generating capacity and higher output, except where it is coupled with the existence of an independent regulator. But regulation on its own also seemed to have little significant effect on the performance variables. In contrast to the results for regulation and privatization, our findings do confirm strongly the overwhelming importance of increasing competition to promote improved performance, in terms of greater electricity generation, generating capacity and improved labor productivity and capital utilization in developing countries. In our results competition dominated as the explanation of performance in electricity generation.
Zhang (2005)	Cross-Regions	The study has found that having **an independent regulator** before **privatizing** generation is associated with higher electricity availability and more generating capacity; and **introducing competition** before undertaking privatization in electricity generation appears to bring about favorable effects in terms of service penetration, capacity expansion, capacity utilization and capital productivity. While it can be hazardous to leap from correlation to causality, the results do seem to confirm that electricity power reform is a complex process and that single reforms, in particular privatization alone, may well disappoint. It does seem that the sequencing of reforms or more specifically the order of the introduction of privatization, competition and regulation matters.

Summary of qualitative evidence studies

The following table summarizes the qualitative evidence studies and provides references to the findings used in the synthesis section of this systematic review. Studies in working paper stage are labelled as such.

Study	Location	Type of Reform/ Intervention	Design	Findings
Babatunde (2011)	Nigeria	privatisation, changes in the electricity tariff design, regulation, unbundling	institutional analysis (after)	"The investment climate in Nigeria is quite challenging. For example, the majority of the IPPs would like to construct their plants within the Niger Delta area where sources of energy (for example, gas supply) needed to run their plants are guaranteed. " (p. 379)
Bhattacharyya (2007)	India, Pakistan, Bangladesh, Sri Lanka, Nepal	privatisation, regulation	institutional analysis and case study using government and regulatory body data (before and after)	"In absence of any demonstrable benefits of a successful reform of the power sector in the region, various stakeholders remain sceptical about the outcome, thereby affecting acceptance of the reform agenda." (p.329) "Little progress was made between 1996 and 2003, mostly due to political instability of the country." (p. 321) "Continued political instability is a source of slow progress of power sector reform in the region. […] A fast-track process can achieve milestones but even this

Study	Location	Type of Reform/ Intervention	Design	Findings
				requires strong political support and more importantly, is not a guarantee for success, as Orissa experience shows. Absence of political stability in the region makes the future prospect of reform bleak." (p.327) The authors further outline a situation of political instability in all five countries with many changing governments due to a lack of political consensus, poor stability of governing coalitions, and partly dismissed due to corruption.
Dornan (2014)	Fiji	private sector involvement, changes in the electricity tariff design, regulation	institutional analysis (before and after)	"Explaining reform in Fiji requires an understanding of the political drivers for and against change. One important factor has been political instability [...].Four Fijian governments have been overthrown in coups, with two military coups in 1987, a civilian-led coup in 2000, and another military coup in 2006 [...]. Political instability in Fiji has been partly the result of tension between the indigenous and Indo-Fijian populations (which comprise 57% and 37%

Study	Location	Type of Reform/ Intervention	Design	Findings
				of the total population, respectively) and a race-based electoral system that features communal seats open only to candidates and voters from certain races […] A strong military and the development of a "coup culture" have also played a role. Political instability has resulted in policy inconsistency and reversals of power sector reforms, including the unbundling and subsequent re-bundling of the FEA *[Fiji Electricity Authority]*." (p. 707)
Eberhard et al. (2011)	Sub-Saharan Africa	privatisation, private sector involvement, regulation, unbundling	institutional analysis and case studies using various primary and secondary sources (before and after)	In Chpater 7 of their book, the authors depict Africa's power funding gap and which areas require improvements to attract more external funding.
Estache & Rodriguez-Pardina (2000)	Argentina, Chile	privatisation, decentralisation, regulation, competition	institutional analysis and case study using government and utility data (before and after)	"No matter how many generators are there, if there is monopoly control over the primary source (gas, water, etc.) there are little chances to have competition as the monopolist can extract all the rents from the downstream activity." (p. 20) "[…] that this is not

Study	Location	Type of Reform/ Intervention	Design	Findings
				necessarily confined to head-to-head competition. Competition for the market and yardstick competition are also important instruments for regulators. Competitive tendering for monopoly concessions can improve the efficiency of the process. The periodic re-tendering of the concession as proposed in Argentina seem to be an interesting approach although high transaction costs and the asymmetry of information between the incumbent and other participants might prove to be a serious limitation." (p. 21)
Gabriele (2004)	Argentina, Brazil, Chile, China, India	privatisation, private sector involvement, regulation	institutional analysis (before and after)	"The early unbundling and privatization process of the Chilean electricity utilities was not accompanied by strong restrictions on ownership concentration […]. The power sector remained a highly oligopolistic, vertically integrated industry acting in a very imperfect competitive context." (p. 1324) "The maximum potentially achievable degree of competition remains limited, and by

Study	Location	Type of Reform/ Intervention	Design	Findings
				all practical means electricity and gas markets in most developing countries retain features which can be considered quasi-monopolistic." (p. 1334)
Greco & Petrecolla, Romero (2011)	Argentina	privatisation, decentralisation, changes in the electricity tariff design, regulation, competition, unbundling	institutional analysis and case study using government/ utility/ regulatory body data (before and after)	The authors describe based on a complementary analysis of the gas and electricity sector in Argentina the successes and failures of different competitive arrangements.
Haanyika (2006)	developing countries in Latin America, (Sub Saharan) Africa and Asia	privatisation, private sector involvement, regulation	institutional analysis (before and after)	"However, despite the country's desire to privatise, the process failed on account of limited interest by private investors" (p. 2981)
Han, Jiang & Fan (2005)	China	private sector involvement, changes in the electricity tariff design, regulation, competition, unbundling	institutional analysis (before and after)	"At present, the price of power enterprises owned by the central government is too low and those of regional and foreign invested power enterprises are too high." (p. 193)
Haselip, Dyner & Cherni (2005)	Argentina	privatisation, liberalisation, unbundling	institutional analysis and case study using utility data (before	"In Argentina, supporters of electricity reform argue that since privatisation, blackouts have reduced and significant price

Study	Location	Type of Reform/ Intervention	Design	Findings
			and after)	reductions have been achieved. On the other hand, critics of the Argentine reforms argue that the privatisation of the electricity sector, whilst benefiting high-income groups, has, at the same time, failed to provide equitable benefits to poorer segments of society." (p. 1-2)
Jamasb et al. (2015), working paper	developing countries in Latin America, (Sub Saharan) Africa and Asia	privatisation, liberalisation, changes in the electricity tariff design, regulation, competition, unbundling	institutional analysis and case studies using various secondary sources (before and after)	See Section 5.3 .
Joskow (2008)	Argentina, Brazil, Chile, Colombia	privatisation, liberalisation, changes in the electricity tariff design, regulation, competition, unbundling	institutional analysis (after)	"Market power is a significant potential problem in electricity markets, but the cure can be worse than the disease. Try to deal with potential market power structurally ex ante rather than ex post." (p. 22)
Kapika & Eberhard (2013)	Kenya, Tanzania, Uganda, Zambia, Namibia, Ghana	privatisation, private sector involvement, liberalisation, regulation, unbundling	institutional analysis and case studies using various primary and secondary sources (before and after)	In this book, the authors assemble the reform experience from six Sub-Saharan African countries. Data and explanation for the cases of Kenya and Uganda is provided that shows how the two countries

Study	Location	Type of Reform/ Intervention	Design	Findings
				managed to introduce significant capacity from independent power producers in their electricity systems.
Karekezi & Kimani (2002)	Sub-Saharan Africa	privatisation, regulation, unbundling	institutional analysis and case study using government and regulatory body (before and after)	"In many French-speaking countries of West Africa, labour unions have resisted energy sector reform." (p. 929) "[…] majority of the eastern and southern African countries are characterised by low electrification levels both in urban and rural areas. […] Current reforms appear to only address improvement in financial and technical performance expected from the advent of IPPs and privatisation initiatives. Equally important should be the objective of expanding electrification, particularly of rural communities and the urban poor." (p. 933-934) "With regard to the regulation of the power sector, there appears to be some reluctance to establish independent regulatory agencies. Available records indicate that, by the end of 1997, only Ghana,

Study	Location	Type of Reform/ Intervention	Design	Findings
				Kenya, Malawi, South Africa and Zambia had set up independent regulatory agencies. Since then, the only three other countries that have established independent regulatory agencies in the year 2000/2001, were Cote d'Ivoire, Uganda and Namibia." (p. 931) Besides, the authors outline some aspects of how the transformation of power utilities from social welfare institutions into profit-making commercial entities impacted the poor.
Kayo (2002)	Zimbabwe	privatisation, regulation	institutional analysis and case study using utility and regulatory body data (before)	"Lack of an enabling legal and regulatory framework has constrained the entry of the private sector. Even though the Electricity Act was revised in 1996, the revisions still require that new entrants who intend to build power plants with a capacity above 100kW apply and seek approvals from the utility and the responsible Government department." (p. 963)
Kodwani (2009), working paper	India	regulation	institutional analysis and case study using utility data (before and after)	"[…] limited success is partly attributed to regulators because wider institutional changes in property rights institutions (the industry

Study	Location	Type of Reform/ Intervention	Design	Findings
				operators remain in public sector), entrenched subsidies and political interests have not been addressed at state level leaving regulatory commissions with limited real power to influence the behaviour of players." (p. 13) For the case of India, the author particularly gives examples of subsidies to the agriculture sector.
Kozulj & Di Sbroiavacca (2004)	Latin America	privatisation, changes in the electricity tariff design, regulation, competition, unbundling	institutional analysis and case study using government and regulatory body data (before and after)	"Indicators connected with prices and impacts on household budgets clearly show the deeply regressive nature of the reforms. Not only has electricity service become more expensive for low-consumption users, but the real income of the population has declined or remained unchanged:" (p. 81) "Apart from the direct impact of reforms, this article emphasizes that the indirect impact of energy sector reforms, which are closely linked to the macroeconomic policies that were applied, has been more severe than the direct impact. The reforms have affected the capacity for generating employment,

Study	Location	Type of Reform/ Intervention	Design	Findings
				increased foreign indebtedness, and inevitably led to corrective policies that have further worsened the problem of poverty." (p. 83) "Apart from the direct impact of reforms, this analysis emphasizes that the indirect impact of energy sector reforms, which are closely linked to the macroeconomic policies that were applied, has been more severe than the direct impact. The reforms have affected the capacity for generating employment, increased foreign indebtedness, and inevitably led to corrective policies that have further worsened the problem of poverty." (p. 81) "This was manifested in growing unemployment and a deepening recession. The reform plans ended up producing strong recessions and an increase in poverty levels and social inequality. At the same time, the remittance of privatized company benefits required foreign loans, which in turn increased

Study	Location	Type of Reform/ Intervention	Design	Findings
				the foreign indebtedness of the affected countries, making the continuation of monetary appreciation infeasible. Devaluation followed, and its negative impact on living costs increased poverty." (p. 81-82)
Malgas & Eberhard (2011)	Ghana, Côte d'Ivoire, Morocco, Tunisia	privatisation, regulation	institutional analysis (before and after)	"Hybrid public–private power markets give rise to new problems, not least of which are the challenges of attracting sufficient new investment and ensuring security of supply." (p. 3191)
Malik, Mahmood & Ahmed (2009)	Pakistan	private sector involvement, regulation, unbundling	institutional analysis and case study using government/ representative survey/ utility data (before and after)	"The reason behind the privatisation of KESC *[Karachi Electric Supply Corporation]* was its poor financial management and governance structure. The Government instead of improving its management practices and minimising institutional weaknesses, started with the process of privatisation to get better results. More than three years have passed since KESC shares have been transferred to the private owner […] The major problem faced by KESC prior to privatisation was a poor governance structure. It

Study	Location	Type of Reform/ Intervention	Design	Findings
				seems that the new management has failed to improve the corporate governance at KESC. [….] *There is a need to develop financial and commercial skills for quick decision-making, accountability, and commercial orientation to re-mould KESC into an economically profitable company.*" (p.20/21)
Meher & Sahu (2013)	India	privatisation, private sector involvement, changes in the electricity tariff design, regulation, competition, unbundling	institutional analysis and case study using utility and regulatory body data (before and after)	"A cost-reflective tariff structure would normally result in the lowest tariffs being charged to industrial customers, which have the highest consumption and load factor. The highest tariffs would be paid by household customers. Hence, the pricing policy followed in Odisha is far removed from rational principles. This uneconomic pricing policy has an adverse impact on the financial health of the distribution companies, the incentives and consequences for inter-sectoral resource allocation and the lack of cost consciousness and demand-side management." (p. 464) "In this regulation, there

Study	Location	Type of Reform/ Intervention	Design	Findings
				are the problems of determining allowable costs, there being very little incentive for a firm to hold down operating costs and there being no clear guideline on how the capital stock should be measured." (p.464)
Millán (2006)	Latin America and the Caribbean	privatisation, private sector involvement, liberalisation	institutional analysis (before and after)	"Many LAC *[Latin America and the Caribbean]* countries lack some of the political and regulatory institutional conditions for supporting the sort of reforms implemented. Reforms and institutional conditions should conform. The main consideration when designing or evaluating a regulatory framework should be a crude assessment of the people and organisations that will be in charge of implementing and enforcing it. Because institutions take time to develop, an evolutionary approach to reform may be preferable to a big bang approach." (p.5299)
Murillo & Finchelstein (2004)	Argentina	privatisation, regulation, competition, unbundling	institutional analysis and case study using electricity sector data (after)	"Es notable, al respecto, que dentro de las veinte centrales con mayor potencia instalada, la inversion no se produjo en todas las centrales térmicas sino en aquellas

Study	Location	Type of Reform/ Intervention	Design	Findings
				donde los privados eran mayoritarios y tenian que distribuir menos de sus potenciales ganancias con el sector público.Al respecto, vale la pena senalar que si bien un socio público que comparte ganancias puede disminuir los riesgos de expropiación desde el punto de vista de la maximización de los recursos fiscales, la lógica politica parece imponerse a los actores del sector. La privatización de las centrales térmicas parece haber generado menos resistencia politica que la de las hidroeléctricas, muchas de las cuales permanecen aún bajo propiedad pública. Los privados parecen haber extendido esta lógica a la posibilidad de expropiación en su comportamiento de inversiones pese a que el marco regulatorio – crucial para explicar inversiones según Levy y Spiller (1995) – era el mismo para todo el sector.” (p.138)
Nagayama &	Argentina	privatisation, regulation,	institutional analysis and	“In privatising state-owned electric utilities,

Study	Location	Type of Reform/ Intervention	Design	Findings
Kashiwagi (2007)		competition, unbundling, wholesale market	case study using government data (after)	Argentina worked to minimise the impact of employee layoffs, and carried out sufficient employee-protection measures such as providing, as an allowance, government revenues obtained through privatisation, to retirees from government enterprises. Considering that the lack of benefits for the employees in the power sector reforms in Asian countries such as Thailand, Indonesia and Sri Lanka was the main cause of delay in the progress of the reform, adequate consideration and prior preparations for workers is an important lesson to be heeded." (p. 128)
Nair (2008)	India	privatisation, regulation, unbundling	institutional analysis and case study using government and regulatory body data (before and after)	"[…] in comparison with models in developed countries, the Indian regulator is not lacking in the necessary powers and enforcing instruments. […] Compounding this problem are factors relating to inherited institutional culture and some entrenched governance practices. […] To understand why the task of overcoming

Study	Location	Type of Reform/ Intervention	Design	Findings
				such barriers will be particularly difficult in India's electricity sector, it is sufficient to note that the official Tariff Policy (2006) itself underlines this concern. […] Some prevailing administrative practices accentuate the problem. It is standard practice for state governments to nominate senior officials (generally including the executive head of the line ministry) to the boards of unbundled utilities. This provides a tacit government sanction to the way the utility is managed, including its poor performance in critical areas, holding out few incentives to reform. Added to the fact that senior posts in the undertakings are also manned by ex-SEB *[State Electricity Boards]* personnel, the arrangement generates a sense of immunity, in some cases plain resistance, to regulatory intervention even where the poor performance standards persist." (p. 123) "The point is that India's electricity regulator is currently seized largely

Study	Location	Type of Reform/ Intervention	Design	Findings
				with the problem of regulating negativities: huge shortages of supply, revenue deficits of utilities, losses through pilferage, uncollected bills, etc." (p. 114-115)
Nepal & Jamasb (2012)	Nepal	private sector involvement, unbundling	institutional analysis and case study using government and regulatory body data (before and after)	"However, small systems are characterised by small size and low load density of the market. Hence, the benefits of vertical separation are difficult to realise in small markets dominated, in particular, by large hydroelectric resources due to high minimum efficient scale of power generation.[…] The small size of the market limits the effectiveness of wholesale markets as only a limited number of generating companies can be supported leading to oligopolistic market situations and can be susceptible to market power." (p. 243) "Although the generation segment is open to private investors, barriers to entry still exist in terms of discriminatory network access to independent power producers. NEA *[Nepal Electricity Authority]* as a single buyer tends to favourits

Study	Location	Type of Reform/ Intervention	Design	Findings
				own generation thus distorting competition and discourages new entry in generation." (p. 249)
Nepal & Jamasb (2015)	Nepal	private sector involvement, unbundling	institutional analysis (before and after)	"The general tendency in these countries involved the progression from a vertically integrated state-owned monopoly towards an unbundled competitive market. Fig. 1 shows that the process involved progressively introducing competition in the generation, wholesale and retail level respectively. The single buyer model with IPP participation remains the dominant reform model across many Asian and African countries, while the majority of LACs *[Latin America and the Caribbean]* have pursued creating a competitive wholesale and retail market based on the standard model." (p.18/ 19)
Pineau (2005)	Cameroon	privatisation, regulation	institutional analysis and case study using utility data (after)	"As recent creations of the government, with little experience in regulation, highly politicised board members and lack of external - non-national - board members, these agencies do not have the depth in expertise and

Study	Location	Type of Reform/ Intervention	Design	Findings
				power to influence the sector. The absence of foreign board members makes corruption easier because of the small, restricted group involved, with a majority directly appointed by the government. Consequently, accountability and transparency still have to be developed. Their financial independence is limited by the restricted funding they receive through the industry levy, and they have to rely on external donors' or lenders' financial resources." (p. 154)
Pineau (2007)	Cameroon	privatisation, regulation	institutional analysis and case study using government/ representative survey/ utility/ regulatory body/ expert interview data (before and after)	"Summary of incoherencies: Cameroonian electricity reform policy analysis process: 1. No assessment of the financial impact of macroeconomic disruptions (interest rates and currency devaluation) 2. No assessment of the governmental diversion of Sonel's funds 3. Conflicting goals 4. Privatisation strategy set as a goal 5. World Bank's purpose to promote private

Study	Location	Type of Reform/ Intervention	Design	Findings
				foreign investment 6. Conflicting impact categories 7. Non-specific impact categories 8. Absence of accountability mechanisms 9. Lack of consideration for various levels of privatisation 10. Reluctance of private investors to invest 11. Priority gap between national priorities and foreign private investors 12. Equity issues between consumers" (p.172)
Pollitt (2008)	Argentina	privatisation, liberalisation	institutional analysis and case study using utility and regulatory body data (before and after)	"As in Chile, where a similar system exists, Argentina obliged all new public transmission investments above $2 m (on the 500 kV system) to be competitively tendered. This implied that the incumbent transmission companies did not have a monopoly on new lines in their areas. Between 1992 and 1997 there were four competitive tenders for nearly 2000 km of new lines. The first three resulted in new entrants, the final one (which attracted 12 bidders) was won by Transener." (p.

Study	Location	Type of Reform/ Intervention	Design	Findings
				1553)
Pollitt (2004)	Chile	privatisation, regulation, unbundling	institutional analysis (before and after)	“For most developing countries the opposite bias prevails: a tendency to renege on regulatory contracts with initial private property holders leading to high costs of capital and failed reforms.” (p.253)
Rosillo-Calle et al. (2002)	Brazil	privatisation, regulation, competition	institutional analysis and case study using utility data (before and after)	The article gives a detailed account of the proceeds originating from the privatisation in the Brazilian electricity sector.
Rudnick & Zolezzi (2001)	Latin America	privatisation, liberalisation, regulation, competition, unbundling	institutional analysis (before and after)	“Disputes regularly arise among market players about allocation of transmission payments, with the regulator frequently having to intervene to arbitrate.” (p. 182) “This has not limited reduction in the prices of the distribution service over time, but critics still argue that the huge efficiency gains have not always reached the final consumers, most remaining with the monopoly.” (p. 183)
Srivastava & Kathuria (2014)	India	privatisation, unbundling	institutional analysis and case study using government	“The first lesson that Delhi experience gives is that the commitment of the government critically matters in the success of

Study	Location	Type of Reform/ Intervention	Design	Findings
			and utility data (before and after)	power reforms. The lack of clarity and commitment of the political decision makers subjects the power reforms to uncertain and mostly failed outcomes." (p. 13)
Von der Fehr & Millán (2003)	Colombia, Honduras, Guatemala	privatisation, regulation, competition	institutional analysis (before and after)	"Competition is a potent regulatory instrument, and there is further scope for market-based solutions in all three countries. However, great care must be taken when opening up new markets. First, one must be aware of whether technological, economic, and institutional conditions are conducive to a competitive outcome." (p. 357)

Missing information, outliers and approximations in the synthesis process

We extracted information from in total 271 estimations from 26 studies. This number excludes estimations from included studies, which did not comply with the inclusion criteria for this review. Erdogdu (2011*b*), for example, also reports results for developed countries.

We only had to exclude one estimation based on an outlier assessment of Standardized Mean Difference values, where outliers have been defined as

Outlier = abs(SMD)>2 | abs(SE(SMD))>5 | abs(SE(SMD))<0.

Sen and Jamasb (2012) seemed to have used a wrong unit for one of their outcomes.

Through our various approximation approaches, we managed to retrieve standard deviation figures of the outcome variable for 246 of the 270 estimations. In 52 percent of these cases, the standard deviation has been approximated by "Borenstein's formula" and in eleven percent of the cases by "Higgins formula" (see Appendix 0). Thus, 24 estimations had to be dropped due to missing standard deviation figures, which implied that one complete study left the sample of studies used for this review (Vagliasindi and Besant-Jones 2011).

Among the remaining 246 estimations from 25 studies, we retrieved 697 intervention variables and coefficients, among them 152 interaction terms. 359 of the 545 non-interaction coefficients (66%) contributed to at least one pool used for the calculated of effect sizes. It has to be noted though that there have been a couple of studies investigating *Liberalisation* and *Regulation* used multiple intervention variables from the same Intervention Type so that another 114 coefficients were not included at Intervention Type level due to Priority Criterion PCa11 (see Appendix 0).

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