IDS WORKING PAPER
Volume **2016** No **472**

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August 2016

Institute of
Development Studies

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Summary

The need to shift from fossil fuels to renewable energy systems is now broadly accepted, and our understanding of how different policy mechanisms can support this process is growing. To date, much of this research has focused on developed countries, but the need for this shift is increasingly being recognised as important in countries at all levels of development. The circumstances of these countries are different, however, suggesting that approaches to policy identification and evaluation may also need to be adapted. These differences are found in three areas: first, many developing country governments face severe budget constraints and competing calls on public resources to address poverty. The finances available to support policy mechanisms are therefore more limited than in many developed countries. Second, given the immaturity of financial systems, the most important obstacles to investment in renewable energy may be unrelated to the specifics of these investments, but reflect more general problems. Third, while issues of political economy are important for power sectors everywhere, they can be particularly pronounced in developing country settings. Before we can assess the potential effectiveness of different policy mechanisms to support renewable energy investment in developing countries, therefore, we need first to understand what the most important constraints to these investment are. Given the very large number of potential constraints, an approach is needed to narrow this set systematically, and identify those constraints which are most important, or 'binding'. The research presented in this paper adapts and extends the 'growth diagnostics' approach developed by Hausmann, Rodrik and Velasco (2004) for this purpose, and applies this to renewable energy investment in two developing countries: Ghana and Kenya. The resulting 'green investment diagnostics' thus complements existing work on policy evaluation in developed countries, offering a diagnostic tool specifically designed for developing country settings that could be applied alongside these mechanisms.

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Acknowledgements

Introduction

The need to shift national energy systems away from fossil fuels towards renewable sources is now broadly accepted. As renewables have generally been more expensive than fossil fuel alternatives, however, this has usually required some kind of public policy support to make projects competitive. Given that a number of different policy tools could potentially achieve this goal, it is important to be able to robustly assess their relative effectiveness.

A range of methodologies has been developed to inform such decisions. Until relatively recently, cost-benefit analyses (CBA) have been the principal approach. As environmental goods are often non-traded, however, this required environmental valuation techniques to be developed and refined, allowing environmental impacts to be incorporated in CBA assessments more generally (Pearce 1998).

As well as concerns over the monetisation of nature in some quarters, CBAs have been criticised on methodological grounds. Critics point out that CBA is underpinned by neoclassical assumptions such as 'representative agent', which prevents the views of heterogeneous stakeholders being taken into account, and 'immutable preferences', which precludes the possibility that environmental preferences will change as awareness grows (Greening and Bernow 2004). Also, while the *economic efficiency* CBA measure is an important consideration, it is not the only one. If the goal of policy is relatively tightly defined, for example, then 'cost effectiveness' may be a more appropriate evaluation criterion.[1]

Appropriate evaluation criteria are crucial. While there is no consensus on which are most important for assessing environmental policies, a number of criteria, in addition to those given above, are found in the literature (Gupta *et al*. 2007; Harrington, Morgenstern and Sterner 2004; Mundaca and Neij 2009):

- *environmental effectiveness* is the extent to which environmental goals are achieved;
- *low transaction costs*, which may be hidden and are often higher than assumed in standard CBA or cost effectiveness estimates;[2]
- *equitable distribution* of the costs and benefits resulting from the policy;
- *political and institutional feasibility*, or whether there is sufficient support and legitimacy for the policy, and sufficient institutional capacity to design and implement the policy.

As these criteria tend not to be included in CBAs,[3] tools able to capture a range of criteria have been developed, most notably multi-criteria decision-making (MCDM) models. MCDM approaches seek to identify Pareto optimal policies, where no other feasible policy exists that is at least as good on all other criterion, and better on at least one (Greening and Bernow *op cit.*).

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[1]   Economic efficiency is distinct from cost effectiveness. In the latter, the goal of policy is firmly specified, with different approaches assessed on how cost effectively they can achieve these goals. In the former, the goal of policy is a part of the appraisal. For example, when considering how much to prioritise different forms of transport intervention – roads, rail, cycle routes – a cost-benefit analysis would be used. If considering how to maximise the amount of roads built for a given budget, a cost-effectiveness approach would be used.

[2]   An interesting strand of literature has developed to assess the role of transaction costs in evaluating environmental policies. As pointed out above, many energy efficiency measures are assumed to have negative economic costs, yet they are not adopted to the extent this would imply. One explanation is that transaction costs are significantly higher than assumed. See Mundaca, Mansoz, Neij and Timilsina (2013) for a review.

[3]   There is no reason in principle why CBAs could not take account of distributional or equity considerations by altering the weight given to benefits that accrue to different groups. Poverty considerations might see benefits to the poor over-weighted, for example, which would also be compatible with the diminishing marginal utility of income from a welfare perspective. Greening and Bernow (2004) suggest Rawls' 'max-min' criterion would have a similar effect.

Through the application of these techniques, we now have a better understanding of which are likely to be most effective in different circumstances. A shortcoming is that they have largely been applied to high-income countries. Our concern, however, is with understanding how low and middle income countries can avoid becoming locked into fossil-fuel energy systems. More specifically, we seek to identify the most important obstacles to the expansion of renewable capacity, and to specify the policy instruments most likely to address these obstacles. This requires a different approach to those described above for three reasons.

First, developing country governments face more severe budget constraints than their high-income country counterparts, and also have other urgent policy priorities, particularly poverty alleviation. As a result, providing substantial and sustained financial support for renewable energy is not as feasible. To take account of this, we focus on renewable energy projects that are broadly economically and financially competitive with fossil-fuels.[4] The abundance of renewable energy resources in many developing countries, combined with the falling costs and increasing efficiency of renewable technologies, make competitive renewable energy technologies a growing set.

Second, obstacles to renewable energy investment in developing countries may have little to do with environmental policies. Financial markets tend to be immature and perceived risks higher. As a result, there is generally less finance, particularly long-term finance, available. Some of the most important constraints may therefore be a problem for longer-term investments more generally. Alternatively, some countries may be able to generate sufficient funds, but renewable projects may be relatively unattractive for a variety of reasons, which may or may not be policy-dependent. Distinguishing between these different types of constraints is important.

Third, although the policy evaluation tools described above increasingly take account of political feasibility, questions of political economy are often more important in developing countries, particularly in energy sectors. Mapping the political waters (in terms of the actors, interests and incentives) in the chosen policy area is thus particularly important for effective policy design.

These three factors suggest that, before policy options can be evaluated, prior steps are needed in low- and middle-income country settings. First, the area where policy intervention is most needed must be identified. Second, the set of policy options that are likely to be feasible from a political economy perspective needs to be defined. From the perspective of policy-makers in low- and middle-income countries these issues translate into the following questions:

(i)   To what extent should they seek to develop renewable energy sources?
(ii)   If renewables are to be part of the energy mix, which technologies should be prioritised?
(iii)   Once a particular technology has been prioritised, what types of policy measure are likely to facilitate investment?
(iv)   Which of these measures are most likely to successfully navigate the choppy waters of real-world politics?

The methodology set out in this paper aims to provide guidance on each of these questions. On the first two questions we focus on technologies that are economically and financially viable, as well as being technically feasible in particular locations. For the third, considerable research has examined barriers to investment in developed countries, but this is often less useful than it could be for low-income economies.[5] A wide range of obstacles are often cited,

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[4]   Economic viability takes into account 'returns' for society as a whole, whilst financial viability looks at the private returns for firms or individuals.

[5]   See Pueyo, Spratt, Schmitz, Willenbockel, Dent, Wade and Crosland (2015) for a review of this literature.

with suites of reforms recommended to address them. This does not identify which obstacles are most important, and so which policy areas could maximise 'bang for bucks'. For countries with severe budget constraints and finite policy formulation capacity, this is a major problem.

This resembles the situation with historical research on growth in developing countries, where far-reaching, non-prioritised and politically unrealistic reform programmes were often proposed. This led Hausman *et al.* (2004) to develop the *growth diagnostics* approach to identify the 'binding constraints' to growth. Growth diagnostics assumes that more severe problems should produce observable 'symptoms'. Based on this logic, a framework was developed to home in systematically on the binding constraints on growth through the accumulation and triangulation of evidence. Policy interventions could then be focused in these areas.

Due to these similarities in problem and context, we have developed the *green investment diagnostics* framework for the ex-ante selection of areas of policy intervention most likely to remove obstacles to investment in renewable technologies. The rest of the paper is structured as follows. Part 1 describes the growth diagnostics approach developed by Hausmann *et al.* (2004) and its relationship with green investment diagnostics. Part 2 describes the methodology and data used. Part 3 gives background on Kenya and Ghana. Part 4 gives selected, preliminary findings from the ongoing piloting of the framework in these countries, and concludes.

1 From growth to green investment diagnostics

Hausman *et al.* (2004) developed the growth diagnostics framework to answer the following question: 'For this particular country, at this particular time, what is preventing the country from achieving higher sustained and shared growth?' (Haussmann, Klinger and Wagner 2008: 4). Their methodology is based on the idea that 'there may be many reasons why an economy does not grow, but each reason generates a distinctive set of symptoms' (*ibid.*: 4). The identification of these symptoms through a logical decision tree framework enables a weight of evidence to be built and the identification of the most binding constraint to growth.

The process starts by asking what is restraining growth in the most fundamental level, ruling out potential constraints in some cases, and following the line of reasoning in others as increasingly specific questions are asked at each level. Is low investment due to low potential returns or a lack of finance? If it is low returns, is this because of a lack of supporting infrastructure, for example. At each level, questions are addressed by searching for evidence of four diagnostic signals that we would expect to see if a potential constraint was 'binding':

(i)   The price (or shadow price) of the constraint should be high.
(ii) Historical movements in the constraint should produce significant changes in the desired outcome.
(iii) Agents in the economy should be attempting to overcome or bypass the constraint.
(iv) Agents less intensive in the constraint are more likely to survive and thrive, and vice versa.

The process is thus one of elimination, with potentially binding constraints ruled out when no symptoms are found, allowing an increasing focus on those most likely to be problematic and a continuing accumulation of evidence for and against these options.

Our framework adapts and extends this approach to investment in the renewable energy sector, asking: 'for this country, at this particular time, what is preventing higher levels of investment in a specific technology for which there is an economic rationale?' We draw a number of features from the growth diagnostic approach: we assume some constraints are more important than others and that it possible to identify these systematically; a logical decision-tree framework is used to identify these constraints and test for observable 'symptoms'; Finally, we employ an iterative approach to build and triangulate a cumulative weight of evidence.

Some important differences should be noted. First, our aim is not to increase growth rates, but to increase the rate of investment in particular renewable energy technologies. Second, while growth diagnostics emphasises the need to identify a *single*, binding constraint, our approach is likely to identify more than one constraint, though the number would still be low. Third, where growth diagnostics looks for symptoms of binding constraints using the four 'diagnostic signals' listed above, we introduce an important prior step. This reduces the large initial set of potential constraints through a quantitative assessment between comparable countries. Having identified a small set of issues that are most likely to be problematic, we then apply an adapted version of the diagnostic assessment described above.

A fourth difference is that identifying the binding constraint(s) is not the end of the story. Our approach also involves political economy analysis to map and navigate the policy process.

Reform in the power sector is often a highly politicised process (Besant-Jones 2006). Increases in electricity prices and vested interests can be powerful sources of political opposition. Lack of political commitment can also frustrate implementation of agreed policies. Identifying the actors who seek to block or adopt different policies is thus as important as identifying the binding constraint. Our political economy approach builds from the insights of Brian Levy's 'working with the grain' approach. Levy argues that optimal solutions may be unachievable but workable ways forward may nonetheless be found by identifying the sources of support for reform and using them as entry points that can unleash an ongoing, virtuous circle of cumulative change (Levy 2014). Having identified the most important area for policy interventions, this can help inform which policies are most likely to be feasible, and therefore effective in addressing the identified issue.

2 Green investment diagnostics: methodology

The green investment diagnostics (GID) approach has the following steps:

(i) Identify target technologies that are economically and financial viable.
(ii) Undertake a comparative assessment of potential constraints to investment in these technologies using economic and social indicators organised in a hierarchical decision-tree framework.
(iii) Undertake a deeper search for diagnostic evidence in areas identified as potentially problematic to identify policy areas which are the most 'binding'.
(iv) Conduct political economy analysis to identify the most viable policy options in these areas given political economy realities in the country concerned.

2.1 Identify target technologies (i.e. asking the right question)

Our dependent variable is the sub-optimal adoption of particular renewable generation technologies for which there is an economic rationale. The diagnosis must therefore start with the history of relevant investments in the country and the costs of different renewable energy technologies. Is investment insufficient in all generation technologies, for example, or

only in renewables? Are there periods of intense activity or stagnation? Are these linked to growth or other factors? Which renewables are most cost-competitive with fossil fuel alternatives?

Answering these questions will suggest technologies where investment is less than would be expected given the country context and relative economic and financial attractiveness. Target technologies to be analysed should meet the following conditions:

- The relevant renewable energy resources are abundant but underutilised.
- They are low economic cost technologies in the country.
- They do not impose excessive balancing costs on the electricity system.
- They are potentially financially competitive with fossil fuel alternatives (or can be made so at reasonable cost and duration to the government).

The first condition is assessed by comparing the renewable energy resource technical potential with forecasted demand and the installed and planned capacity using the resource. This shows which technologies are underinvested compared to their technical potential.

The second condition concerns the economic attractiveness of potential technologies compared to alternatives. The economic cost of different generation alternatives can be assessed with the levelised cost of energy (LCOE), which measures the total cost of production over a project's lifetime. This includes capital investments and discounted future operation and maintenance (O&M) costs. The total quantity of discounted electricity produced is divided by discounted costs to give a unit cost, or LCOE.

To calculate LCOE on an economic rather than financial basis we need to include all net costs borne by society. We thus include externalities, exclude taxes and use social discount rates rather than the cost of finance. Externalities mostly refer to the damage cost of SO_2, NO_x, CO_2 and particulates when the generator does not pay for the damage through taxes or other mechanisms. Subsidies refer to both capital and operations. All capital costs relevant to the project, even if not paid by the investor, such as transmission lines required for a project, are included. Social discount rates reflect the cost of finance in the absence of specific market or technology risks.

An economic assessment of renewable energy technologies must also take account of the balancing costs they impose on the system. This is the third condition. Time variable energy resources like wind and solar PV contribute less to capacity adequacy[6] than flexible sources, many of which are fossil fuel based. Thus, while variable, low-carbon technologies have low operating cost, they may also supply little capacity compared to fossil fuels. Renewables technologies may therefore increase system costs due to the greater operating reserves that must be carried to manage uncertainty. Whether these effects should be included in LCOE calculations remains controversial, not least as whole-system costs are not confined to one technology alone. For simplicity, we propose to keep the assessment of balancing costs separate from LCOE calculations.[7]

Our final condition concerns the financial viability of renewable energy projects, and the means by which this is achieved. Financial viability is assessed through the risk-adjusted financial rate of return (FRR), which must be competitive with other investment options to be

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[6] Capacity that can meet peak residual demand.

[7] The estimation of balancing costs needs to be specialised to local conditions. An approach to assess the balancing costs of increased variable capacity consists of two steps: First, assessing the additional operating reserve volumes required to balance a given intermittent capacity and the related cost per MWh generated. Second, identifying and estimating quantitatively any binding engineering limits on the total variable generation capacity which can be integrated in the present system and in future scenarios for installed controllable capacity. This requires discussions with local engineers who have knowledge of operating reserve requirements in the relevant national context.

viable. We assess financial viability by comparing the Internal Rate of Return (IRR) of different renewable energy technologies and with a benchmark rate of return.[8] As only costs and revenues for the investor are considered, we include taxes and subsidies, use the actual cost of debt, but exclude externality costs not borne by the investor. The IRR of fossil fuel based generation projects is used as a benchmark for comparison. Other benchmarks used are taken from investments with similar risk-return characteristics. Examples include energy and other infrastructure projects in countries with similar risk profiles, or returns from other asset classes with similar levels of risk that could occupy a similar position in a diversified investment portfolio.

Technologies that are competitive with fossil fuels from an economic perspective may still be financially unattractive for two reasons. First, economic measures include externalities but financial measures do not. Second, economic viability is measured using the social discount rate, whereas financial viability uses the actual cost of finance. Economically viable projects may thus be rendered financially unviable where the costs of financing are high. As renewable energy projects generally require larger upfront investment, the cost of finance is a larger proportion of total project costs than comparable fossil-fuel projects. This is particularly problematic in developing countries, which are viewed as higher risk by investors, raising the cost of finance.

The usual solution to both issues – i.e. the way that financial viability is achieved – is to subsidise renewable energy project revenues through price premiums delivered via mechanisms like feed-in-tariffs, or to subsidise costs. As we are concerned with avoiding excessive public costs to developing country governments, the key question is how large these subsidies need to be, how long they are required for, and who will meet them? Where the subsidy is small and likely to diminish further over time, the benefits of renewable energy may justify this. Where the cost is large, however, it is unreasonable to expect the government of a developing country to bear this cost, which amounts to a drag on its development prospects. If public financial support is provided by external actors, perhaps through donor support, however, this constraint no longer applies.

Having identified attractive renewable technologies where investment has been historically low in the country but potential is high, we ask what are the most important factors constraining investment in these particular technologies in this country? The remaining steps of the green investment diagnostics approach are designed to answer this question and develop solutions.

2.2 International comparison of potential constraints: diagnostics decision tree

A very large number of issues could potentially affect whether or not particular investment are made. Narrowing this down to a manageable size requires a method of assessment broad enough to capture the full set of options, but detailed enough to provide guidance on where more detailed analysis should be applied.

There are two parts to this process. First, following Hausmann *et al.* (*2004*) a decision-tree is developed to capture potential constraints. The first 'node' on the tree starts with the question: why is investment in technology X so low? There are two possible answers. Either the type of finance needed is not available, or there is a sufficient supply of suitable finance, but the investment is not attractive compared to alternatives. These two options (which are not mutually exclusive) divide to form the next level of the decision-tree. Another way of looking at it is that two separate decision-trees are formed at this point, one exploring potential constraint in the financial system (i.e. that could be important for any type of

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[8]   The IRR is defined as the rate of return that brings a series of positive and negative cash flows to a net present value of zero, hence measuring the underlying return the equity investor expects to achieve by investing in the project.

investment), the other exploring constraints that are specific to the particular investment in question.

If there are problems in the investment-specific decision-tree, is it because risks are too high, or returns too low. If it is a question of risk, which risks? If returns are too low, is this because revenues are insufficient or costs are too high? Similarly, if there are problems in the finance-supply decision-tree, is this because sufficient capital does not exist, or because financial institutions are not intermediating these funds efficiently? If the problem is intermediation, is this due to a lack of competition and, if so, what factors are restricting competition? And so on.

As one moves down each decision-tree, potential constraints become more specific and explanatory – i.e. we may know that a lack of competition in the banking sector is low, but this becomes policy relevant if we know why this is the case. At each decision-point, possible explanations are assessed through international comparison. For each branch – or 'node' – of the decision-trees (e.g. is competition in the banking sector too low?) proxy variables are identified, and the 'performance' in our target country is compared with that in other countries.

Here we have organised comparator countries by income group, and calculated the 'best' and 'worst' for each group, as well as averages (median or mean as appropriate). All low, middle and high income countries are used in this assessment. In total, each decision tree consist of 5 or more levels, 70 or more decision-points, and roughly double this number of proxy variables. All variables are normalised between 0 and 100, with the country receiving a score in this range.

This 'first order symptom diagnosis' provides an initial assessment of potential problem areas. From more than 140 potential constraints, analysis of the level and pattern of country performance in each area allows us to narrow the search significantly. In simple terms, if a middle-income country is the best performing of all middle-income countries in a particular area, it is unlikely that this is a major constraint to investment. The hierarchical approach of increasing specificity enables us to say more than this, however. The identification of areas of potential concern at one level is augmented by analysis of possible causes in subsequent levels. As potential problem areas are ruled out, we are left with a small number of areas which the evidence suggests may be the most important constraint, and a growing understanding of why.

2.3 Identification of the binding constraints: deep diagnostic evidence

As well as highlighting areas of potential concern, the comparative approach described above indicates which may be the most severe – i.e. a score of 1 is more potentially troubling that one of 49. Whilst these differences in scale provide suggestive evidence of the severity of constraints, however, they are not conclusive. As pointed out by Hausmann *et al.* (2004) the scale of a problem may not always equate to how 'binding' it is. In some cases, a country may score extremely badly in a particular area, for example, but this may have little impact on investment incentives. To address this issue, the second order symptom assessment looks for supporting or refuting evidence in the areas identified as potentially important.

Following Hausmann *et al.* (2004), we look for 'diagnostic signals' in four areas.

2.3.1 The (shadow) price of the constraint should be high

Where the issue is a shortage of supply – e.g. finance, infrastructure, skills, confidence, stability – we would expect the price to be high. If the constraint is an insufficient supply of general finance, for example, we would expect to see very high real interest rates. If the

problem was restricted to long-term finance, then interest rates for this type of finance should be high. If a lack of supporting infrastructure was binding, we would expect the infrastructure that did exist to generate high returns. This is not restricted to constraints with market prices. The problem may be a lack of skilled workers, a symptom of which would be high wages in relevant sectors.

If the issue is excessive risk, we would expect to see this reflected in mitigation instruments like insurance premiums or exchange rate hedging tools. If the first-order assessment suggests that returns are being depressed by high costs, the second stage would dig deeper, identifying specific prices and shadow prices, to focus in on which elements are the most important.

2.3.2 Movements in the constraint should produce significant change in the desired outcome

If the constraint is binding, we would expect to see significant impacts when it is relaxed - i.e. more finance generally, or increased allocation of capital to these kinds of investment. Where the high cost of finance is the issue, for example, historical periods of low real interest rates should be associated with increased investment. If the constraint is a lack of international finance, then historical periods of relatively high capital inflows should be associated with an increased availability of long-term investment funds. Such a finding would lead to further examinations of the constraints to increasing the supply of international finance, and so on.

Where a lack of competition between banks is reducing the supply of long-term, affordable finance, periods of greater competition should result in an increase in this supply. In contrast, if long-term finance exists but is being skewed towards long-dated government bonds because of high interest rates, then low government rates should see long-term, private investment rise.

2.3.3 Agents in the economy should be attempting to overcome or bypass the constraint

Where problems are serious, we would expect to observe firms and households trying to overcome them. A lack of infrastructure should lead to greater use of alternatives, for example. Problems with electricity supply would see businesses using their own generators. A lack of capital from the financial system would cause firms to use more of their internal resources.

There are too many potential constraints to anticipate the behaviours for every case. An intermediate step is to think in terms of general categories of constraint, as in Table 2.1.

Table 2.1 Examples of symptoms caused by avoidance of types of constraint

Supply of appropriate finance		Relative attractiveness of investment	
Category of constraint	*Potential behaviour*	*Category of constraint*	*Potential behaviour*
Market competition too low	Monopolistic practices; informal alternatives	Revenues too low	Search for alternatives; poor maintenance
Inputs unavailable and/or expensive	Low usage; use of alternatives	Costs too high	Low usage; use of alternatives
Supporting physical infrastructure lacking or poor	Development of alternatives	Risks too great	High use of formal and informal mitigation tools
Supporting policy framework lacking or poor	Development of informal alternatives	Portfolio benefits weak or lacking	Strong, synchronised cyclical patterns of behaviour
Social and economic context too volatile	Risk averse behaviour	Social and economic context too volatile	Risk averse behaviour

Although these categories are too general to provide guidance from a policy perspective, they illustrate the logic used in the analysis.

2.3.4 Agents less intensive in the constraint more likely to survive and thrive, and vice versa

While the presence of a constraint should encourage agents to avoid it, advantages will also be conferred on businesses that are less reliant upon it, and vice versa. Hausmann *et al.* (2008) describe this with an evocative metaphor:

> What is the binding constraint to animals thriving in the Sahara desert? This is not unlike the question of what limits economic growth in a country. However, in the Sahara, it is instructive to note that of those few animals that do thrive in that environment, a very large proportion are camels and a very small proportion are hippopotamus. The fact that the animals most intensive in the use of water, hippopotamus, are scarce while the animals least intensive in the use of water, camels, are thriving suggests that the supply of water may be a binding constraint to the spread of animals in the Sahara.
> (Hausmann *et al.* 2008)

Different sectors use different inputs more or less intensively. Tobacco firms, for example, have relatively high cash-flows and so are less dependent on external finance than sectors like plastics or textiles. With respect to finance, tobacco firms are 'camels' and plastics firms are 'hippos'. If access to finance is the binding constraint, therefore, we would expect to see cash-rich sectors performing relatively well (*ibid.*). What this might mean in its broadest sense for our categories of constraints is sketched in Table 2.2.

Table 2.2 Examples of those likely to thrive given particular constraints

Supply of appropriate finance		Relative attractiveness of investment	
Category of constraint	*Potential beneficiaries*	*Category of constraint*	*Potential beneficiaries*
Market competition too low	Incumbents	Revenues too low	Providers of alternative sources of revenue
Inputs unavailable and/or expensive	Those using none/few of the inputs	Costs too high	Those using none/few of the inputs, or with abnormally high revenues
Supporting physical infrastructure lacking or poor	Those not reliant on this infrastructure	Risks too great	Those not exposed to risk, or able to naturally hedge
Supporting policy framework lacking or poor	Those not reliant on policy support, or able to create effective alternatives	Portfolio benefits weak or lacking	Those able to anticipate and benefit from cyclical processes
Social and economic context too volatile	Those insulated from volatility, or benefiting from it	Social and economic context too volatile	Those insulated from volatility or benefiting from it

Taken on their own, none of these four 'diagnostic signals' might be sufficient to identify a binding constraint with certainty. As they are worked through, however, evidence supporting particular constraints will build cumulatively. As this evidence comes independently from different sources, the resulting triangulation should also build confidence. By the end of the process, therefore, a reasonable hypothesis should have emerged as to which policy areas exhibit constraints that are 'binding' with respect to investment in general, and to investment in the target technologies in particular. The final stage of the methodology applies a 'rapid

political economy analysis' to the identified policy areas, with the aim of identifying which policy options are likely to be most feasible given the country context.

3 Country context for Kenya and Ghana

Fieldwork to test and refine the approach is ongoing in Kenya and Ghana. Before presenting some preliminary results, the following sections provide some brief background information.

3.1 Energy and renewable energy in Kenya

Electricity generation in Kenya comes from both renewable and non-renewable sources. Renewable energy accounts for about 72 per cent of the total electricity, most of which is hydro and geothermal. Thermal energy from fossil-fuel sources accounts for most of the rest of Kenya's energy supply. Of the sources considered, wind has the least effective capacity of 25.5 MW, which equates to just 0.2 per cent of generating capacity. Solar power in Kenya is mainly from off-grid, so is not included in these estimates.

The country is implementing the '5000+MW plan' to increase installed capacity to 6,762MW by 2017. An important component of this is Kenya's Least Cost Development Plan (LCDP), which attempts to ensure that the country's energy supply expands using the most cost effective sources.

Table 3.1 Energy production in Kenya, 2013

	Effective capacity(MW)	Generation (%)
Hydro	797.0	39.1
Thermal	632.0	28.3
Geothermal	347.8	31.9
Cogeneration	21.5	0.5
Wind	25.5	0.2
Total	1823.8	100.0

Source: GoK (2015).

According to the LCDP, the LCOE ranking of base load projects identifies geothermal with a load factor of 93 per cent as the least cost source (LCOE between 6.9 Us/kWh to 9.2 Us/kWh). Wind was also quite competitive, with an LCOE ranging between 9.1 Us/kWh to 12.2 Us/kWh.[9]

Despite these ambitious expansion plans, chronic delays in implementation are common. Also, more than half of the planned expansion of supply will come from carbon intensive generation capacity, mainly coal and natural gas, while renewables with a large potential, namely wind and solar, remain unutilised. As well as high quality solar resources, Kenya has some of the most potentially productive wind resources in the world, which remain largely untapped. Barriers to investment can be separated into general financial issues, and those particular to renewable energy or particular renewable sectors.

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[9] The LCDP assumes a discount rate between 8 per cent and 12 per cent.

For general constraints, renewable energy technology projects require significant financing, but there is lack of funding and inadequate financing in Kenya (GEF 2009). Inadequate financing, for example, is the explanation for the relatively small amounts of electricity generated from geothermal since drilling began in 1955. According to Waissbein, Glenmarec, Bayraktar and Schmidt (2013) the country generally lacks long-term affordable financing.

For renewables, GEF (2009) suggests the high up-front costs as the main barrier. To attract private investment, high rates of return are required. This is not straightforward in many cases, however, for various reasons. In the wind sector, for example, Independent Power Producers face barriers in access to grids, lengthy and uncertain processes to issue permits, limited local supply of expertise or a lack of long-term price guarantees, (Waissbein *et al*. 2013).

Regulatory and political barriers also form another major obstacle towards investments in renewable energy. GEF (2009) suggest this may be due to weak institutional frameworks while UNEP (2012) stress the uncertainties and risks associated with new technologies.

For all these reasons, negotiating for a good tariff is key for successful investments. In 2008, the Ministry of Energy adopted a Feed-in Tariffs Policy, which is considered an important step towards attracting more investment. Many project developers, however, consider the tariff to be too low to boost returns sufficiently. For wind energy, the Feed-in Tariffs Policy only provides a tariff for wind projects of 50MW and lower (GoK 2011). Because of the lack of a guaranteed tariff for larger wind projects, each project has to negotiate its own tariffs with Kenya Power, creating significant transaction costs. Also, negotiating an attractive tariff with Kenya Power has proved difficult as the country has historically relied a lot on hydropower, which is a relatively cheap form of energy (4 USD cent/kWh) (GoK 2011).

Inadequate or antiquated grid infrastructure also inhibits investments in renewable energy. In Kenya most renewable technologies are in remote areas where there is lack of transmission infrastructure to connect the project activity to the national grid. Technical issues, such as the inability of the grid to absorb increasing shares of fluctuating power from renewable energy sources are also a problem (GoK 2011). To add to this, the national transmission company may not provide easy access to the grid for renewable energy producers (*ibid.*).

To summarise, while Kenya produces a significant quantity of renewable energy, this is focused on hydro and geothermal. The country's unusually high quality wind resources remain untapped and its vast reserves of geothermal energy have tremendous scope for expansion. Various constraints to investment have been proposed. Identifying which of these are the most important, and putting in place reforms to address these, will be key to realising this potential.

3.2 Energy and renewable energy in Ghana

Before the late 1990s, Ghana's electricity was almost entirely generated by hydropower. Since then, thermal (largely diesel) sources have steadily increased reaching 51 per cent of capacity in 2015. There is a minimal investment in non-conventional renewable energy,[10] which represented less than 1 per cent of installed capacity in 2013, as shown in Table 3.2 below.

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[10]   Non-conventional renewable energies exclude the most mature hydro and biomass technologies.

Table 3.2 Energy production in Ghana, 2012

	Effective capacity	**Capacity (%)**
Hydro	1382	52.57
Thermal	1245	47.36
Solar	2	0.08
Total	2629	100.00

Source: Energy Commission of Ghana (2013).

Interestingly, most of the funds for the expansion of electricity supply, which has doubled since the late 1990s, have been donor-driven, with little contribution from the Government of Ghana. This has led to the development of conventional energy types at the expense of new renewables (Kumi and Brew-Hammond 2013).

In recent years endemic intermittent supply shortages and environmental concerns have caused a shift in thinking, with considerable attention now focused on natural gas, and on solar and wind energy, where Ghana has abundant resources. As in Kenya, however, increasing investment faces major constraints.

Given that Ghana's energy sector has been largely supported by donor funding, it is reasonable to assume that private investment suited to these types of investment is in short supply in the country. The alternative hypothesis, that this type of finance is abundant but has been crowded out by donor funds, seems rather implausible.

Turning to renewable energy specifically, the literature suggests that new renewable energy technologies face numerous challenges in Ghana, often thereby rendering them uncompetitive relative to conventional energy sources (Kemausor *et al*. 2012; Kemausor *et al*. 2014; Energy Commission of Ghana 2013; Ndzibah 2013). These include, *inter alia*: high up-front and operation and maintenance costs, and high perceived risk of various kinds, including regulatory.

The fact that Ghana has such limited experience with non-conventional renewables is likely to make potential risks loom large in the minds of investors, as there are few if any examples to point to where financial, political or technical risks have been successfully overcome.

Proponents argue that measures to boost project competitiveness, such as concessionary loans, grants, are required to change this situation, and could potentially make technologies such as waste to energy, wind and solar financially viable (Kemausuor *et al*. 2012). With respect to least cost technologies, wind and waste to energy are viewed as the most promising, but this potential remains almost entirely untapped.

To summarise, unlike Kenya, Ghana has very limited experience with non-conventional sources of renewable energy. As well as general financial constraints, and barriers particular to these sectors, it must therefore overcome heightened perceptions of risk, as there is no track record upon which to build.

4 Green investment diagnostics in Kenya and Ghana: selected, preliminary findings

The first stage of the green investment diagnostics (GID) analysis aims to narrow down the large set of potential constraints to a more manageable size. As described in Part 2, this has two components, represented as two decision-trees. One tests for symptoms of constraints within the financial system generally, while the second tests for project-specific issues.

The first-order assessment thus identifies a small set of investment constraints to be analysed in more detail for 'symptoms' of binding constraints, before policy options are identified and assessed from a political economy perspective. This research is ongoing in both countries, with results expected in 2016.

In this section we present some findings from the first-stage analysis of the financial systems. Following the decision-tree framework this is organised sequentially at different levels. As we move through these levels, symptoms and potential constraints become increasingly specific, focusing on potential explanations for problems previously identified.

Following Hausmann *et al.* (2004), potential financial constraints are categorised as either a lack of underlying finance (insufficient capital) or a failure of the financial system to transform and allocate this finance efficiently (poor intermediation). At each level, the issues identified in the decision-tree are captured by proxy variables. Performance on these variables in Kenya and Ghana is then shown with respect to three comparator groups: the countries of sub-Saharan Africa (SSA); all low-income countries (LICs); and all middle-income countries (MICs).

All results are normalised between 0 and 100. A score of 0 would indicate that Kenya or Ghana is the worst performing of the group, while a score of 100 would make them the best.

Here we join the analysis at level 3, the results from which are given in Table 4.1. Looking at potential constraints to capital first (i.e. the bottom half of the table) we see that the cost of savings does not seem to be an issue. This supports findings from previous levels that domestic savings are not a cause for concern. On external finance, restrictions on investment do not appear to explain the low level of capital inflows observed previously, and neither does macroeconomic and political instability. In all these cases, both countries perform well against comparators, including MICs.

Turning to intermediation, we find more issues of concern. Further evidence is found that domestic markets may be a source of constraint for equity finance. Whether on volume, liquidity, or numbers of stocks, both countries score badly. For supporting infrastructure, fixed line broadband is an issue in both countries, but this is not the case with mobile internet, particularly in Kenya, where non-fixed line usage is very high. Conversely, access to electricity does not appear to be a constraint in Ghana, but the situation in Kenya is worse.

The final area of concern is the predominance of short-term finance and the high return expectations of banks, with both countries performing badly on all associated measures. This offers some early explanation for the low competition in both banking sectors found at previous levels.

Table 4.1 Third level assessment of financial system constraints

			SSA		LIC		MIC	
			Kenya	Ghana	Kenya	Ghana	Kenya	Ghana
Intermediation	Low survival rate	% bank assets liquidated	100	.	100	.	100	.
	Only short-term finance	Liquid assets to deposits and short term funding	10.33	25.68	2.71	23.13	12.80	19.09
	Bank returns expectations excessive	Return on assets (after tax)	23.10	39.77	18.22	20.43	16.36	20.99
		Return on equity (after tax)	43.12	48.36	27.68	28.45	23.58	25.91
	Regulation not tailored to different institutions	Composite regulatory flexibility	33.33	33.33	33.33	33.33	25.00	25.00
	Lack of supporting infrastructure	Fixed broadband subscribers	0.99	2.05	20.64	42.63	0.48	0.99
		Internet users	77.38	24.40	121.5	38.32	54.67	16.34
	Lack of instruments	Stock market volume	3.08	0.26	18.92	1.60	2.49	0.26
		Stock market turnover	11.09	5.96	7.51	4.04	4.06	2.24
		Number of listed companies	10.15	10.77	17.90	18.99	0.17	0.21
Capital	Expensive savings	Saved in last year	98.61	66.76	100.0	68.94	54.27	37.53
		Bank non-interest income to income	75.21	68.51	75.94	69.17	67.26	62.50
	Capital controls	Investment Freedom composite	58.82	82.35	71.43	100	58.82	82.35
	Macro and political instability	Inflation rate	86.80	74.50	76.41	50.02	88.93	79.14
		Public economic management	100	52.63	100	50.00	94.12	41.18
		Public accountability and corruption	66.67	80.95	95.00	110	63.33	73.33
	Taxes too high	Taxes on income, profits, capital gains	19.97	58.14	0.00	43.61	22.57	55.39

Table 4.2 summarises findings from all levels for each country, with potentially more acute problems highlighted in bold.

Table 4.2 Summary of potential financial issues

	Kenya		Ghana	
	Capital	Intermediation	Capital	Intermediation
1	Low investment High short-term debt	Low private sector credit	Low investment	**Low private sector credit**
2	Low external savings **Limited FDI**	**Few bank branches** Limited domestic equity **Low bank competition**	**Low external savings** Limited FDI **Low ODA to power sector**	**Few bank branches** **Limited domestic equity** Low bank competition
3	Low incomes High taxes	**Short-term bias** High return expectations **Poor ICT infrastructure** Low electricity access **Illiquid stock market**	Low incomes	**Short-term bias** High return expectations Poor ICT infrastructure **Illiquid stock market**
4	Bank insolvency risk	**Regulatory entry barriers** **Regs. not promote comp.** High short-term returns	Bank insolvency risk	**Regulatory entry barriers** **Regs. not promote comp.** **High short-term returns**
5	-	**No public credit info.** **Low financial diversity**	-	**No public credit info.** **High short-term returns** **Low financial diversity** **Few skilled ICT workers**

While financial intermediation appears a much greater problem than the supply of capital in both countries, this relates to domestic rather than external finance. Domestic savings are relatively high, but the supply of private credit is low, suggesting that savings are not being intermediated through the financial systems effectively. For external finance the issue is different. Here both countries perform relatively badly in terms of attracting private capital flows of the type needed for renewable energy investment. While both countries are recipients of significant official development assistance (ODA), Ghana performs particularly badly on this measure when we look at the power sector specifically. As ODA, usually in the form of concessional debt, is often an important element of project finance structures in many countries, this may be a significant problem. The most fundamental constraints identified in both countries are therefore: (a) a failure to attract external capital of the form desired, and (b) an inability to transform and allocate domestic capital efficiently and effectively.

Domestic intermediation does not appear to be constrained by an overly concentrated banking sector in either country. Despite relatively disbursed bank ownership, competition is low, and the penetration of branches limited. There is also evidence of excessive return expectations in both banking sectors, as well as a preference for short-term finance, particularly in Ghana.

For causes of low competition, we find quite high barriers to entry in both countries, including informal barriers such as credit bureau coverage in Ghana. There is also a failure to actively promote competition on the part of regulatory agencies in both countries. For short-termism, the availability of very high short-term returns, particularly in Ghana, appears to be a significant explanatory factor: if banks can obtain high returns with low risk by lending short-term to government and other more established sectors, there is a less of an incentive to provide longer-term finance in relatively new areas such as renewable energy.

For constraints to attracting external finance, concerns over political and economic instability, or regulatory or institutional quality do not seem to be the problem. On all measures of this kind, both countries perform relatively well. It seems likely that binding constraints in this area relate to more investment-specific risks which are addressed in the second decision-tree framework. The fact that Ghana attracts very little ODA to the power sector, compared with both other countries and with the ODA it receives more generally, is indicative of sector-specific issues that may be constraining investment.

Looking at supporting financial instruments and infrastructure, there is evidence that the supply of domestic equity may be operating as a constraint. While Ghana scores worse on some measures, detailed examination of different aspects of the domestic equity market finds consistently low scores for both countries. For infrastructure, access to electricity is an issue in Kenya but less so in Ghana. Both countries score very badly on the ICT related infrastructures.

5 Conclusion

In this paper we have described the green investment diagnostics methodology and given some early findings from its application in Kenya and Ghana. We have also provided a rationale for why, given the increasingly sophisticated policy evaluation tools that have been created, another one is needed. We hope that future work in this area will enable us to refine the approach further, and create a flexible tool for identifying the binding constraints to renewable energy investments in developing and emerging economies.

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