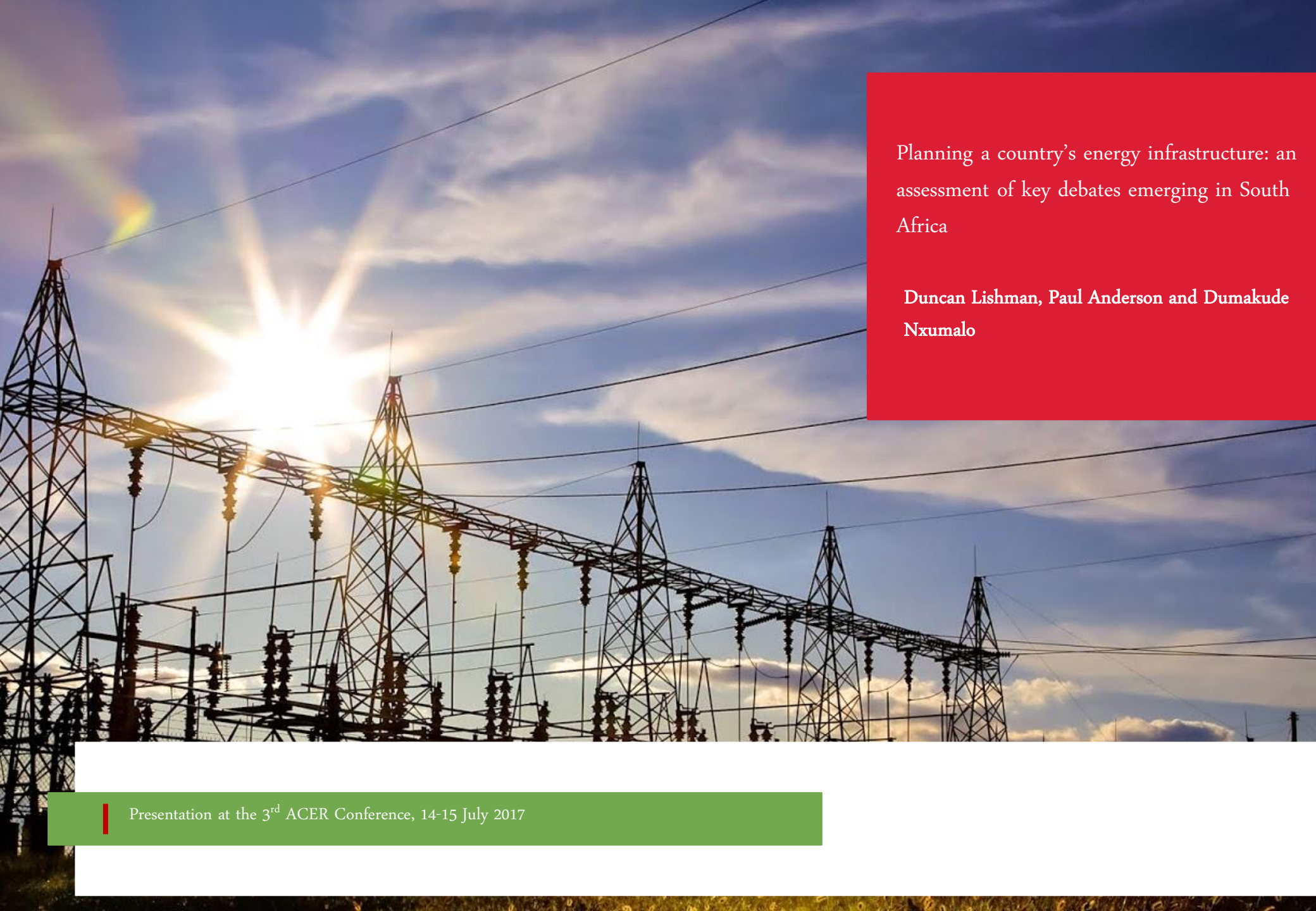

Planning a country's energy infrastructure: an assessment of key debates emerging in South Africa

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What are the key messages to take away from our paper?

- **Energy planning matters and the development of energy plans is commonplace**
  - Generally based on a forecasting model (demand, supply) with various assumptions and scenarios
  - Many countries do them but in different ways (and for different purposes?)
  - We pull out three issues that are important for energy planning – highlighted below:

What is the purpose of energy planning?

Energy forecasts can be just an outlook but can also be used to drive policy

How should environmental concerns be accounted for?

Emission limits are usefully included in the modelling of an energy plan, but applying externality costs requires more care

What matters when comparing generation technologies?

If you're thinking about deciding between technologies (i.e. as substitutes), then two things really matter – (i) relative cost and (ii) degree to which they are technically interchangeable

Energy plans explored I: What is their role and ultimate purpose?

Some diversity in the role and purpose

- Energy outlooks
  - Agnostic to policy: includes what's there and what's likely. Not taking a view on where one should go
  - US, Australia, Canada, Sweden, the UK
- Energy plans
  - Aspirational in nature: usually one is taking a view of direction and how to get there through policy tools
  - EU, Angola, South Africa, Tanzania
  - SA's IEP – role and purpose
    - to be informed by existing policy;
    - to provide long-term forecasts that shape energy investments; and
    - offer recommendations to policy makers

When does a plan come together?

i. Balance competing policy objectives – implies a need to prioritise
   - *SA's IEP: all are equal but some are more equal than others?*

ii. Establish clear hierarchy/division between plans (won't always be the case)
   - *SA's IEP and IRP (and Gas Utilisation Master Plan and Liquid Fuel Infrastructure Plan)*

iii. Extract key modelling implications and link these clearly to policy recommendations
   - *SA's IEP can more meaningfully linked implications to policy*

Energy plans explored II: How should environmental considerations be accounted for?

- Society places increasing weight on the environmental impact of energy choices, particularly from fossil fuels
- Two ways of taking this social valuation into account in the modelling: emissions limits and externality pricing

Emissions limits	Externality pricing
• Aspirational in the real world • Binding constraint in the model which can be used to guide investments • Many countries use it in their energy plans/outlooks – EU, US, South Africa, Angola, Tanzania • EU particularly interesting as the modelling targets steep emissions reductions	• Limited application in the real world (carbon taxes in certain countries) • Price signal in the model that shapes the energy mix • SA's IEP prices a range of emissions – material impact on overall system costs, ranging from 7-15%

Issues that arise from modelling emissions limits and externalities:

- Risk of double-counting in the model with both emissions limits and externality pricing
  - Worth thinking about emissions limits or externalities – might guide one to a similar place
  - Multiple scenarios are useful to gauge impact of environmental concerns
- Non-monetary externalities won't be reflected in real-world decisions (if priced in reality, then must be included!)
  - Including non-monetary externalities should be done with caution – what is one trying to achieve?
- Pinning down accurate prices for non-monetary externalities is difficult – externalities report for the DoE: *"actual monetary values presented here would require significantly more research before they could be used in other policy work"*[1]
- Fossil-fuel emissions aren't the *only* externalities from technology choice (only environment? then shale gas too?)

[1] DoE IEP 2016: Annexure C1 – Energy system externalities in South Africa (Vivid Economics), p. 14

Energy plans modelled III: What matters in the comparison of renewable and nuclear technologies

- With the shift away from fossil fuels (and absent advances in carbon capture and storage technologies), suggests renewable and nuclear are important for the evolution of the energy mix
- These technologies have emerged front and centre in the debate about South Africa's energy future – pitted as either/or
- We consider two elements to be particularly important in their evaluation

[1] <u>Costs</u>:

- Relative cost of technologies important for determining the mix
- In SA: levelised cost per kWh of nuclear and renewables (wind and solar)
  - (a) Nuclear: What's a good cost comparator?
    - No recent experience domestically
  - (b) Renewables: What is the projected learning rate?
    - Domestic experience under REIPPP which has seen wind and solar prices come down dramatically
    - Global growth in renewables (REN21 and Bloomberg Energy Outlook) and its impact on costs
- Cost of transmission and distribution infrastructure
  - Important cost to be taken into account, particularly for small, dispersed generation assets (e.g. renewables)
  - Angola, Kenya and Tanzania all include it. But many, like South Africa, are missing this element
- Transparency of assumptions and opportunity for public comment

Energy plans modelled III: What matters in the comparison of renewable and nuclear technologies

[2] <u>Interchangeability of renewable and nuclear technologies</u>:

- Are these technologies substitutes or complements? And if they are substitutes, to what degree?
- There are suggestions they're interchangeable
  - In SA, both the IEP and IRP suggest this (perhaps a question of whether substitution is only at the margin – is this why the IRP imposed a build constraint on renewables?)
  - Work by others in SA, primarily the CSIR, demonstrate that an unconstrained model requires no nuclear and is instead predominantly renewable
  - Emerging debate in the US (Jacobson et al 2015, cf. Clack et al 2017)
- Issues to consider
  - **Technical feasibility:** Ultimately a technical assessment and outside the scope of our paper, <u>but</u> the debate appears to place less emphasis on this (relative to cost concerns) even though it is of critical importance
  - **System adequacy** (ability of the power system to match the evolution in electricity demand): Different energy mixes in a plan need to conform to some agreed-upon metrics of system adequacy to ensure they're comparable

<u>Whither the debate?</u>

- In SA, we have a reprieve on making an immediate decision
  - Western Cape High Court's ruling nullifies nuclear cooperation agreements
  - Currently excess supply in the system, with more supply coming online and weak demand
- Important we use this time to make the "right" decision

Conclusions

- A synopsis on energy planning: most countries are doing it, but could they be doing it better?
- If one is going to embark on compiling an energy plan, our paper provides guidance in three areas:

What is the purpose?

Energy forecasts can be just an outlook but can also be used to drive policy

- If one wants to successfully guide policy in the energy sector, then careful attention should be paid to the design of the plan

How should the environment be accounted for?

Emission limits are usefully included in the modelling of an energy plan, but applying externality costs requires more care

- Although aspirational in the real world, emission limits can be a binding constraint in the model
- Externalities that have real-world prices should of course be priced
- Non-monetary externalities may not be helpful (don't affect decisions in reality, double counting)

What matters when comparing technologies?

Important information requirements need to be satisfied for one to have comfort that the model can properly "choose" between different generation technologies

- Relative cost of different generation technologies (levelised cost)
- Degree to which the generation technologies are technically interchangeable

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