Initial analysis of the direct environmental impacts of CSP and PV in South Africa

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MSc Conservation Ecology

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Content

- Introduction
- Objectives and scope
- Methodology
- Results (highlights)
- Conclusions
Introduction

The short version

Need for diversification of energy system

Where does this go and what is the environmental impact?

<table>
<thead>
<tr>
<th>Technology</th>
<th>Total (MW)</th>
<th>Allocation remaining (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>2660</td>
<td>660</td>
</tr>
<tr>
<td>PV</td>
<td>1899</td>
<td>626</td>
</tr>
<tr>
<td>CSP</td>
<td>600</td>
<td>0</td>
</tr>
<tr>
<td>Small Hydro</td>
<td>19</td>
<td>116</td>
</tr>
<tr>
<td>Biomass</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Biogas</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>Landfill</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>5237</td>
<td>1488</td>
</tr>
</tbody>
</table>

Where does this go and what is the environmental impact?

- RE Whitepaper 2003
- IRP 2010 & Update 2013
- REIPPPP since 2011
Introduction

Current impact assessment approaches

• Legislation (EIA regulations in National Environmental Management Act (Act no. 107 of 1998)
  – Mandatory EIAs at project level
• SEA for RE deployment (RE Development Zones)
  – Wind and PV only, no CSP
• Not much action in the research space
Introduction

Distribution of development footprints

Biome?
“A broad ecological unit having similar vegetation structure exposed to similar macroclimatic patterns, often linked to characteristic levels of disturbance such as grazing and fire”
(Mucina & Rutherford 2006; Low & Rebelo 1998)
Objectives

(of whole study)

• To identify the direct impacts of solar power on the natural environment in the Nama-Karoo and Savanna biomes on a development footprint scale

• To provide an outlook on what this impact is on a regional scale and into the future

• To provide a starting point in understanding how these impacts can be managed/mitigated locally and across the landscape
Suite of socio-economic impacts

Emissions, impacts, resources used before construction

Transmission line & Substation

Emissions, impacts, resources after decommission

Roads & Pipelines

EXCLUDED

EXCLUDED

INCLUDED

Employment potential
Health & Safety
Culture & Heritage

Immediate natural surroundings

Scope
Suite of socio-economic impacts

Emissions, impacts, resources used before construction

Construction

Operation

Decommission

Roads & Pipelines

Transmission line & Substation

Emissions, impacts, resources after decommission

EXCLUDED

EXCLUDED

INCLUDED

EXCLUDED

Employment potential

Health & Safety

Culture & Heritage

Scope
Methodology

Mixed method approach

- Literature review
  - Structured interviews
    - Purposive and snowball sampling
  - Content and thematic analysis
    - ATLAS.ti 7 & XLSTAT
  - Spatial datasets collection
    - ArcGIS
  - Spatial analysis
  - Site visits

Data collection

Data analysis & Instrument

Results

Synthesis & Discussion

- Indication of direct environmental impacts associated with development in Nama-Karoo and Savanna

- Impact of footprint on landscape into other land uses and biodiversity

- Insight into experience and knowledge of impacts

Site visits
Methodology

Interviewees: Sample description

<table>
<thead>
<tr>
<th>Expert group</th>
<th>CSP</th>
<th>PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research entity</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>State utility</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Designated authority</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Registered environmental assessment practitioners</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Representatives from Independent Power</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Legislators/policy developers</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Specialists</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

- Honours level: 10%
- Masters: 30%
- PhD or higher: 60%
## Methodology

### Spatial analysis: Datasets used

<table>
<thead>
<tr>
<th>Title of data set and year published</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>South African Renewable Energy EIA Application Database Q1 2016</td>
<td>Department of Environmental Affairs</td>
</tr>
<tr>
<td>National Vegetation Map (Vegmap) 2012</td>
<td>South African National Biodiversity Institute</td>
</tr>
<tr>
<td>South African Protected Areas Data Base Q1 2016</td>
<td>Department of Environmental Affairs</td>
</tr>
<tr>
<td>Important Bird Areas 2015</td>
<td>BirdLife South Africa</td>
</tr>
<tr>
<td>National Protected Areas Expansion Strategy: Focus areas for protected area expansion 2010</td>
<td>SANParks</td>
</tr>
<tr>
<td>Strategic Water Source Areas 2013</td>
<td>Council of Scientific and Industrial Research</td>
</tr>
</tbody>
</table>
Methodology

Site visits – not today
Results

Structured interviews: 4 themes

1. Direct biophysical impacts of solar power
2. Feedback on EIA process
3. Reference to SEA process
4. Management and mitigation measures

Adapted from Saldana (2015)
Results

Structured interviews: Theme 1

Are you aware of any adverse direct environmental impacts which solar power has?

- Yes 95%
- No 5%

• 47 different codes

- Atmospheric/audial impacts
- Biodiversity and ecology impacts
- Impacts on fauna
- Impacts on flora
- Impacts on water
- Landscape impact
- Soil/geological impacts
Results

Structured interviews: Theme 1

- Risk of aerial or leachable toxic chemicals
- Removal/disturbance of topsoil
- Habitat transformation/loss
- Habitat fragmentation
- Diversion of water courses
- Risk of aerial or leachable toxic chemicals
- Impact on total water resource availability
- Diversion of water courses
- Vegetation clearance
- Risk of alien infestation
- Impact on avifauna by towers
- Impact of collision on avifauna by PV panels/heliostats
- Hindrance to animal movement
- Risk of alien infestation
- Risk of aerial or leachable toxic chemicals
- Impact on local ecology & biodiversity
- Visual and dust impact
- Risk of aerial or leachable toxic chemicals
- Impact on micro-climate

Number of quotations

Impact categories

- Soil/ ecological impacts
- Landscape impacts
- Impacts on water
- Impacts on flora
- Impacts on fauna
- Impacts on biodiversity
- Impacts on water
- Impacts on flora
- Impacts on fauna
- Impacts on biodiversity
- Atmospheric/audial impacts

Soil/ ecological impacts:

- Risk of aerial or leachable toxic chemicals
- Removal/disturbance of topsoil

Landscape impacts:

- Habitat transformation/loss
- Habitat fragmentation
- Diversion of water courses

Impacts on water:

- Risk of aerial or leachable toxic chemicals
- Impact on total water resource availability
- Diversion of water courses

Impacts on flora:

- Vegetation clearance
- Risk of alien infestation
- Impact on avifauna by towers
- Impact of collision on avifauna by PV panels/heliostats
- Hindrance to animal movement

Impacts on fauna:

- Risk of alien infestation
- Risk of aerial or leachable toxic chemicals
- Impact on local ecology & biodiversity

Atmospheric/audial impacts:

- Visual and dust impact
- Risk of aerial or leachable toxic chemicals
- Impact on micro-climate
Results

Structured interviews: Theme 1

- Impacts mentioned being specifically related to either CSP or PV
Results

Structure interviews: Theme 2

- Do you think the EIA process sufficiently covers all the impacts of solar power?

- EIA lacks depth in some aspects.
- Layouts of developments can change after EIA was done.
- Potential of impacts occurring not known or able to be identified through EIA process.
- Vegetation removal wasn’t analysed in depth.
- Topsoil removal/erosion control was not well analysed.
- Competency and reputation of EAP and EA company plays a role.
- Cumulative impacts are not covered.
- Sufficient if properly done.

An EAP from the CSIR commented: “EAP’s have a good understanding of impacts, but the assessment thereof is not reinforced by site visits.”
Results

Spatial analysis: footprint per biome

<table>
<thead>
<tr>
<th>Biome</th>
<th>Total area approved solar EIA applications (km²)</th>
<th>Total area of preferred bidders’ developments (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nama-Karoo Biome</td>
<td>4454.9884</td>
<td>702.0326</td>
</tr>
<tr>
<td>Savanna Biome</td>
<td>2854.071</td>
<td>228.1518</td>
</tr>
<tr>
<td>Grassland Biome</td>
<td>988.9336</td>
<td>16.7014</td>
</tr>
<tr>
<td>Fynbos Biome</td>
<td>256.9637</td>
<td>30.3973</td>
</tr>
<tr>
<td>Succulent Karoo Biome</td>
<td>234.3627</td>
<td>5.1049</td>
</tr>
<tr>
<td>Azonal Vegetation</td>
<td>176.4307</td>
<td>10.6397</td>
</tr>
<tr>
<td>Albany Thicket Biome</td>
<td>68.3532</td>
<td>-</td>
</tr>
<tr>
<td>Desert Biome</td>
<td>5.3781</td>
<td>5.3781</td>
</tr>
<tr>
<td>Indian Ocean Coastal Belt</td>
<td>0.9173</td>
<td>-</td>
</tr>
</tbody>
</table>

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Kalahari Duneveld Bioregion 9%
Eastern Kalahari Bushveld Bioregion 13%
Upper Karoo Bioregion 17%
Bushmanland Bioregion 53%
**Results**

**Spatial analysis: IBA**

<table>
<thead>
<tr>
<th>Protection status</th>
<th>Total area of all approved EIA applications within IBA (km²)</th>
<th>Total area of preferred bidders’ developments within IBA (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CSP</td>
<td>PV</td>
</tr>
<tr>
<td>Unprotected</td>
<td>18</td>
<td>535</td>
</tr>
<tr>
<td>Partially</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Fully</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proximity to IBA</th>
<th>All approved solar EIAs</th>
<th>Preferred bidders</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 km</td>
<td>10 (4%)</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>1-5 km</td>
<td>8 (3.2%)</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>5-10 km</td>
<td>7 (2.8%)</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>&gt;10 km</td>
<td>224 (89.9%)</td>
<td>24 (88%)</td>
</tr>
</tbody>
</table>
Results

Spatial analysis

- 8.5% approved solar power EIAs in protected areas
- 17.5% within 0-10km
- 3 PV PBs in biosphere reserves, no CSP PBs
- 17% of approved PV applications in SEA area of which 8% = PB (total 15% of PB)
Conclusions

Key findings & Recommendations

• Solar power developments does have an environmental impact – the severity should and can be managed and proper siting is pivotal

• Cumulative environmental impacts currently not understood or sufficiently assessed

• Knowledge base regarding the impact of solar power development slowly building in South Africa

• Specific research needed to investigate the impact on avifauna
Conclusions

Shortcomings and limitations

• Assumptions made based on best known national plans and datasets
• Spatial analyses done based on these assumptions
• Better structured interview form and larger sample
• Usual resource limitations
References

- Google Earth images
Thank you

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