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SOLAR THERMAL ENERGY RESEARCH GROUP

Future CSP in South Africa – a review of electricity (generation) mix models and their results

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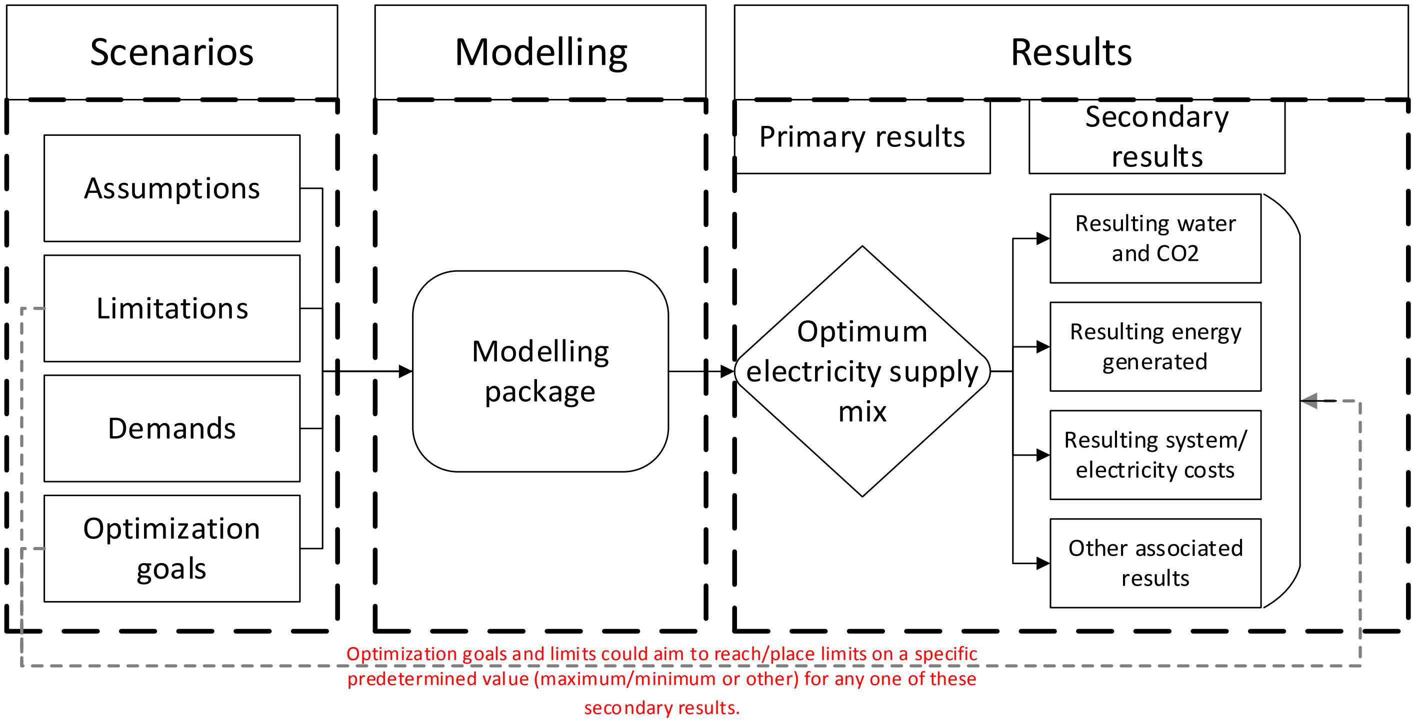
Presentation overview

- Introduction
- Energy systems modelling
- Research approach
- Studies/reports identified
- Results
- Conclusions

Introduction

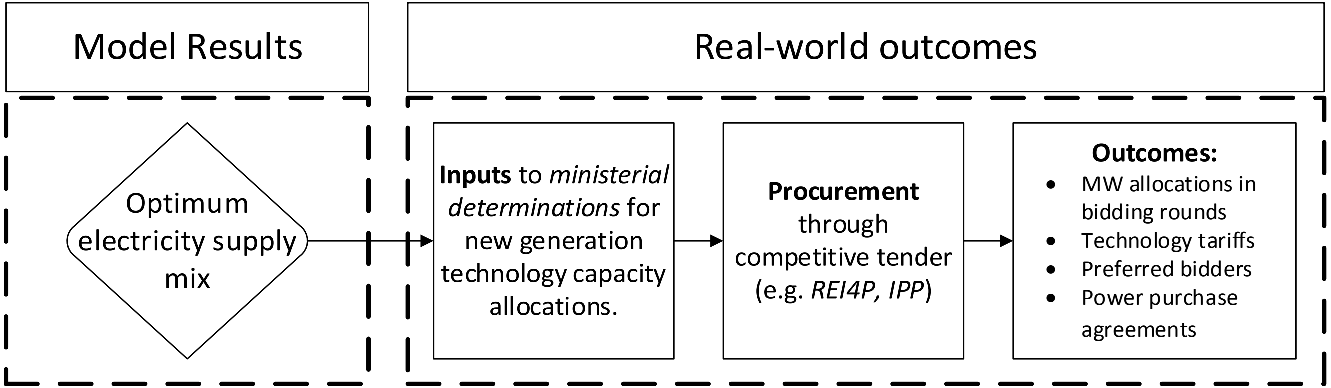
- 2007/’08 Power crisis -> The rise of RETs
- RETs intermittency -> generation capacity uncertainty
- Need for integrated energy planning

Energy systems modelling



SA energy planning and policy

- Carried out by national regulatory bodies – DoE/Eskom/NERSA
- Resulted in first IRP 2010 – only promulgated plan to date, i.e. Basis for informing future developments



SA energy planning and policy

- IRP 2010 followed by:
  - IRP 2013 update (never promulgated)
  - IRP 2016 update (in review phase)
- IRP 2013 - dynamic planning strategy for multiple possible developments in industry/demand/goals.
- IRP 2016 – static planning thus far, with base case, and expected policy-adjusted case.
- Directly impact electricity supply industry in SA – risks for independent renewable energy producers.

Importance & impact of planning

- Results from governmental plans impact industry.
  - IRP 2010 led to industry & market development.
  - IRP 2016 led to outcry from industry, market uncertainty & criticism by experts & academia.
  - PPA's not being signed.
- Results from governmental plans impact further research.
  - Results used as inputs for global and academic studies.

Focus on CSP

- Focus placed on capacities allocated to CSP.
  - Other RET markets already mature.
  - Other RETs already affordable – greater penetration levels.
  - CSP only under-developed RET (Global and SA)
  - CSP can provide fully dispatchable generation (compared to other energy technologies).
  - Possible baseload capacity at larger penetration levels.
- CSP industry – understand market developments and potentials in SA.
- National regulatory bodies – understand true value of CSP as new build option.

Research Approach

1. Identify relevant studies & reports
   - Published >= 2010
   - Restriction in choice of RETs (CSP in particular)
   - Global report - South African results
   - Publically available
2. For each study/report determine the following:
   - Main objective
   - Modelling approach & package
   - Base-, maximum CSP-, and minimum CSP scenario(s).
   - Multiple scenarios with the same CSP capacities – identify scenario with the maximum capacity of other RETs, and one with the minimum capacity of other RETs

Research Approach

3. For identified scenarios, find key available input parameters and assumptions.
4. For identified scenarios, find available key results.
5. Summarise conclusions reached and recommendations derived.
6. Enter above information into database.
7. Analyse trends/correlations found.
8. Draw conclusions, make predictions, find factors of industry/government impacting CSP in SA.

Studies/reports identified

Study/Report Name	Goal of Study	Optimization Parameter
IRP 2010 and 2016	Determine the long term electricity demand and how this demand should be met in terms of generating capacity, type, timing and cost, with a balance between affordability, sustainability, local job creation according government determined policies.	Cost-optimal (with various limits, forced builds and relaxed options)
Integrated Resource Plan 2013	Determine how the long term electricity demand should be by generating capacity-type, timing and cost, taking changes in technology costs and forecasted demands into account, and providing a flexible approach to determining investment decisions in contrast to the fixed capacity plan of the IRP 2010 and 2016.	Cost-optimal (with various limits, forced builds and relaxed options)
CSIR response to IRP 2016	Part of the IRP update process, industry stakeholders engagement for comments and inputs prior to final. The CSIR responded formally on 03-04-2017, finding a least cost, unconstrained electricity mix by 2050, in line with the IRP 2016, to reflect the latest industry-aligned costs and changes. Their approach is conservative, with pessimistic assumptions made for new technologies and more optimistic assumptions made for established ones.	Cost-optimal (with various limits, forced builds and relaxed options)
Greenpeace 2008 and 2011 Energy [R]evolution	Only exception made on relevancy-criteria since it forms part of a series of documents, with the next published in 2011. Scenarios based on the global energy scenario produced by Greenpeace demonstrating how energy related global CO_2 emissions can be at least halved by 2050.	Unclear; limits on CO_2, possibly optimised or simulated to reach goal.

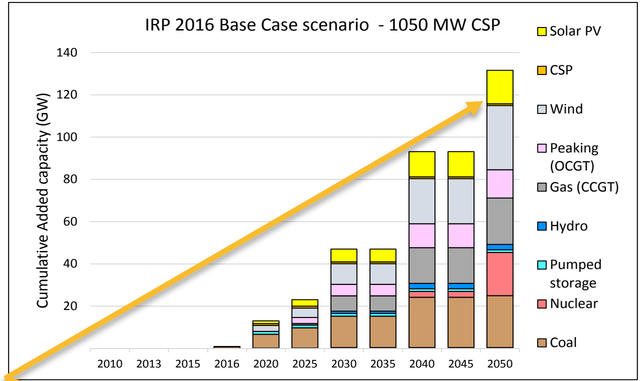
Studies/reports identified

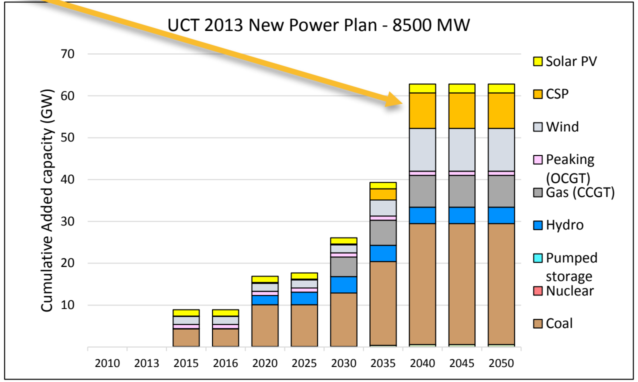
Study/Report Name	Goal of Study	Optimization Parameter
WWF - 50% by 2030 (2010)	To compare the implications of a reference scenario (where capacity is allocated according to the 2007 Eskom investment plan) to that of an alternative scenario, where CO_2 emissions are reduced by adding more RE to the generation mix by 2030, but still meeting demand requirements.	Simulation performed to reach goal of 50% installed capacity by 2030
UCT, Energy Research Centre – Towards a new power plan (2015)	This report looks at key assumptions in the IRP 2010-2030 and the impact that updating some of these assumptions will have on a new power plan. The new assumptions considered are lower demand, updated investment costs of renewable and nuclear technologies and the availability of natural gas import options.	Cost-optimal (with various limits, forced builds and relaxed options)
UCT, Energy Research Centre - Nuclear build plan technical report (2015)	To analyse the South African Government’s stated commitment to 9.6GW of nuclear power against other supply options. A flexible planning approach in the electricity sector is compared to a commitment to the full nuclear fleet for two different demand scenarios.	Cost-optimal (with various limits, forced builds and relaxed options)

Results

- Driving forces:
  - Max. overnight capital costs
  - Annual build limits
  - Capital reduction over period
  - CO2 emission limits
  - Projected demand

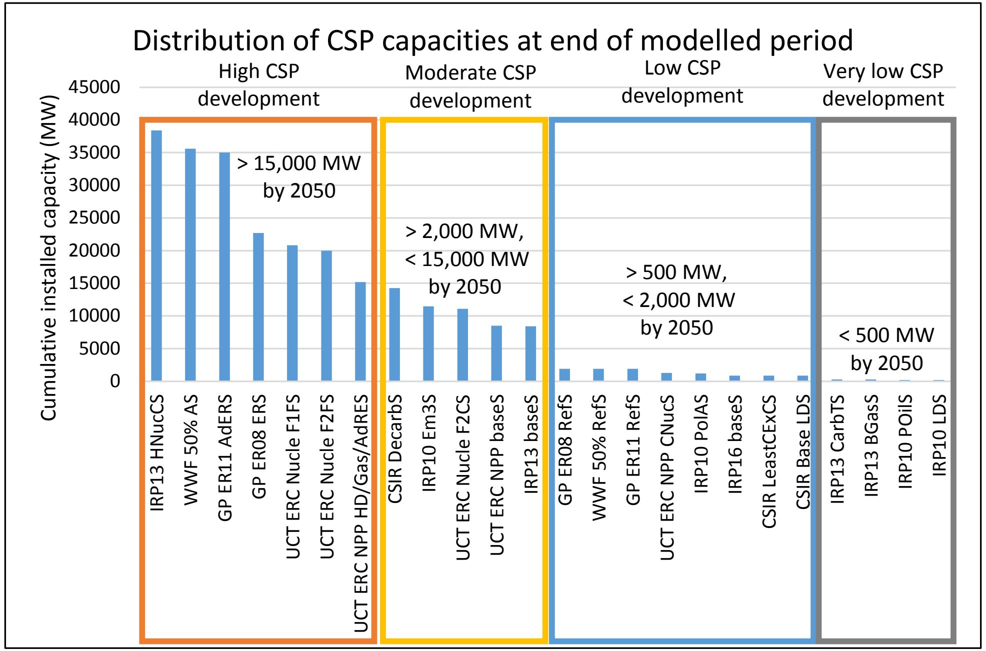
VS



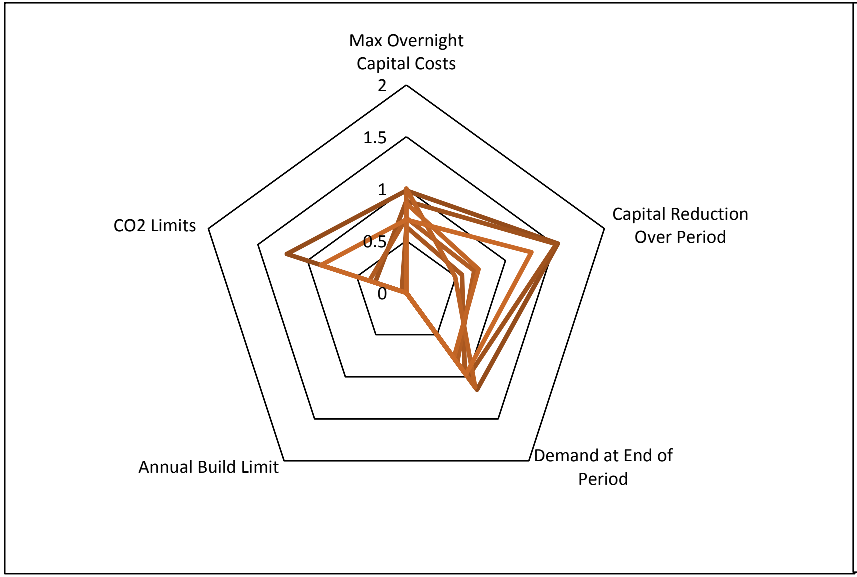


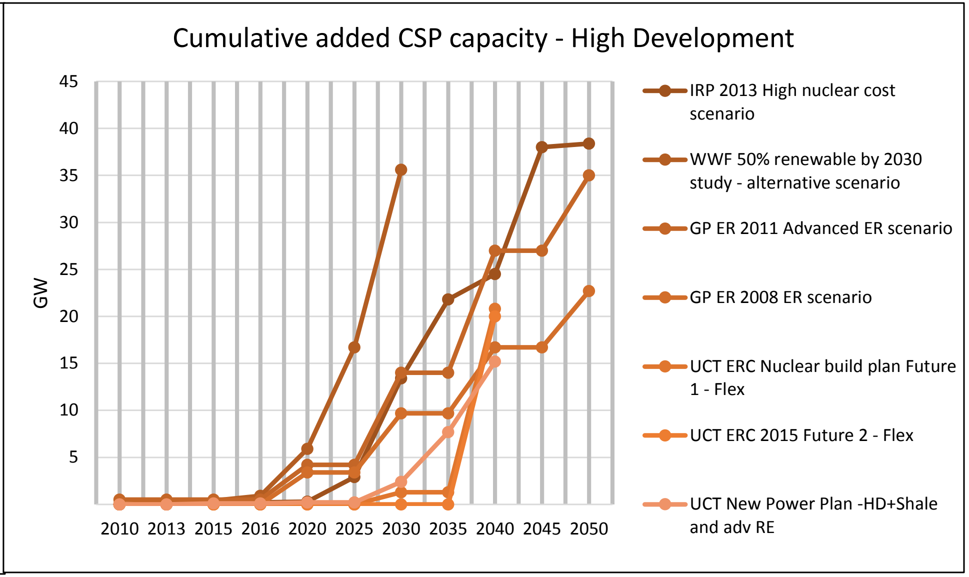
Results

- Varying results between studies
- Clear distinction – high, moderate, low and very low development.
- Grouping of assumptions by development level



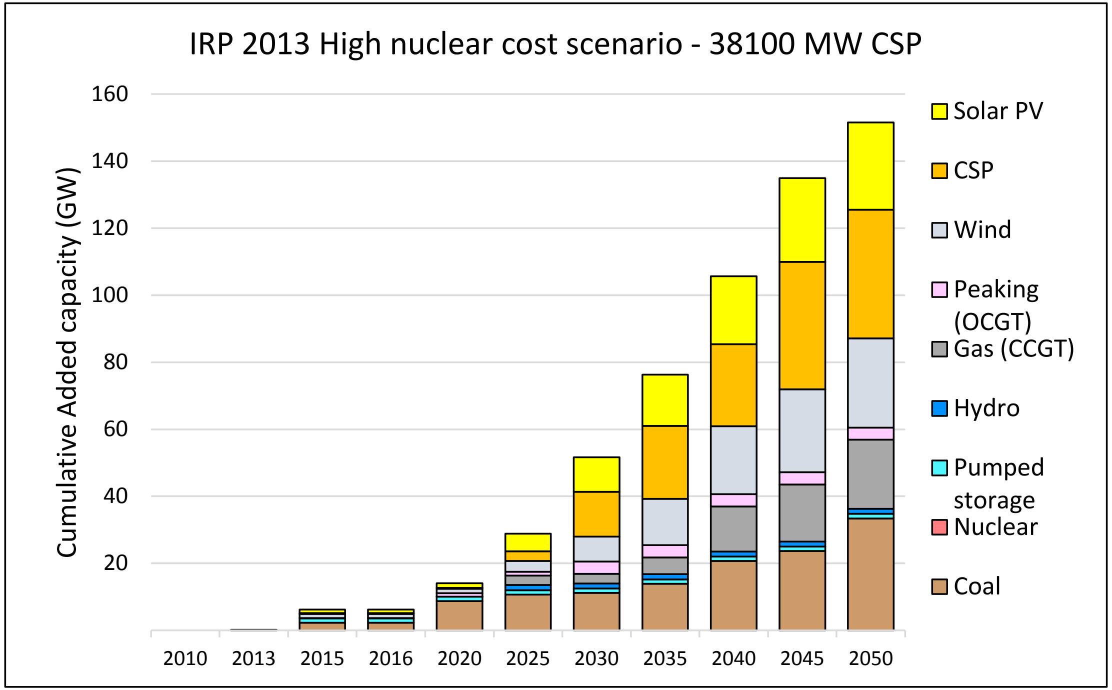
Results – High development



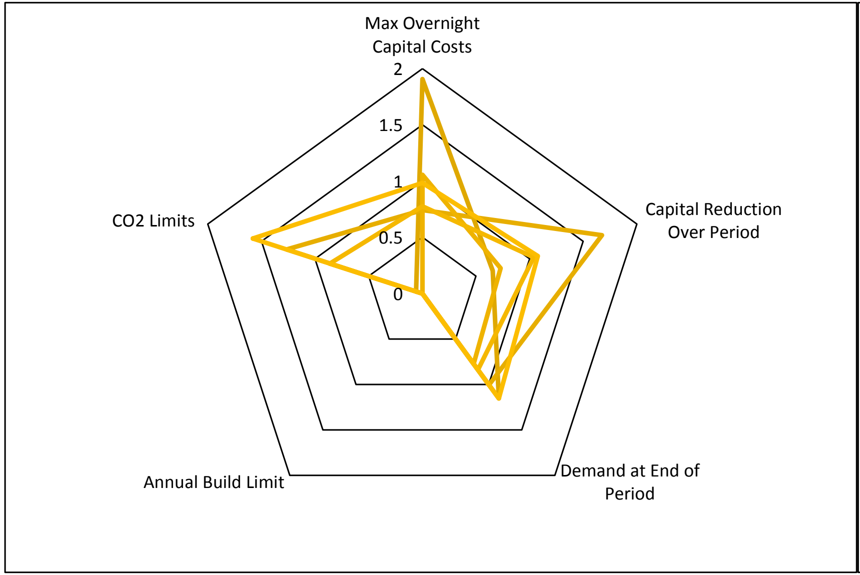


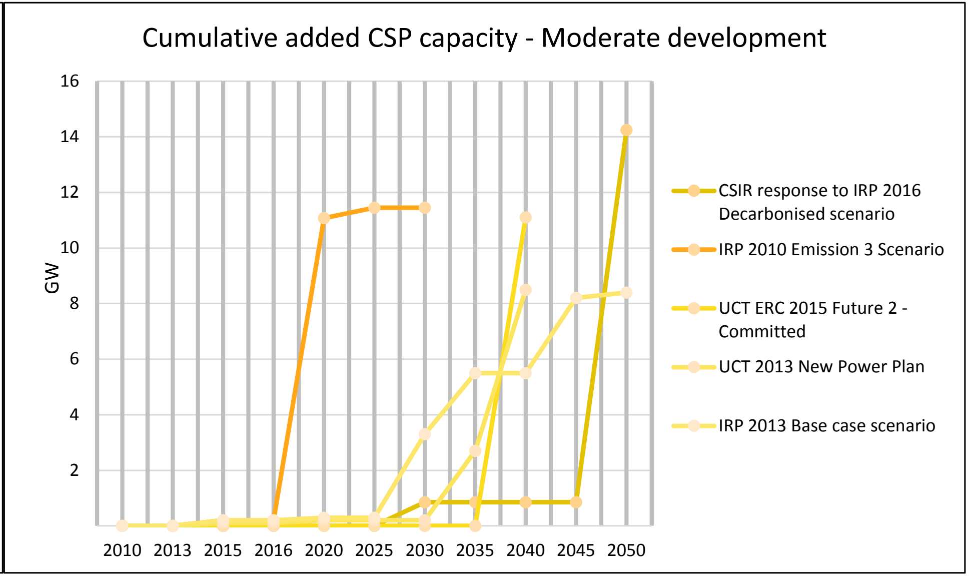
Results – High development

- Highest CSP development case.
- Main driving force: higher nuclear costs and aggressive CO_2 reductions.



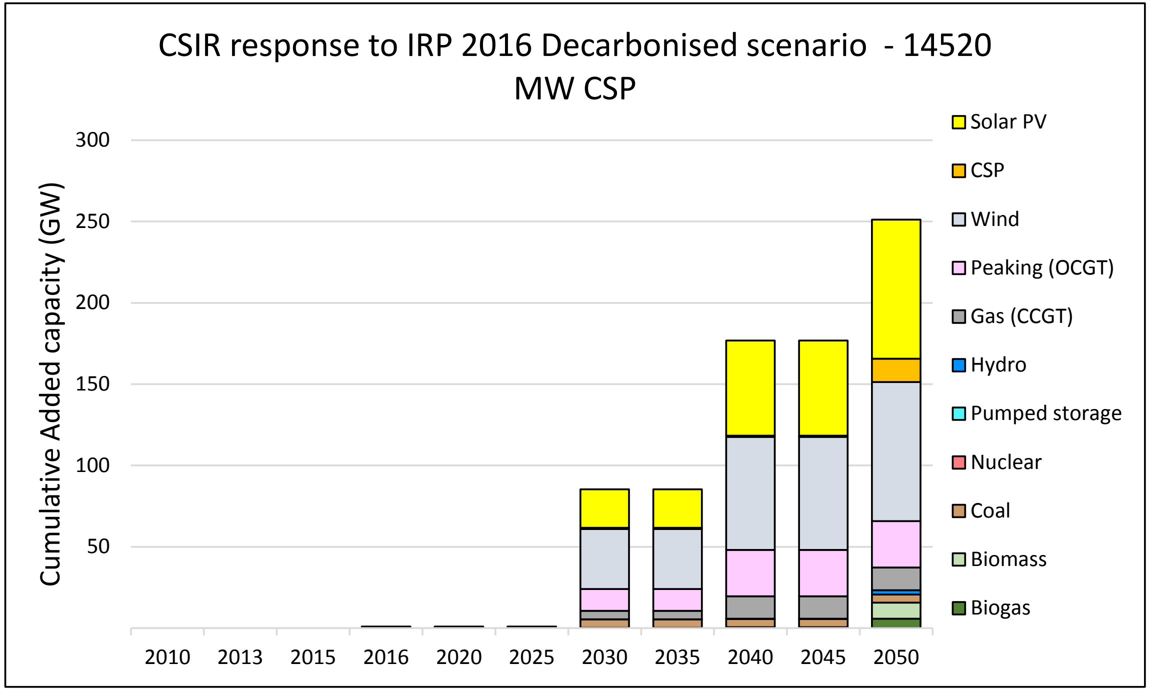
Results – Moderate development



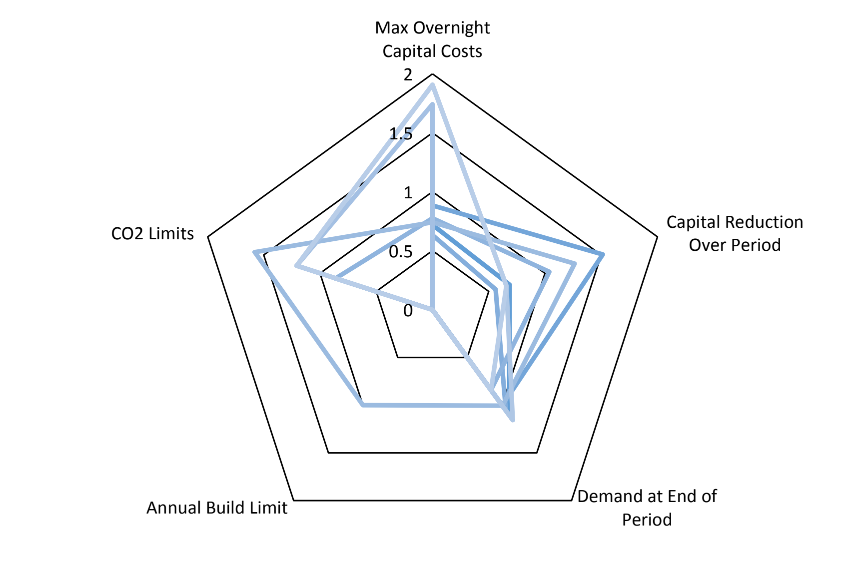


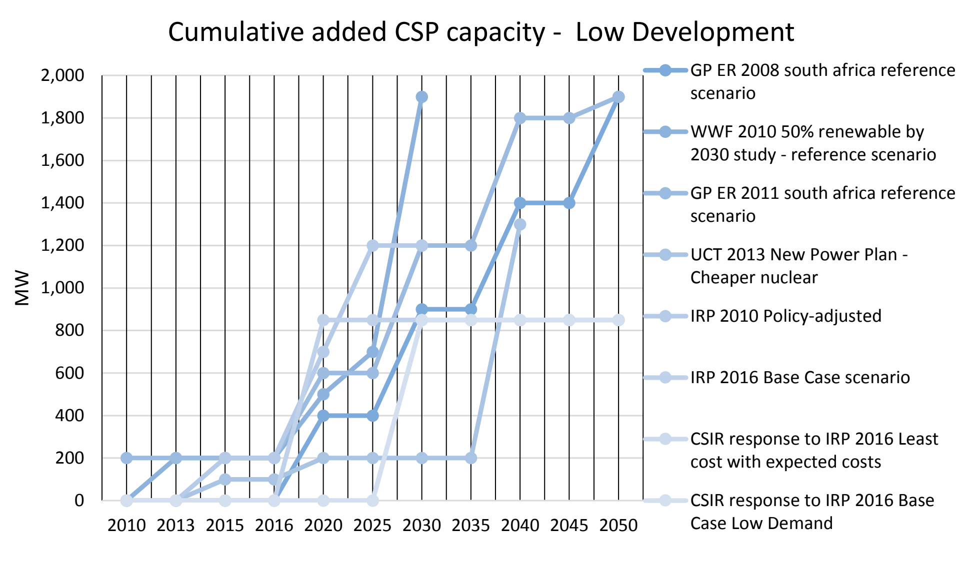
Results – Moderate development

- Highest, moderate CSP development case.
- Main driving force: aggressive CO_2 reductions.



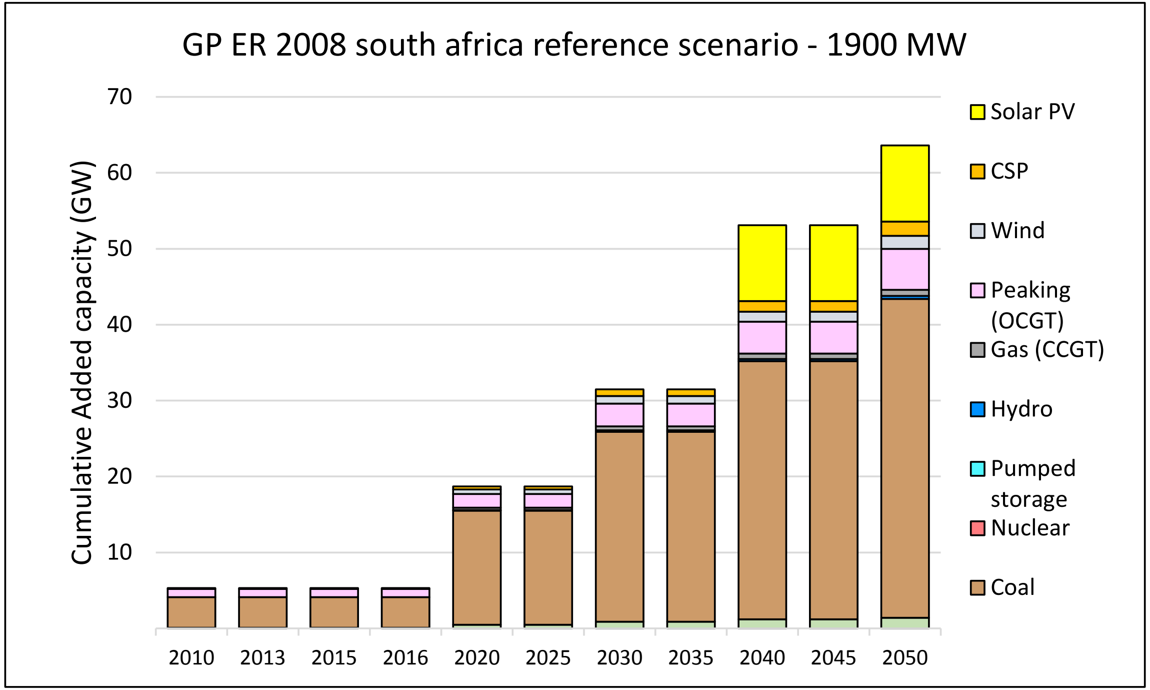
Results – Low development



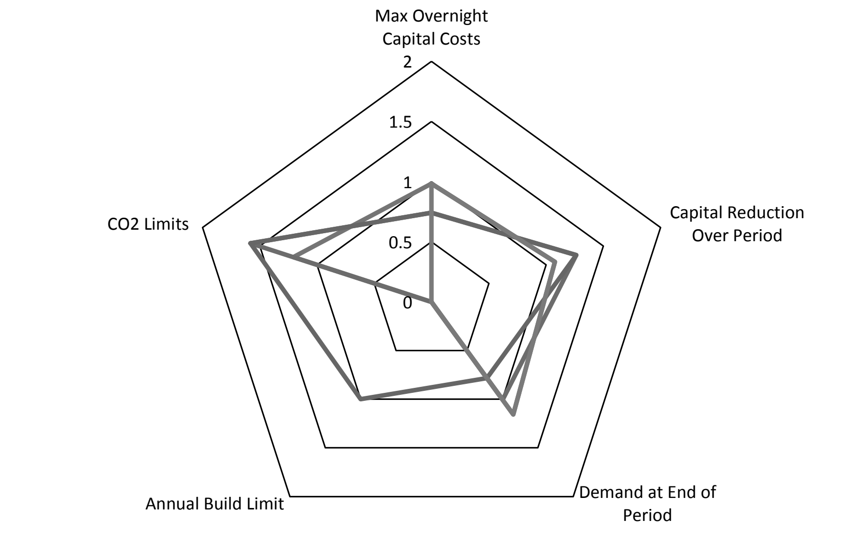


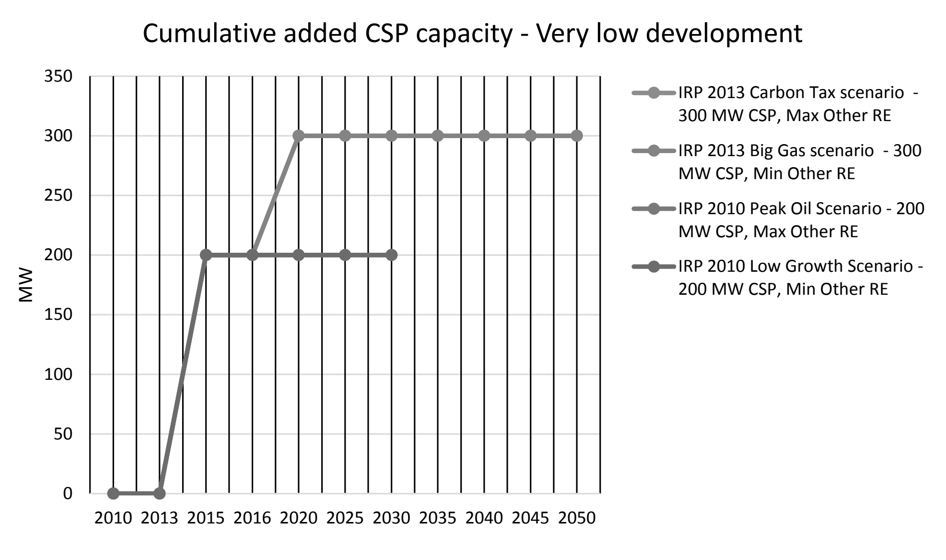
Results – Low development

- Highest, low CSP development case.
- Main preventing force: no CO2 limits.



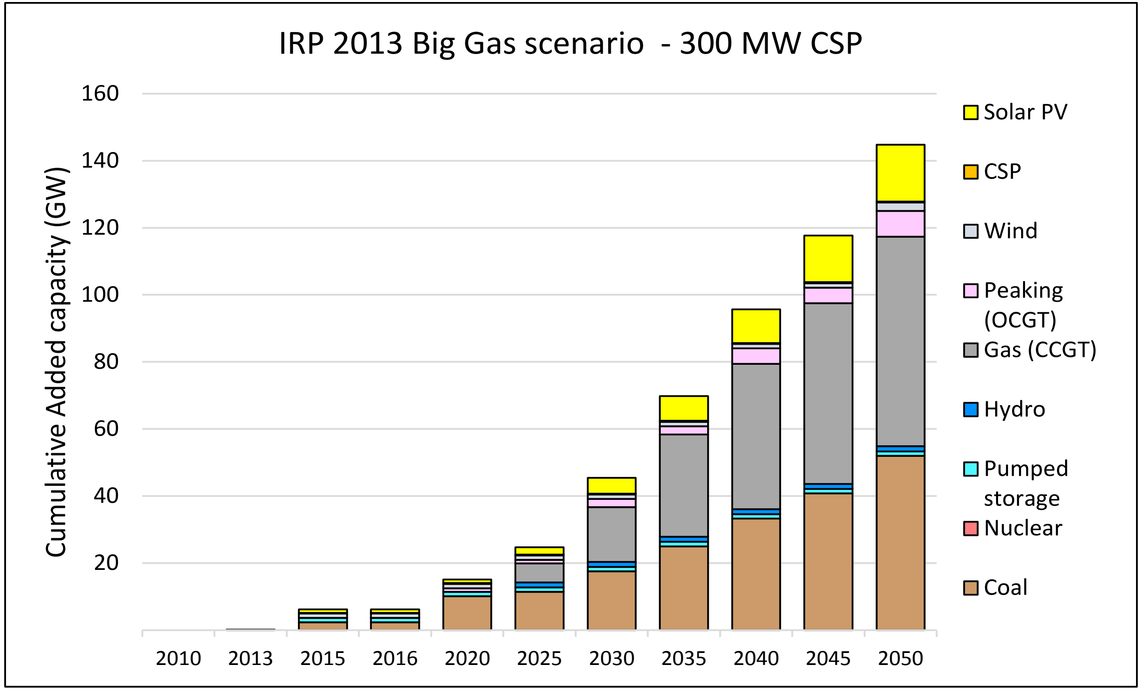
Results – Very low development





Results – Very low development

- Highest, very low CSP development case.
- Main preventing force: large shale gas development.



Conclusion

- For high CSP development:
  - Policies for CO2 reductions from GOVERNMENT.
  - Greater cost reductions from INDUSTRY through higher learning.
  - Aided through no build limits from GOVERNMENT, thereby aiding INDUSTRY learning.
  - Economic growth, leading to higher future demands, stimulated by both GOVERNMENT and INDUSTRY.

Conclusion

- Preventing CSP development:
  - Market uncertainty due to incorrect assumptions in regulatory planning models.
  - High costs and low learning.
  - New-build limits.
  - Non-emission centered planning.
  - Forcing other technologies with little/no scientific reason.

Thank you!

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