A climate, land-use, energy and water nexus assessment of Bolivia

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Energy poverty as a barrier to sustainable development

Electricity access drives development

- There is a strong international correlation between energy access (in kWh/year) and Human Development Index. The UN's Sustainable Development Goals (SDG7) highlight the importance of energy access.
- Bolivia already has 90% electricity access, which is higher than many developing countries. However, the total generating capacity is less than 2 GW, in a country of 11 million people.
- This results in a per capita energy use more than seven times lower than Sweden, which restricts access to modern technology, and limits commercial and industrial potential.

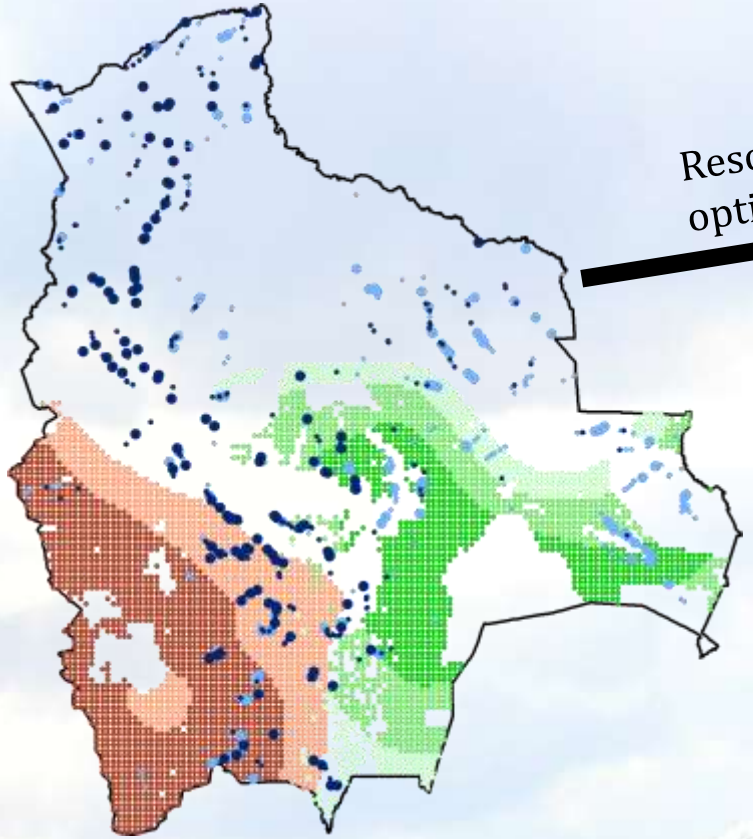
Ensure access to affordable, reliable, sustainable and modern energy for all

Take urgent action to combat climate change and its impacts*

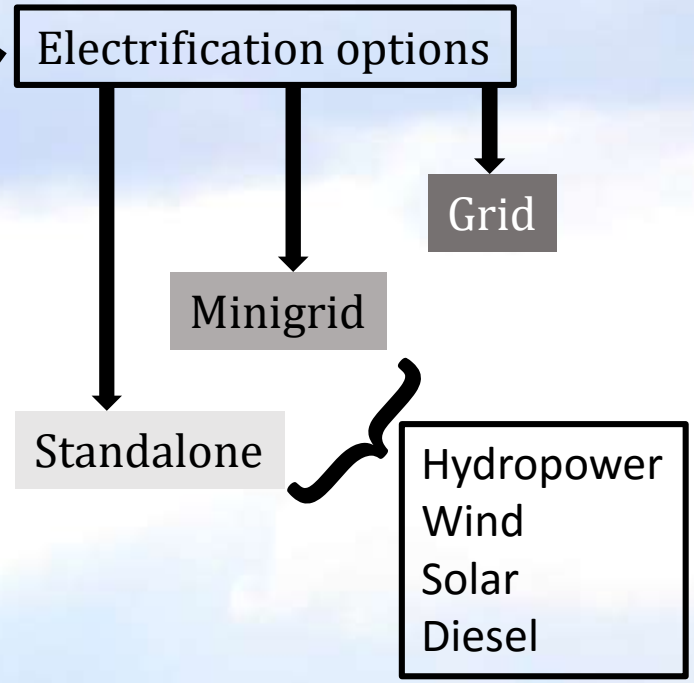
Minimise emissions - maximise resilience

- Bolivia has made strong Intended Nationally Determined Contributions (INDC), which will require careful management of future emissions, especially as it is a country rich in natural gas. SDG13 highlights the importance of climate change.
- Climate projections suggest reduced rainfall and longer dry seasons. This will be compounded by shrinking glaciers, which currently provide water in the dry season.
- This stress on the water system will increase the competition for water between hydropower, agriculture, biofuels and other demands. This will require careful management to ensure Bolivia can reach its targets of universal electricity access and increased electricity production.

Optimal strategies for electricity access and energy resilience



Resources and population density determine optimum electrification option



Spatial resource availability

The **map on the left** shows Bolivia's resources for solar (red), wind (green) and hydropower (blue). Not shown are the variations in diesel price (due to travel times from cities) and the existing extent of the grid.

Optimising investments in energy

- Modelled using OSeMOSYS to find a cost-minimised solution.
- The model included the complete electrical system, from generation to final demand categories.
- It includes greenhouse gas restrictions to model the cost of different emissions targets.

Integrating the hydrological system

- Water model covers 40% of Bolivia's land area
- Includes geospatial layers to accurately model precipitation, runoff and agriculture.
- Climate change impacts on temperature and precipitation are included.

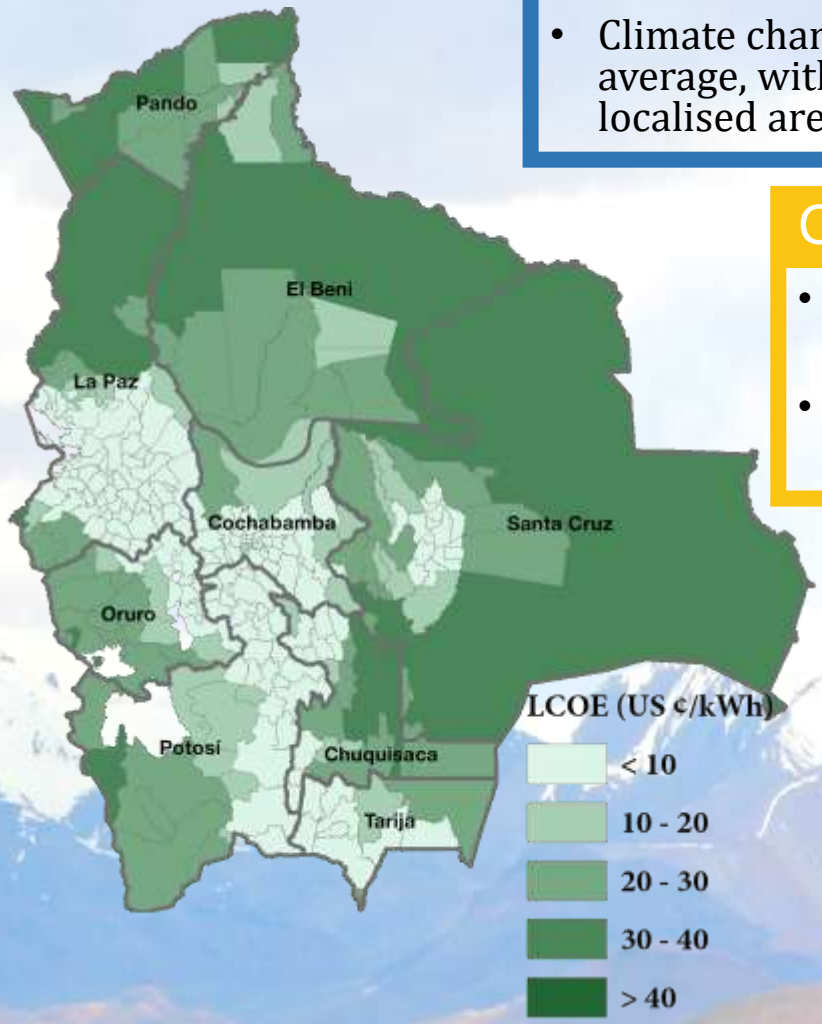
Critical pressure points in the solution to energy poverty

Water competition between sectors

- Water demand from irrigation an order of magnitude higher than municipal and thermal power. Thus this is the focus for future work.
- Climate change expected to decrease hydropower capacity factors 1-3% on average, with bigger impacts in the dry season, and bigger impacts in specific, localised areas.

Climate change mitigation in the energy system

- The investments and running costs of the energy system must be increased by 30% to reduce emissions to the INDC targets.
- Climate change impacts result in average 12% higher costs for users, which has a big impact in areas with more expensive electricity.



Solving the problem of energy poverty

- The **map on the left** shows the variation in cost of electricity. It is cheapest in the central-west area where the population density is highest and grid infrastructure exists. Further away, more expensive solutions like diesel and solar PV are required.
- There is a near inverse relationship between this result and Bolivia's incidence of poverty, so the poorer areas can benefit from the cheaper electricity.
- These results can be used to guide investments in the overall energy system to minimise cost and emissions, and to target areas where subsidies and investments to achieve universal electricity access.