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# Rebalancing Regional and Remote Australia

## A vision for a global carbon sink while creating sustainable communities

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### Supplementary Material

**Figure S1** shows a pictorial representation for the vision of the **Rebalancing Regional and Remote Australia** plan as captured by the change in Australian landscape over a nominal period of 100 years.

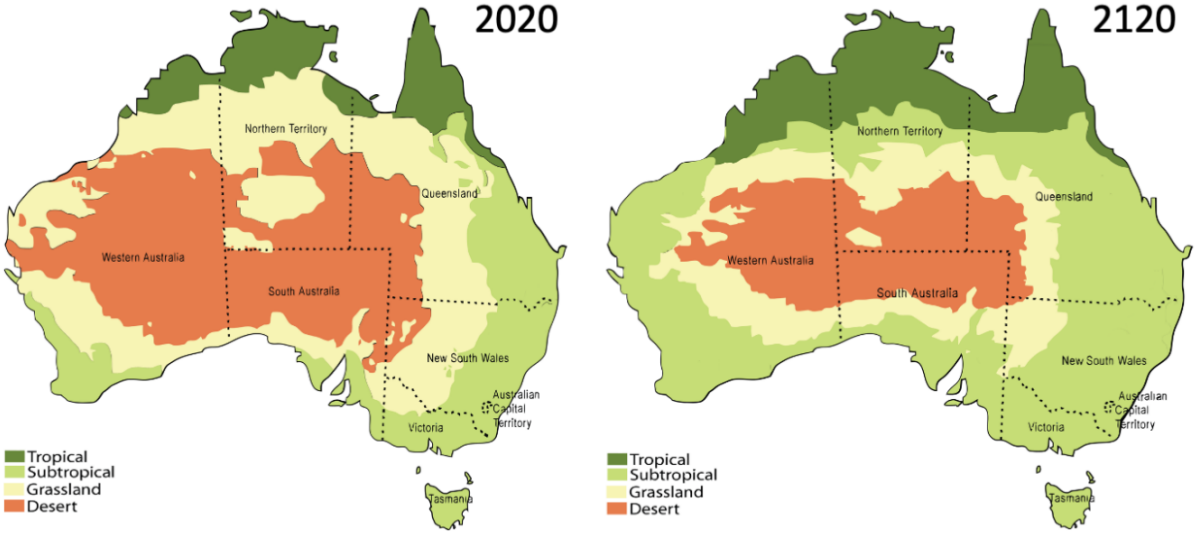


**Figure S1:** Vision for the **Rebalanced Regional and Remote Australia** plan, depicting the transformation of the Australian landscape over a '100 year' timeframe. Left: '2020' current situation; right: target '2120' vision. Dark green: fertile tropical area. Light green: fertile sub-tropical and temperate areas, including rebalanced land, from semi-arid/arid to fertile. Yellowish: grassland/marginal areas. Orange: desert. It is assumed that around 45% of the current agricultural marginal areas can be regenerated into fertile land, and around 10% of desert into grassland.

**Table S1** outlines the foundational assumptions for constructing the budget of the pilot project summarised in **Table 1**. These include:

i) Energy and water requirements are based on current overall national consumption, thereby providing a scalable and adaptable framework for the project's resource demands. This approach, however, may lead to an overestimation of future demands (i.e., conservative estimates) due to potential improvements in efficiencies.

ii) The energy mix transition aims for a future configuration of 70% solar PV and 30% wind power. This target mix considers that the current renewable energy contribution to the primary energy consumption is less than 10% and is chosen to optimize sustainability alongside energy reliability and security.

iii) The water supply strategy envisages 85% of water to be sourced from desalination processes, complemented by 15% from conventional sources such as rivers and groundwater. This distribution represents a balanced approach to resource utilization, emphasizing both innovation in water sourcing and the preservation of natural water cycles. This is particularly relevant given the project's extensive use of water for natural climate solutions.

iv) The majority of the land allocation within the project scope comprises 70% forests and 30% grasslands. This distribution is strategically designed to enhance carbon sequestration capabilities and to foster biodiversity through natural climate solutions.

It is critical to note that these estimates are conservatively calculated to ensure a robust foundation for the initiative. They are intended as initial guidelines, with the anticipation that more detailed feasibility studies will refine these figures, particularly in response to specific local conditions and evolving technological landscapes.

Although the potential implications and risks associated with these activities have been considered, a comprehensive risk register table is beyond the scope of this perspective paper and will be included in a subsequent feasibility study. A comprehensive life cycle assessment (LCA) will also be conducted, including the decommissioning of solar panels and end-of-life technologies. While we have not accounted for all engineered approaches to carbon dioxide removal, such as carbon capture, use, and storage as mentioned in the Climate Change Authority (CCA, 2023) report, these approaches are not necessarily inconsistent with our strategy. Moreover, the role of recently established agencies or initiatives will be accounted for in the planning phase. For instance, the newly established Australian Net Zero Authority (May 2024), which focuses on reskilling jobs from fossil fuels to renewables, will be considered in the implementation phase.

## Reference

Climate Change Authority (CCA) 2023 Reduce, remove and store: The role of carbon sequestration in accelerating Australia's decarbonisation Available at: https://www.climatechangeauthority.gov.au/sites/default/files/2023-04/Sequestration%20Insights%20Paper%20-%20Publication%20Report.pdf

**Table S1**: Main assumptions used for the **Rebalancing Regional and Remote Australia** budget shown in **Table 1**. Water use and energy use are based on current national overall use divided by the total population.

| | **Fixed** | **Annual** |
|---|---|---|
| **GENERAL** | | |
| Population density for pilot | 250 people/km$^2$ | |
| Fraction of water produced by desal | 85% | |
| Fraction of other water supplies (rivers, aquifers, storage) | 15% | |
| Fraction of energy generated by solar PV power | 70% | |
| Fraction of energy generated by wind power | 30% | |
| Area for natural climate solutions | 10000 km$^2$ | |
| of which, Forest | 70% | |
| Grassland | 30% | |
| **WATER** | | |
| Water use (total consumption, person) | | 730000 L/person |
| Water use (afforestation) | | 100 ML/km$^2$ |
| Water use (grassland) | | 250 ML/km$^2$ |
| Average precipitation (grassland areas) | | 0.45 m |
| Water efficiency | 30% | |
| Desalination: CAPEX/OPEX | 1.5 A$/kL | 0.5 A$/kL |
| Water storage: CAPEX/OPEX | 3 A$/kL | 0.9 A$/kL |
| Pipeline | | |
| Pipeline cost | 1000 A$/m | |
| Pipeline length | 200 km | |
| Water for Food | | 500 ML/km$^2$ |
| **ENERGY** | | |
| Energy use (total supply, person) | | 64 MWh/person |
| Solar PV Power (utility-scale) | | |
| CAPEX/OPEX | 0.7 A$/W | 1.5% of CAPEX |
| Capacity factor | 0.25 | |
| Wind Power | | |
| CAPEX/OPEX | 2 A$/W | 3.5% of CAPEX |
| Capacity factor | 0.3 | |
| Transmission lines | | |
| Transmission lines cost | 2000 A$/m | |
| Transmission lines length | 500 km | |
| Power for desalination | 4.5 kWh/m$^3$ | |
| Electrical storage (batteries) | | |
| Cost of batteries: CAPEX/OPEX | 0.15 A$/Wh | 2.5% of CAPEX |
| Duration of storage | 6h | |
| Share of storage of annual generation | 20% | |
| **FOOD** | | |
| Land Acquisition Costs | 150000 A$/km$^2$ | |
| Fertilizers | | |
| Amount | | 20000 kg/km$^2$ |
| Cost | | 500000 A$/kg |
| Seeds | | |

| | | |
|---|---|---|
| Amount | | 400 kg/km$^2$ |
| Cost | | 40 A$/kg |
| Machinery: CAPEX/OPEX | 30 million A$ | 3 million A$ |
| Labour Requirements and Costs | | |
| Labour | 1.5 person/km$^2$ | |
| Cost | | 30 A$/hr |
| Storage Costs | | 50 million A$ |
| Distribution and Retail Costs | | 50 million A$ |
| **INFRASTRUCTURE** | | |
| Land Acquisition Costs | 200000 A$/km$^2$ | |
| Construction Costs | | |
| Residential: CAPEX/OPEX | 1000 A$/m$^2$ | 150 million A$ |
| Office: CAPEX/OPEX | 1500 A$/m$^2$ | 125 million A$ |
| Amenities and Services: CAPEX/OPEX | 2000 A$/m$^2$ | 100 million A$ |
| Roads and Transportation Infrastructure | | |
| CAPEX/OPEX | 1 million A$/km | 125 million A$ |
| Water and Sewerage System Costs | 12500 A$/person | |
| **NATURAL CLIMATE SOLUTIONS** | | |
| Reforestation and Afforestation | | |
| Number of trees per unit area | 50000 trees/km$^2$ | |
| CAPEX/OPEX | 200000 A$/km$^2$ | 15000 A$/km$^2$ |
| Conversions to tCO2 | | |
| Cost | 400 A$/t$CO_2$eq | |
| Water demand | 400000 L/t$CO_2$eq | |
| Land demand efficiency | 2000 km$^2$/t$CO_2$eq | |
| Grassland | | |
| CAPEX/OPEX | 40000 A$/km$^2$ | 4000 A$/km$^2$ |
| **GREENHOUSE GASES** | | |
| Energy emissions | | |
| Coal (34% of 2022 energy mix) | 1000 g$CO_2$eq/kWh | |
| Oil (32% of 2022 energy mix) | 840 g$CO_2$eq/kWh | |
| Gas (26% of 2022 energy mix) | 480 g$CO_2$eq/kWh | |
| RE mix (8% of 2022 energy mix) | 40 g$CO_2$eq/kWh | |
| Sequestration | | |
| Forests | | 2500 g$CO_2$eq/m$^2$ |
| Grassland | | 200 g$CO_2$eq/m$^2$ |
| Carbon Price | 20 A$/t$CO_2$eq | |
| **INCOME** | | |
| Average Household Income | | 80000 A$ |
| Disposable Income | 75% | |
| Average Household | 2.6 people | |
| Tax Revenue | 30% | |
| Amount spent by households as % of disposable income | 85% | |
| **SPACE** | | |
| Water storage | 1 km$^3$/GL | |
| reservoir depth | 5 m | |

| | |
|---|---|
| Desalination Plant | 0.2 $km^2$/GL/day |
| Solar PV power Farm | 0.01 $km^2$/MW |
| Wind Power Farm | 0.0005 $km^2$/MW |
| Gas Power Plant | 0.001 $km^2$/MW |
| Food | 1000 $m^2$/person |
| Land city pilot | 400 $km^2$ |
| Residential space | 35 $m^2$/person |
| Office Space | 10 $m^2$/person |
| Amenities and Services | 15 $m^2$/person |
| Land for recreation | 25 $m^2$/person |
| Road network | 1.5 km/$km^2$ |