

THE RENEWABLE SUPERPOWER WORKFORCE

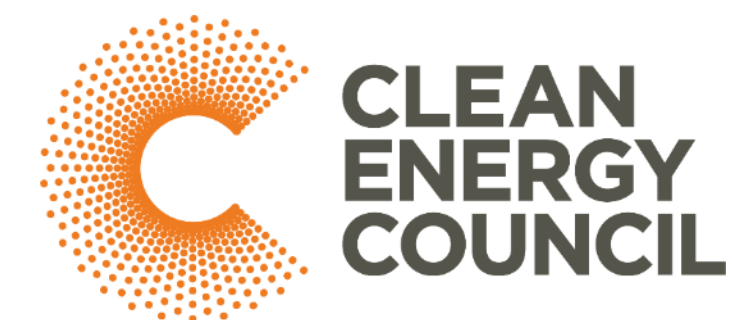
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August 2023

KEY FINDINGS FOR THE AMMONIA INDUSTRY

1. Domestic transition to net zero requires a substantial increase in the size and scale of the clean energy workforce; a superpower transition would be immense.
2. Ammonia is a constituent but comparatively small segment of the transition.
3. Most clean energy jobs will be in regional Australia.



ABOUT THE NET ZERO AUSTRALIA STUDY

The Net Zero Australia project (NZAu) is analysing net zero pathways for both our domestic and export emissions.

Is a partnership between the University of Melbourne, the University of Queensland, Princeton University and management consultancy Nous Group.

The study is rigorous and granular, science-based and evidence-driven, technology-neutral and non-political.



NZAu modelled six scenarios

Demand drivers

REF

Reference

- Projects historical trends, does not model cost impacts of fossil fuel supply constraints
- No new greenhouse gas emission constraints imposed domestically *or* on exports
- Policy settings frozen from 2020 onwards

E+

Rapid electrification

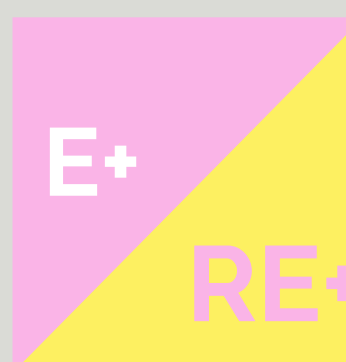
- Nearly full electrification of transport and buildings by 2050
- No limit on renewable rollout
- Lower cap on underground carbon storage

E-

Slower electrification

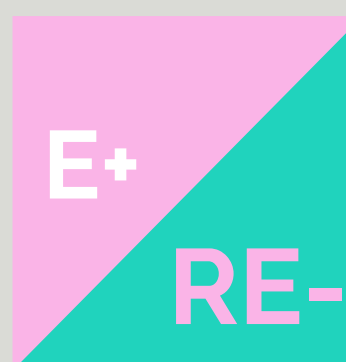
- Slower electrification of transport and buildings compared to E+
- No limit on renewable rollout rate
- Lower cap on underground carbon storage rate

Supply drivers



Full renewables rollout

- No fossil fuel use by 2050
- No limit on renewable rollout rate
- Lower cap on underground carbon storage rate, which is only used for non-fossil fuel sources (e.g. cement production)



Constrained renewables rollout

- Renewable deployment rate limited to several times historical levels (to examine supply chain and social license constraints)
- Much higher cap on underground carbon storage (to make net zero achievable)



Onshoring

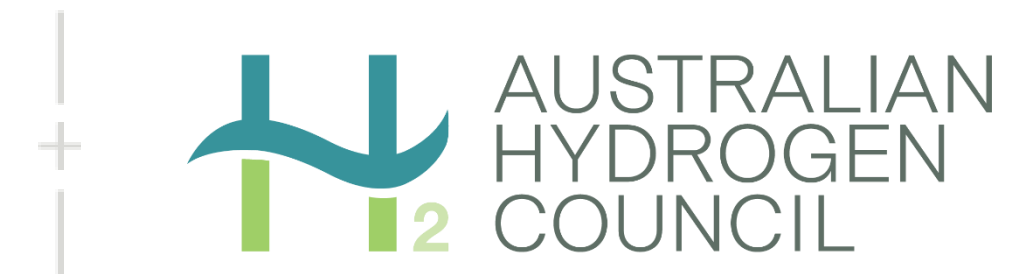
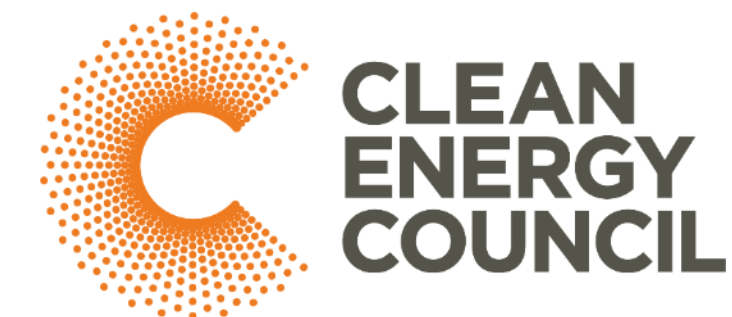
- Local production of iron and aluminum using clean energy
- Progressively displaces exports of iron ore, bauxite, alumina and fossil fuels

The Reference Scenario has *no emissions objective*. All other Scenarios are 'net zero' for both the domestic and exported emissions separately, and start from current emissions, and track in a line to net zero emissions by 2050 (domestic) and 2060 (export). None of the scenarios are forecasts.

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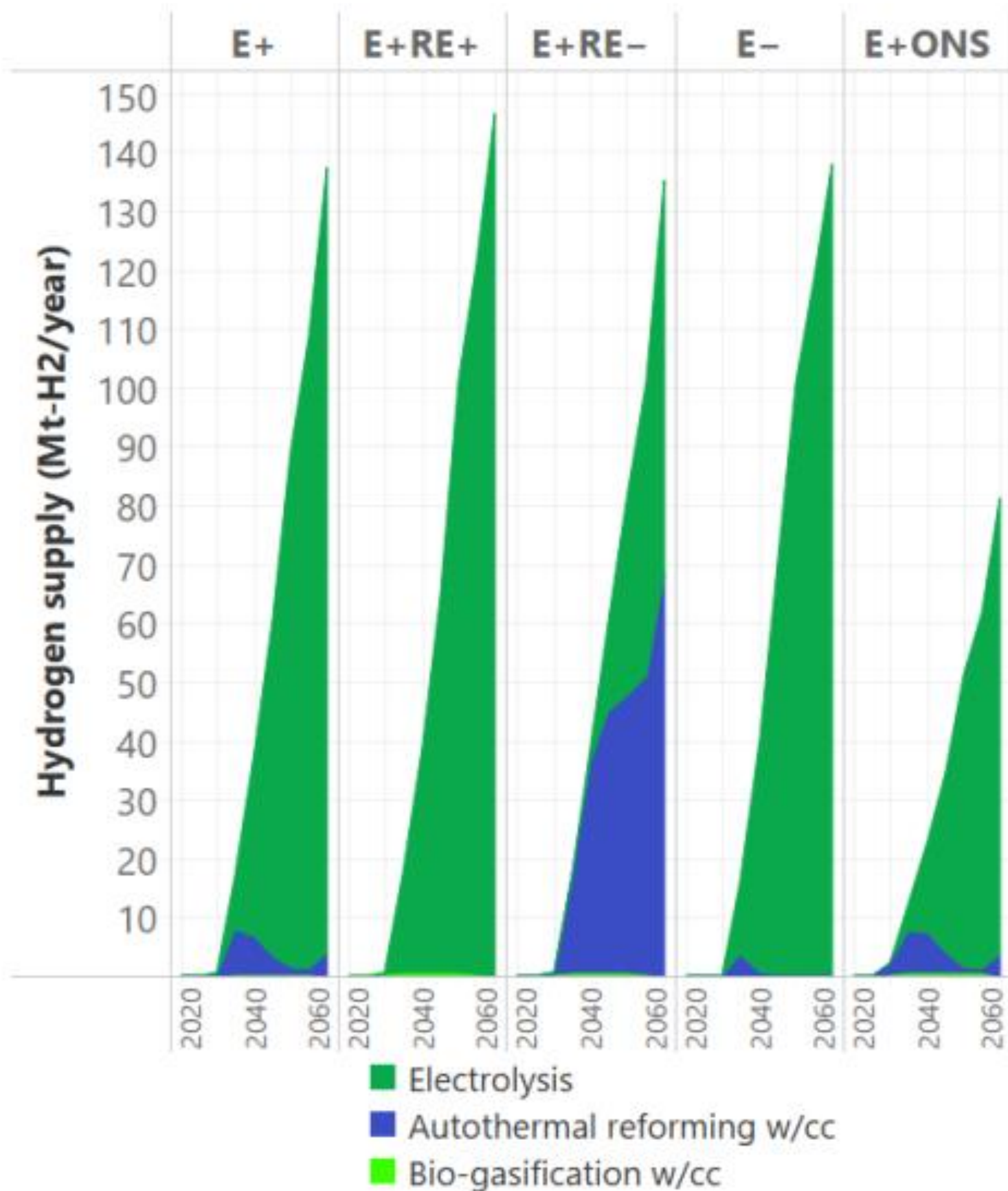
Technology/resource	M	C&I	P	O&M	D
Aluminium production (onshored)		✓	✓		
Autothermal reforming	✓	✓		✓	
Batteries	✓	✓		✓	
Biofuels	✓	✓		✓	
Biomass	✓	✓	✓	✓	✓
CO ₂ storage				✓	
CO ₂ transmission		✓		✓	
Coal	✓	✓	✓	✓	✓
Direct air capture	✓	✓		✓	
Electricity distribution		✓		✓	
Electricity export		✓		✓	
Electricity transmission		✓		✓	
Electrolysis	✓	✓		✓	
Fischer-Tropsch	✓	✓		✓	
Haber-Bosch	✓	✓		✓	
Hydroelectricity	✓	✓		✓	
Hydrogen storage		✓			
Hydrogen transmission		✓		✓	
Iron DRI (onshored)		✓	✓		
LNG	✓	✓		✓	
Methanation		✓		✓	
Natural gas	✓	✓	✓	✓	✓
Natural gas transmission		✓		✓	
Offshore wind	✓	✓		✓	✓
Oil refinery	✓	✓		✓	
Onshore wind	✓	✓		✓	✓
PHES	✓	✓		✓	
Rooftop solar PV	✓	✓		✓	
SMR	✓	✓		✓	
Utility solar PV	✓	✓		✓	✓

- Large coverage across broad range of technologies.
- Lifecycle stages are modelled for each technology and resource based on suitability, substitutability, and the availability of suitable employment factor.
- Emerging technologies less reliably modelled.

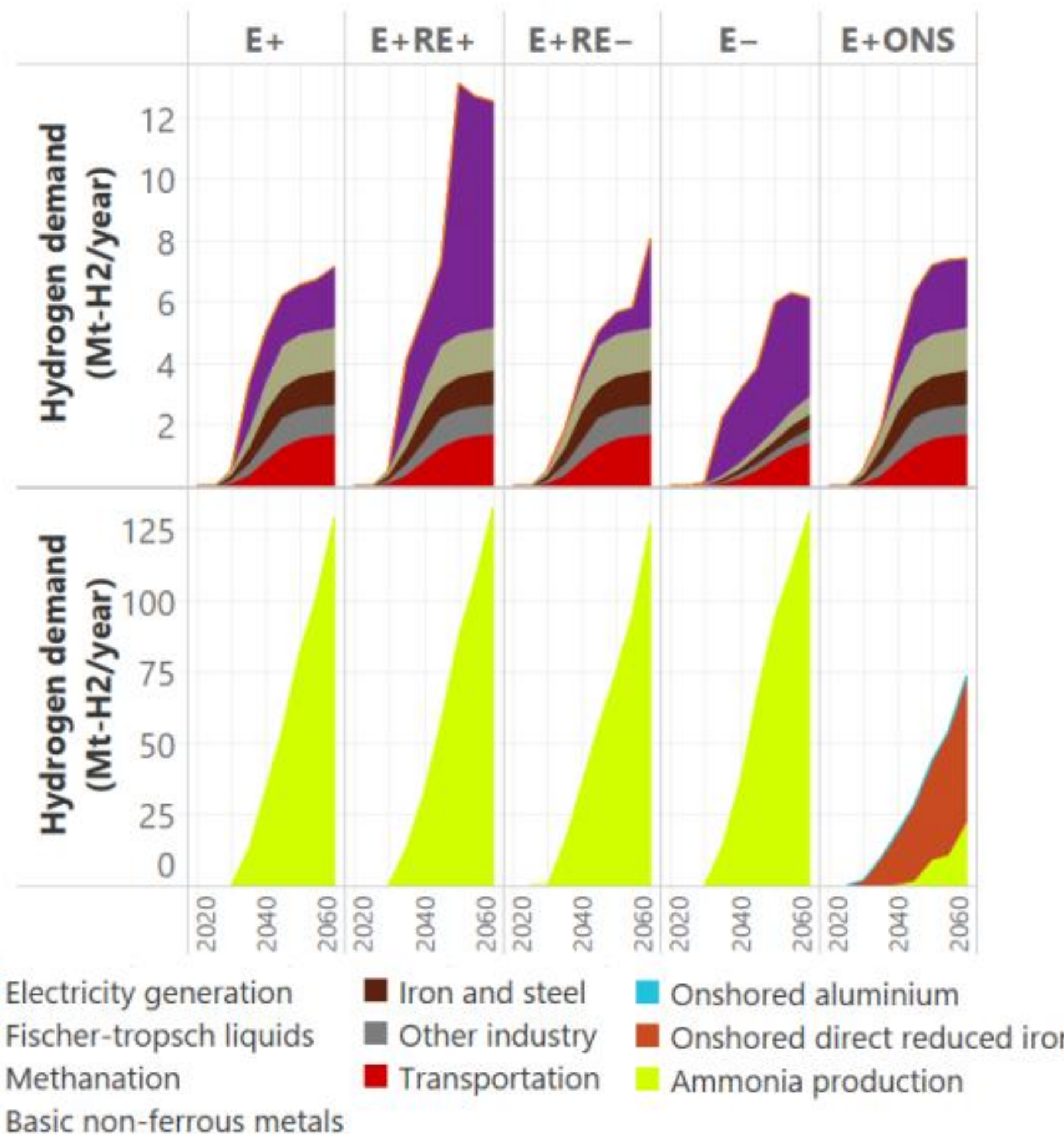


Projected hydrogen supply and demand

Projected hydrogen supply, by technology (Mt-H₂/year)

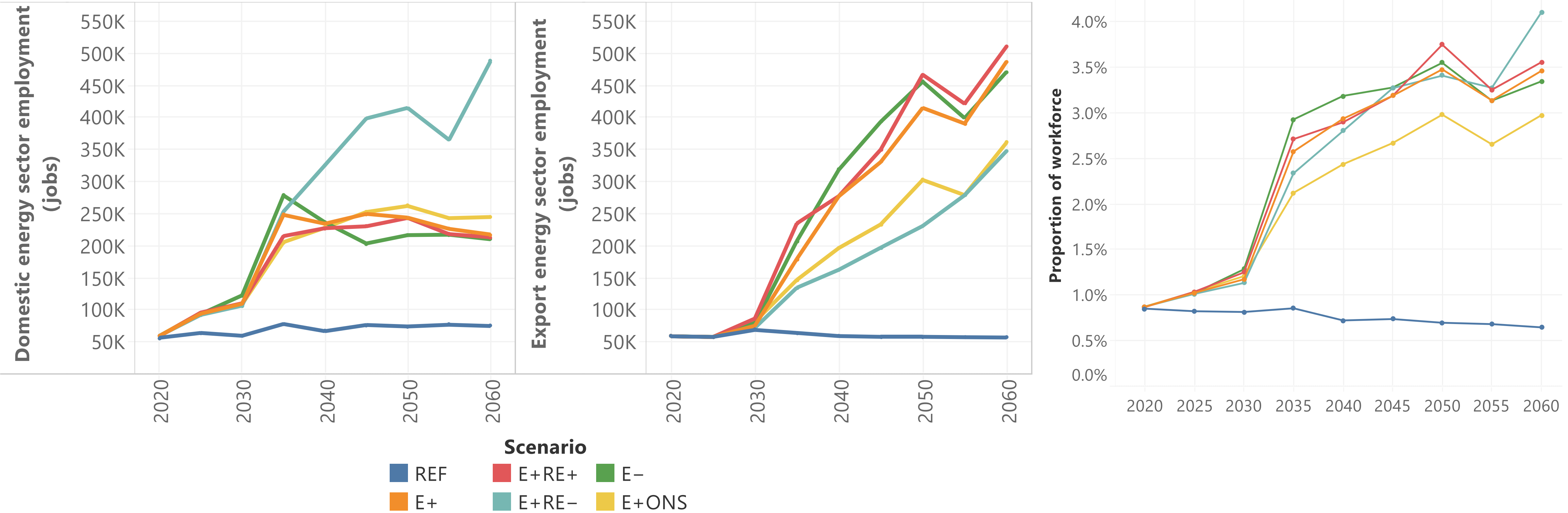


Projected hydrogen use, by sector/technology (Mt-H₂/year). Note 10× difference in y-axis scale



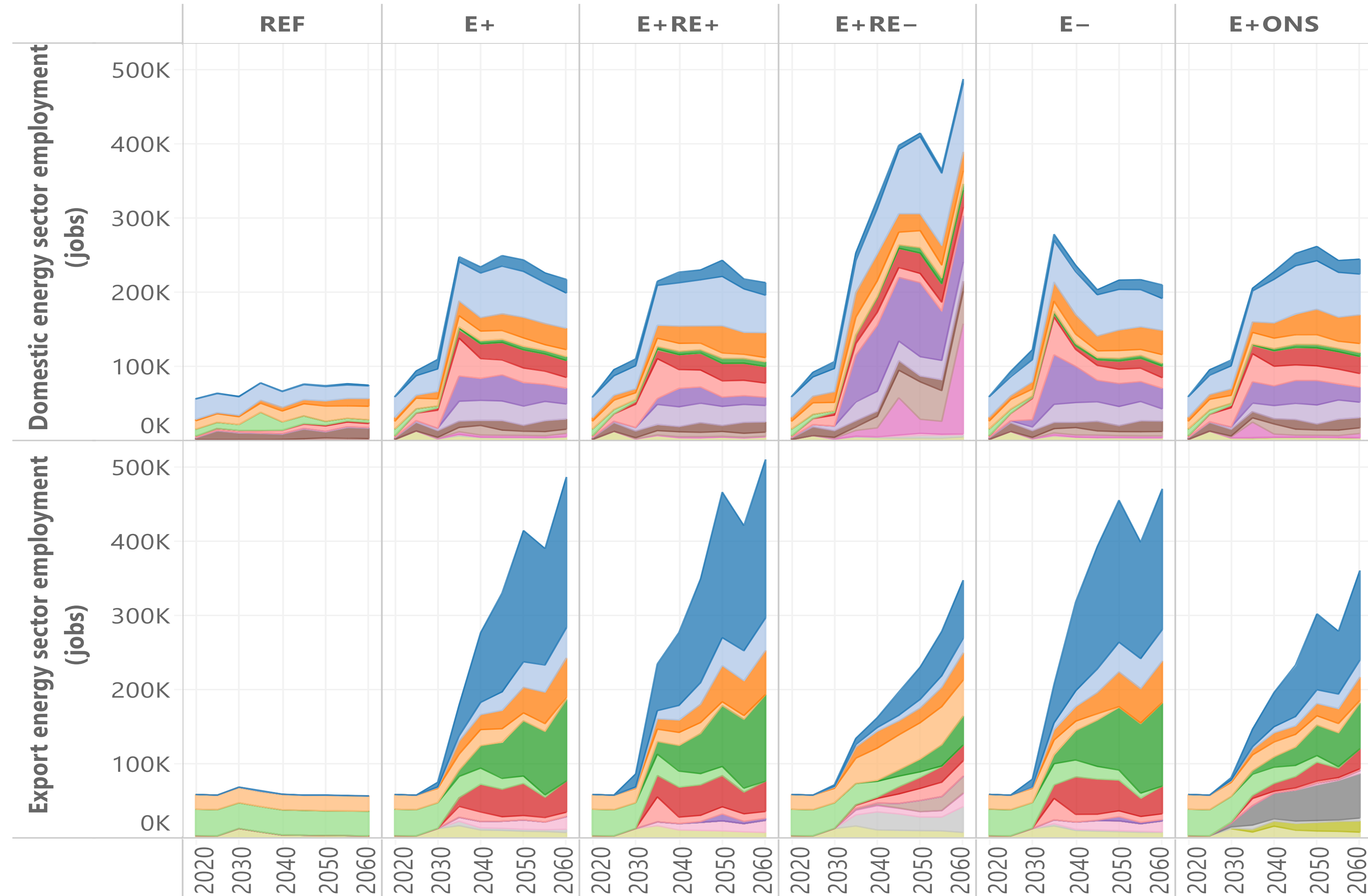
Energy export demand is held constant at 15 EJ/year – about 3× 2050 domestic demand.

The energy sector experiences large job growth



Gross jobs by domestic (left) and export (centre) sectors and Scenario. Values have units of full-time equivalent jobs. Proportion of projected workforce occupied by the energy sector in each Scenario (right).

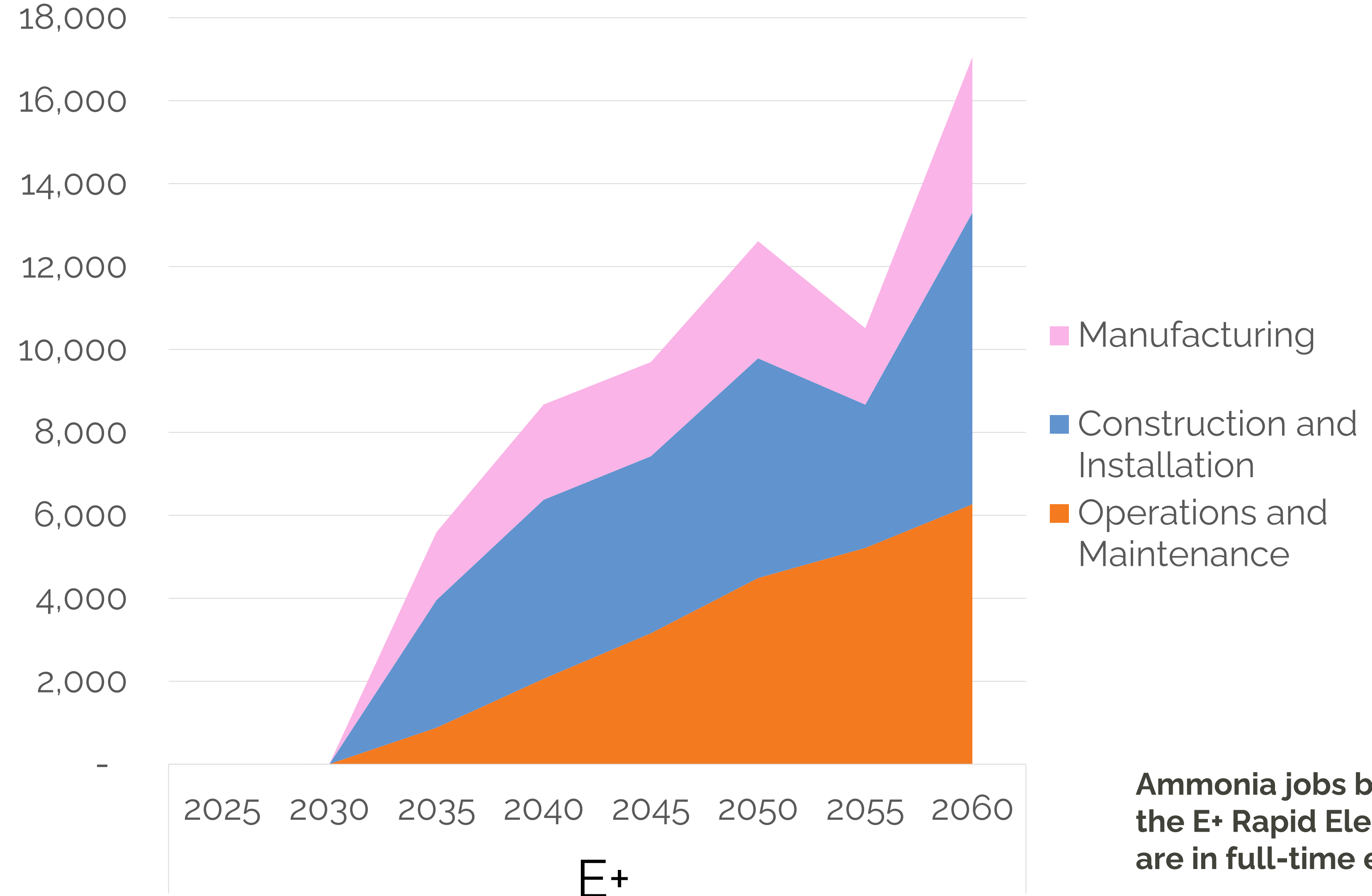
With variable distribution across technologies and sectors



- Technology / resource**
- Utility solar PV
 - Electricity trans. & dist.
 - Batteries
 - Natural gas & transmission
 - Electrolysis
 - Coal
 - Hydrogen storage & trans.
 - Onshore wind
 - Direct air capture
 - Biomass
 - Rooftop solar PV
 - Offshore wind
 - CO2 storage & trans.
 - Haber-bosch
 - Direct reduced iron
 - Autothermal reforming
 - Aluminium production
 - Other

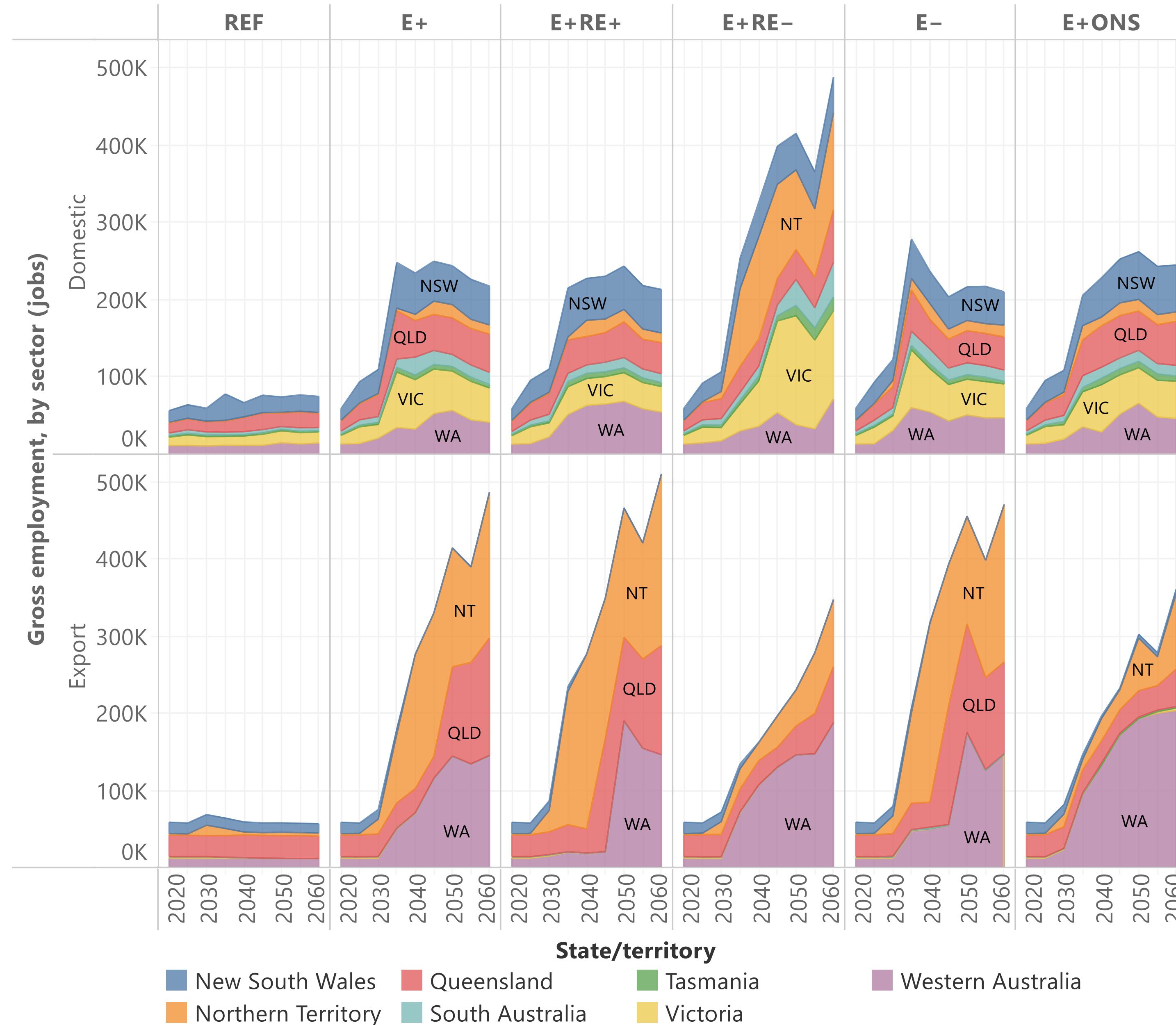
Gross jobs by Scenario and domestic (above) and export (below) sectors, for each modelled technology/resource. Results are in full-time equivalent jobs. Technologies with low individual employment have been aggregated as 'Other'.

Ammonia jobs by lifecycle stage over time

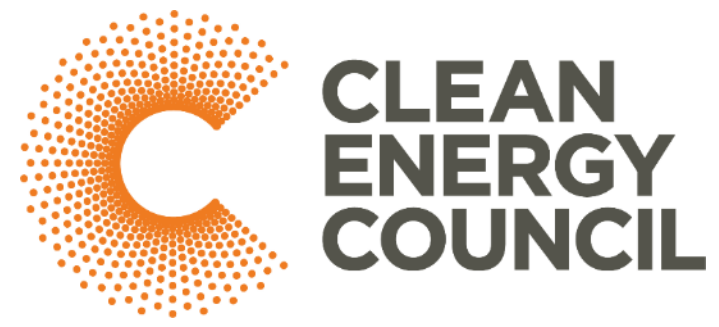


Ammonia jobs by lifecycle stage over time for the E+ Rapid Electrification Scenario. Results are in full-time equivalent jobs.

Export jobs are concentrated on sunbelt states



Gross jobs by sector and state/territory to 2060. We note that NSW here includes the ACT.



THANK YOU

 [cleannrgcouncil](https://twitter.com/cleannrgcouncil)

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