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solutions that transform

Role of Bioenergy in Net-Zero Energy Systems: Meta-Analysis of U.S. Economy-Wide Studies

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TC Biomass Conference | September 2024

Meta NZ Study

5
independent, economy-wide studies

Meta-Analysis of Leading U.S. Economy-Wide, Net-Zero Studies

1. Low Carbon Resources Initiative (*EPRI, GTI Energy*)
2. Open Energy Outlook (*Carnegie Mellon University, NC State*)
3. Evolved Energy Research
4. Princeton University
5. Decarb America (*Bipartisan Policy Center, Clean Air Task Force, Third Way*)

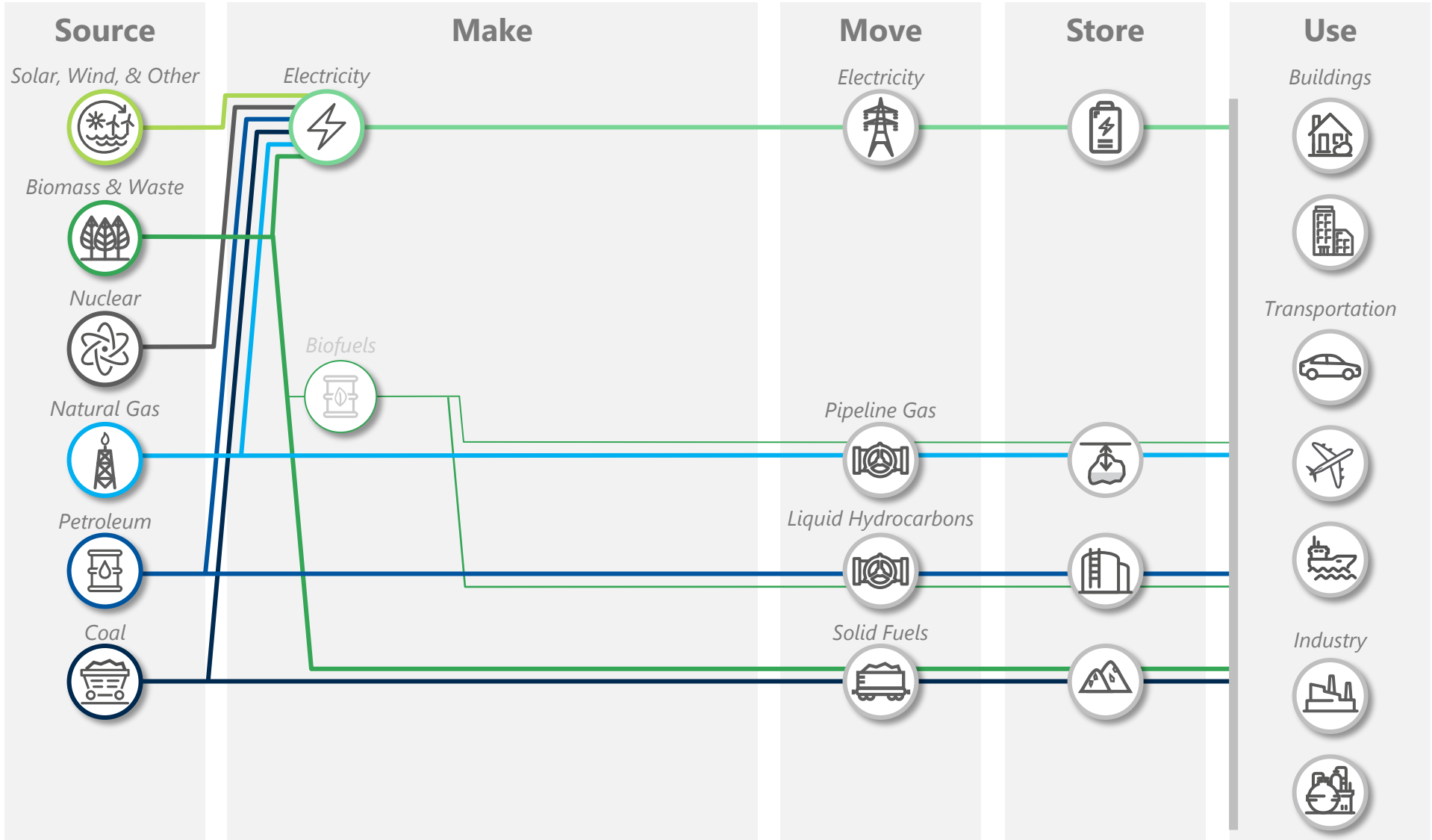
23
scenarios for least cost paths to net-zero

All scenarios achieve net-zero by leveraging:

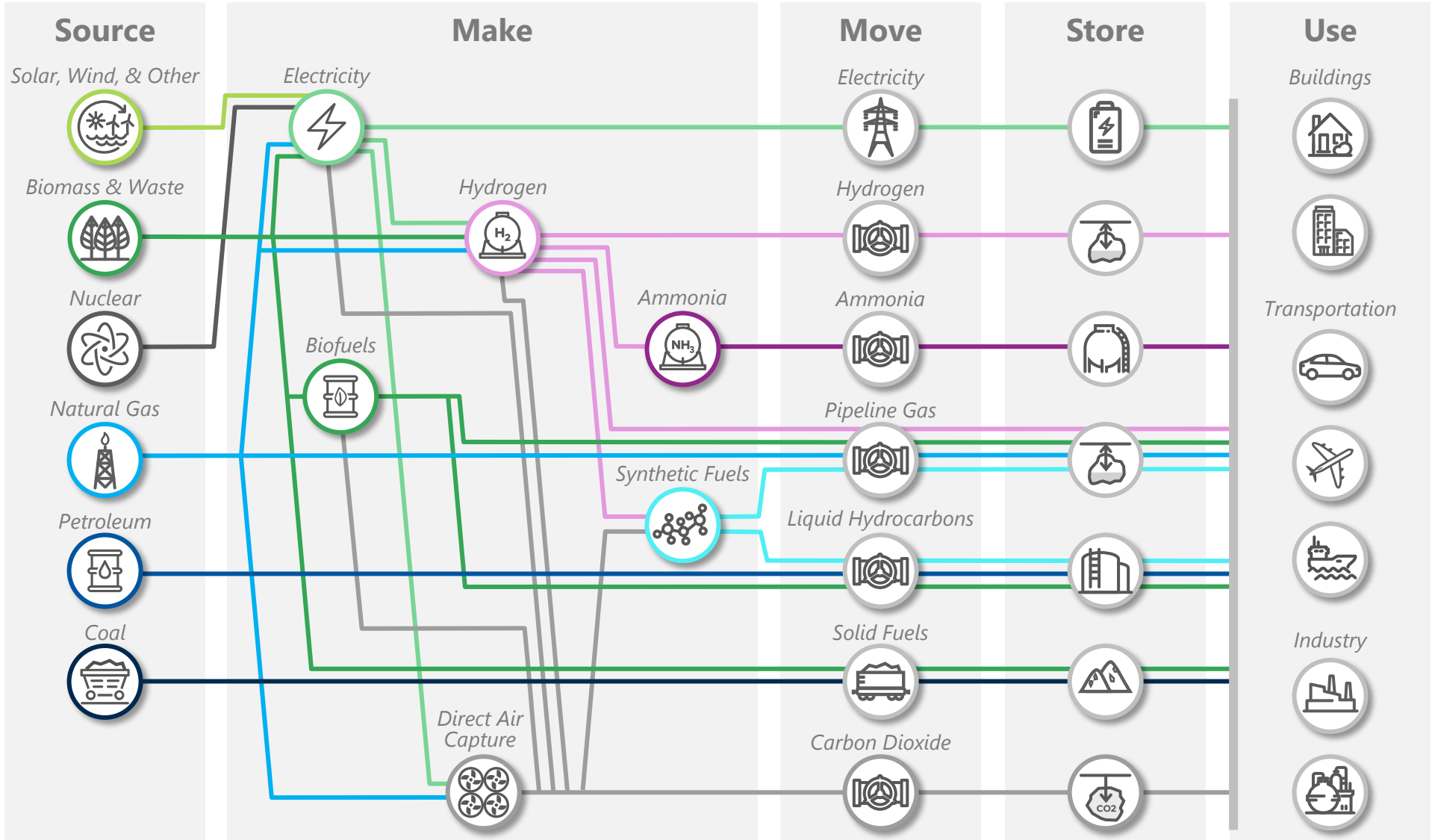
- Variety in electricity
- Variety in fuels
- Carbon management
- Efficiency

full report available at: gti.energy/meta-nz/

Today's Energy Systems

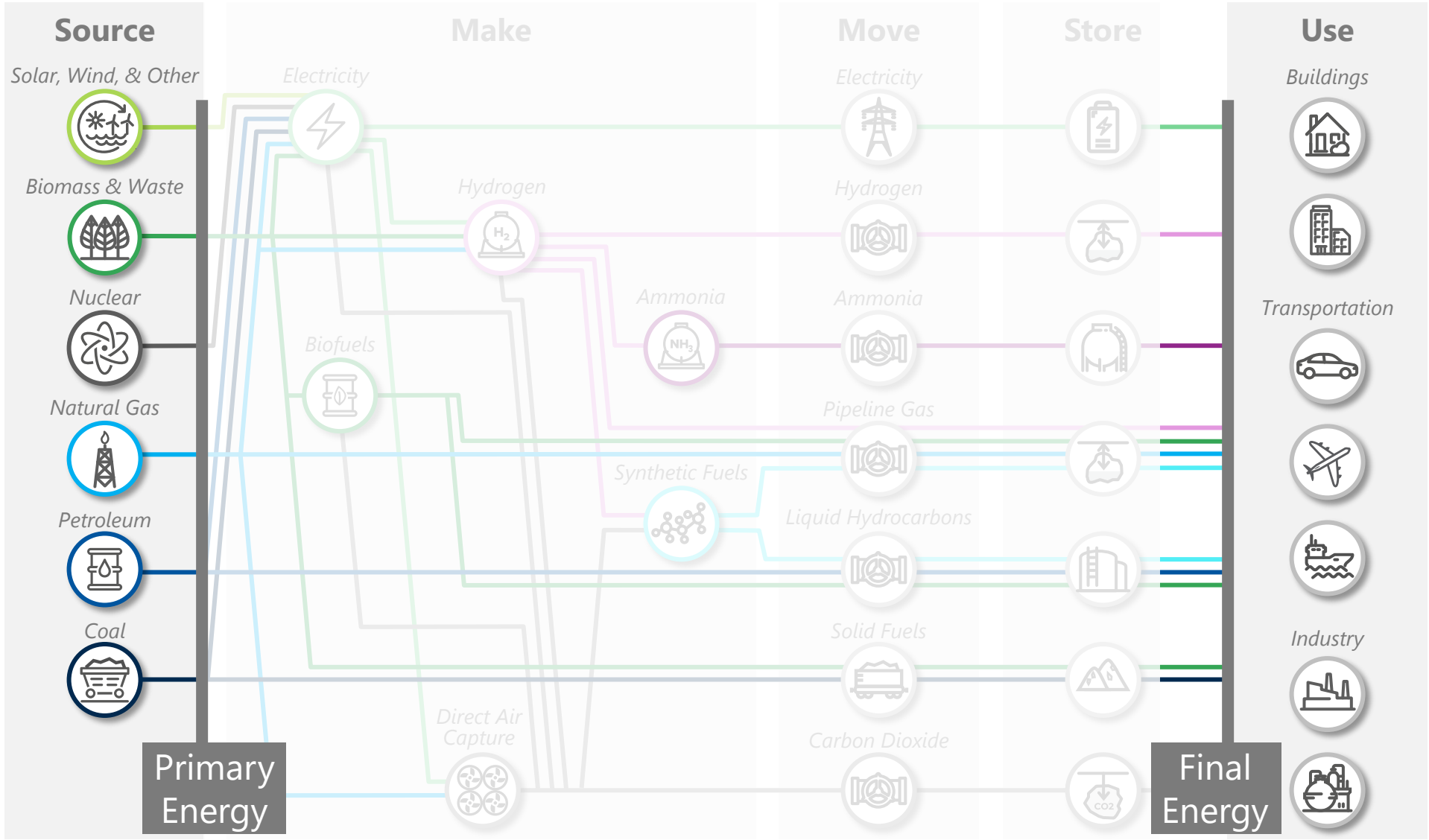


Net-Zero Energy Systems

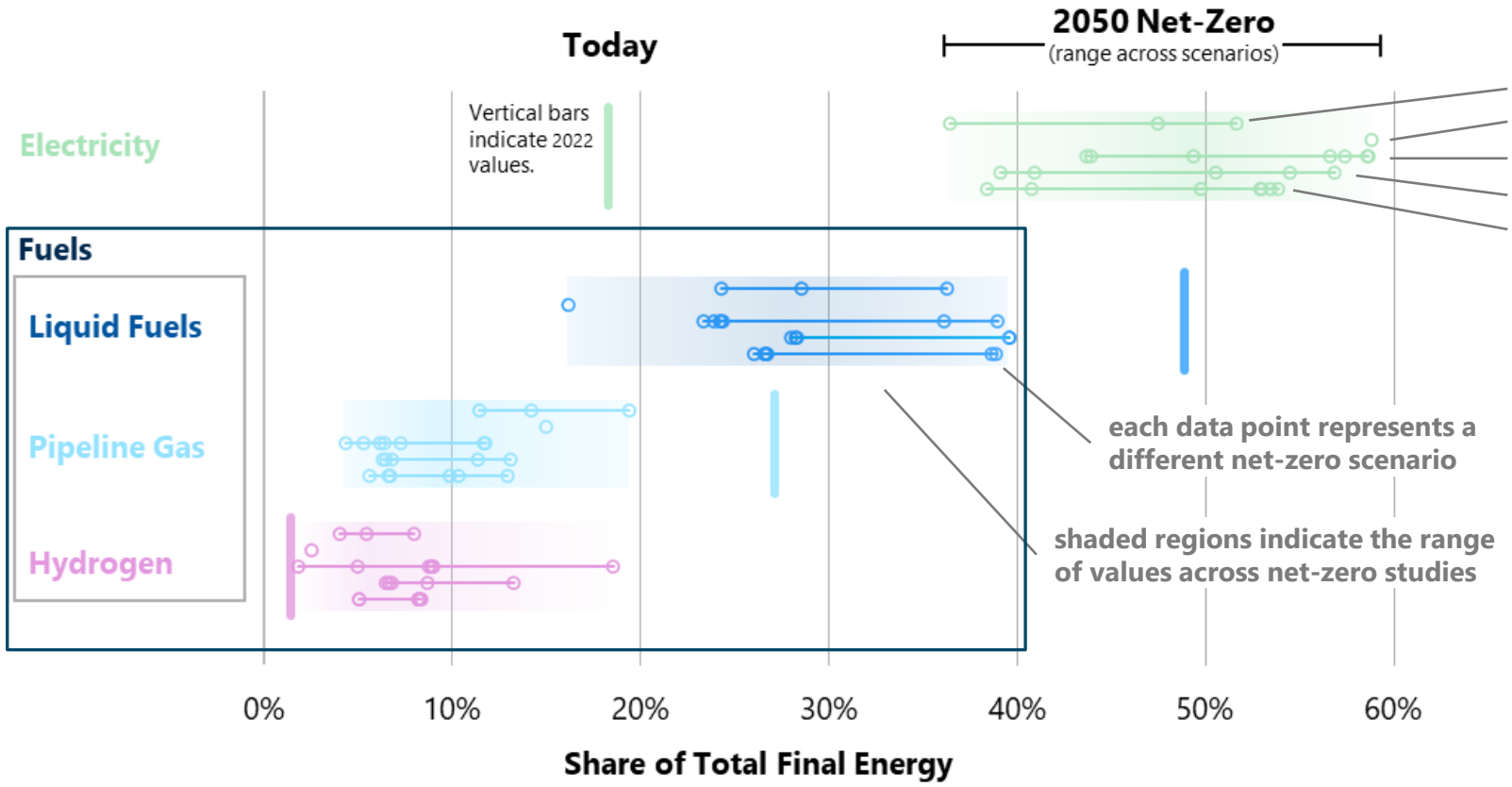


variety
in **electricity**
+
variety
in **fuels**
+
carbon management
+
efficiency

Primary and Final Energy



Final Energy Consumption (End-Use)



top to bottom:

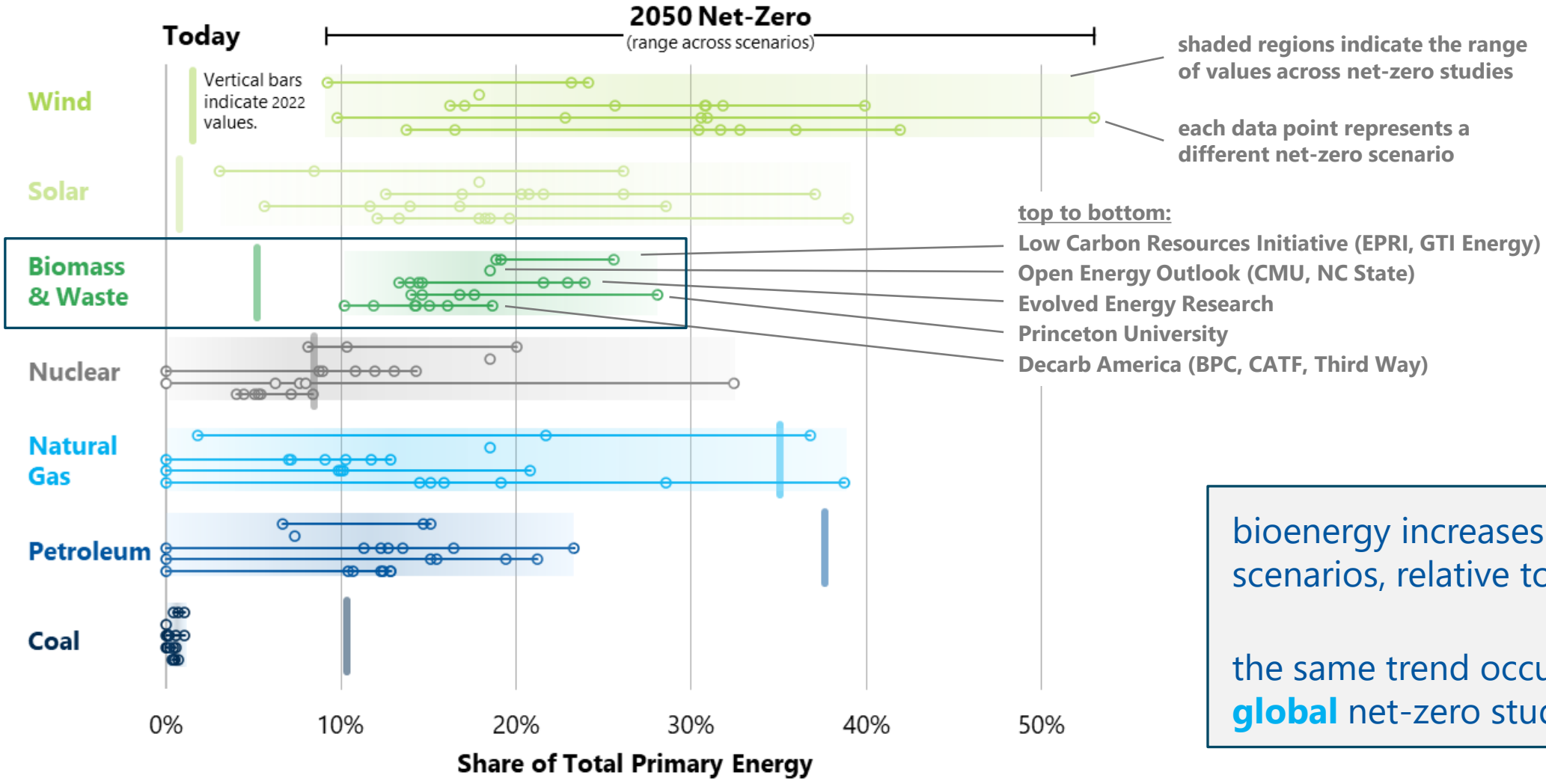
- Low Carbon Resources Initiative (EPRI, GTI Energy)
- Open Energy Outlook (CMU, NC State)
- Evolved Energy Research
- Princeton University
- Decarb America (BPC, CATF, Third Way)

fuels account for **~40-60%** of final end-use energy across all scenarios – bioenergy is a key enabler

report available at gti.energy/meta-nz/

Includes non-energy uses of fuels.
Liquid fuels include ammonia and hydrocarbon fuels derived from petroleum, bioenergy, and synthetic pathways.
Pipeline gas includes fossil natural gas, renewable natural gas, synthetic natural gas, and blended hydrogen.
Coal and biomass account for <2% and <4% of final energy across net-zero scenarios, respectively

Primary Energy Consumption (Sources)



bioenergy increases in **all** scenarios, relative to today

the same trend occurs in **global** net-zero studies

report available at gti.energy/meta-nz/

Geothermal and hydro account for <2% of primary energy across net-zero scenarios.

Bioenergy in Net-Zero Energy Systems

- ☑ **direct end-use** (0.7-4.4 EJ/yr)
- ☑ **electricity generation** (0.0-1.0 EJ/yr)
- ☑ **hydrogen production** (0.1-7.2 EJ/yr)
- ☑ **pipeline gas production** (0.0-3.4 EJ/yr)
- ☑ **liquid fuels production** (0.0-9.6 EJ/yr)
- ☑ **carbon dioxide removal** (0.0-1.2 $GtCO_2$/yr)

thermochemical conversion is key!

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solutions that transform

GTI Energy develops innovative solutions that transform lives, economies, and the environment

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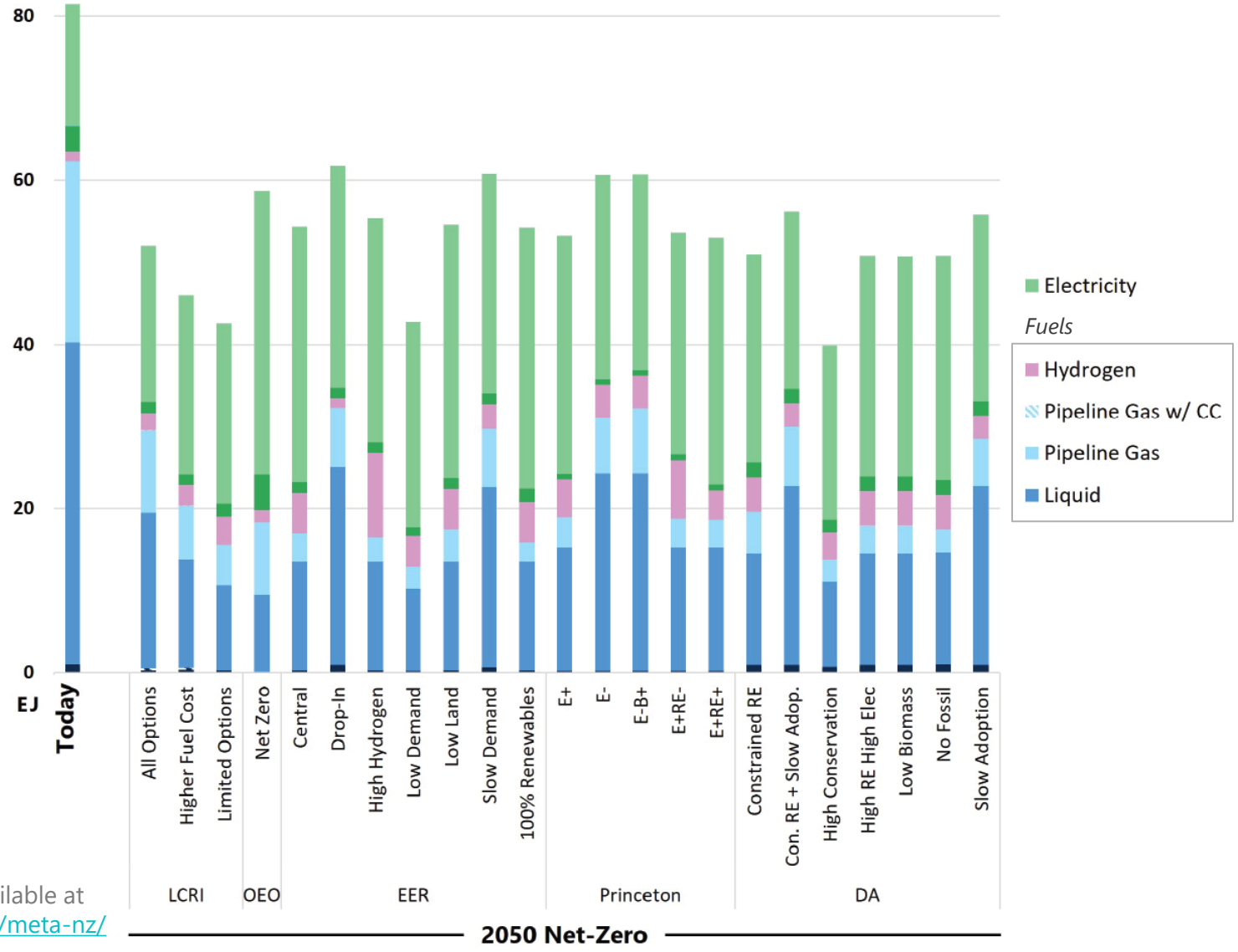
Backup Materials

Annual Final Energy (EJ)



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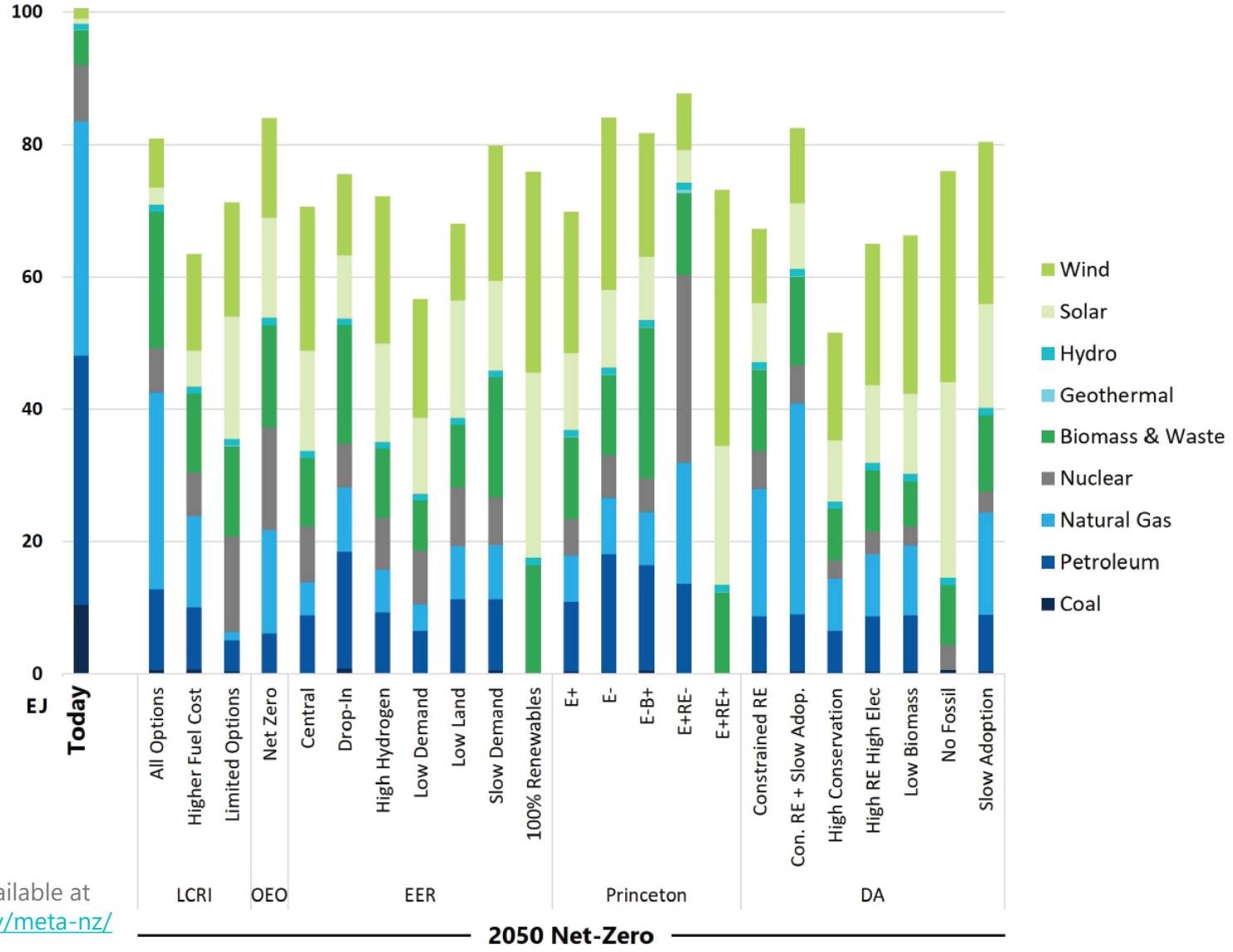
Annual Primary Energy (EJ)



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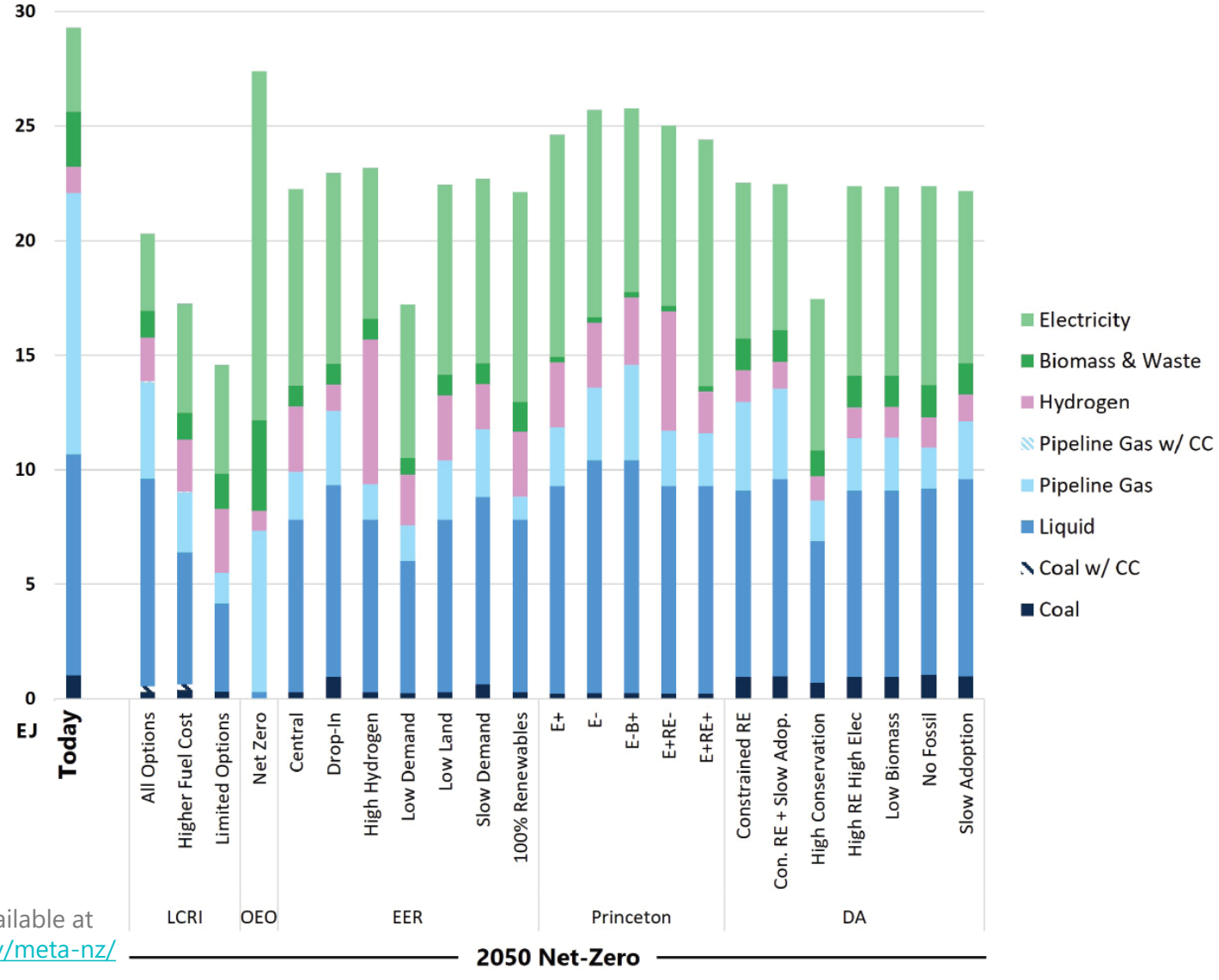
Industrial Annual Energy Consumption (EJ)



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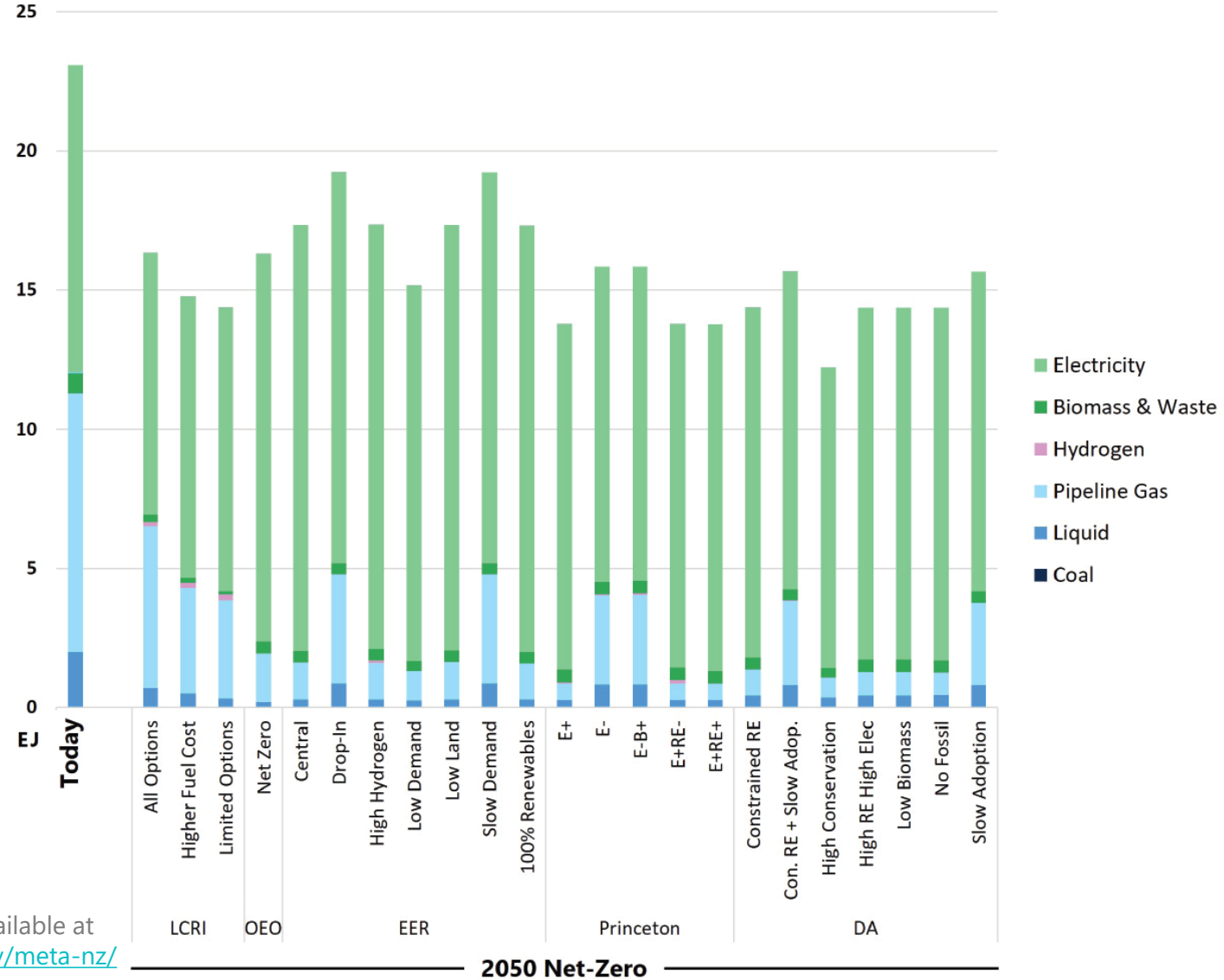
Buildings Annual Energy Consumption (EJ)



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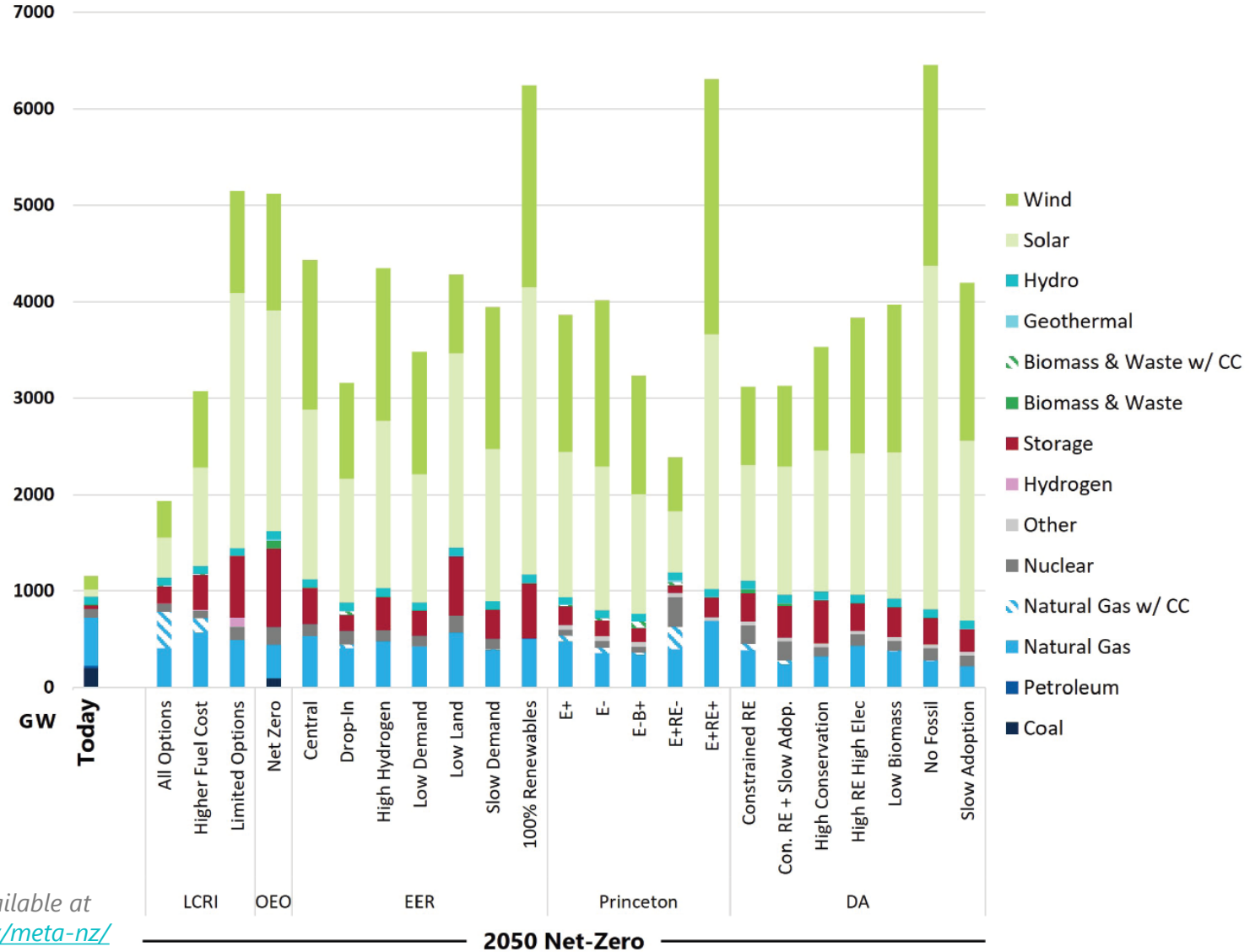
Electricity Generation Capacity (GW)



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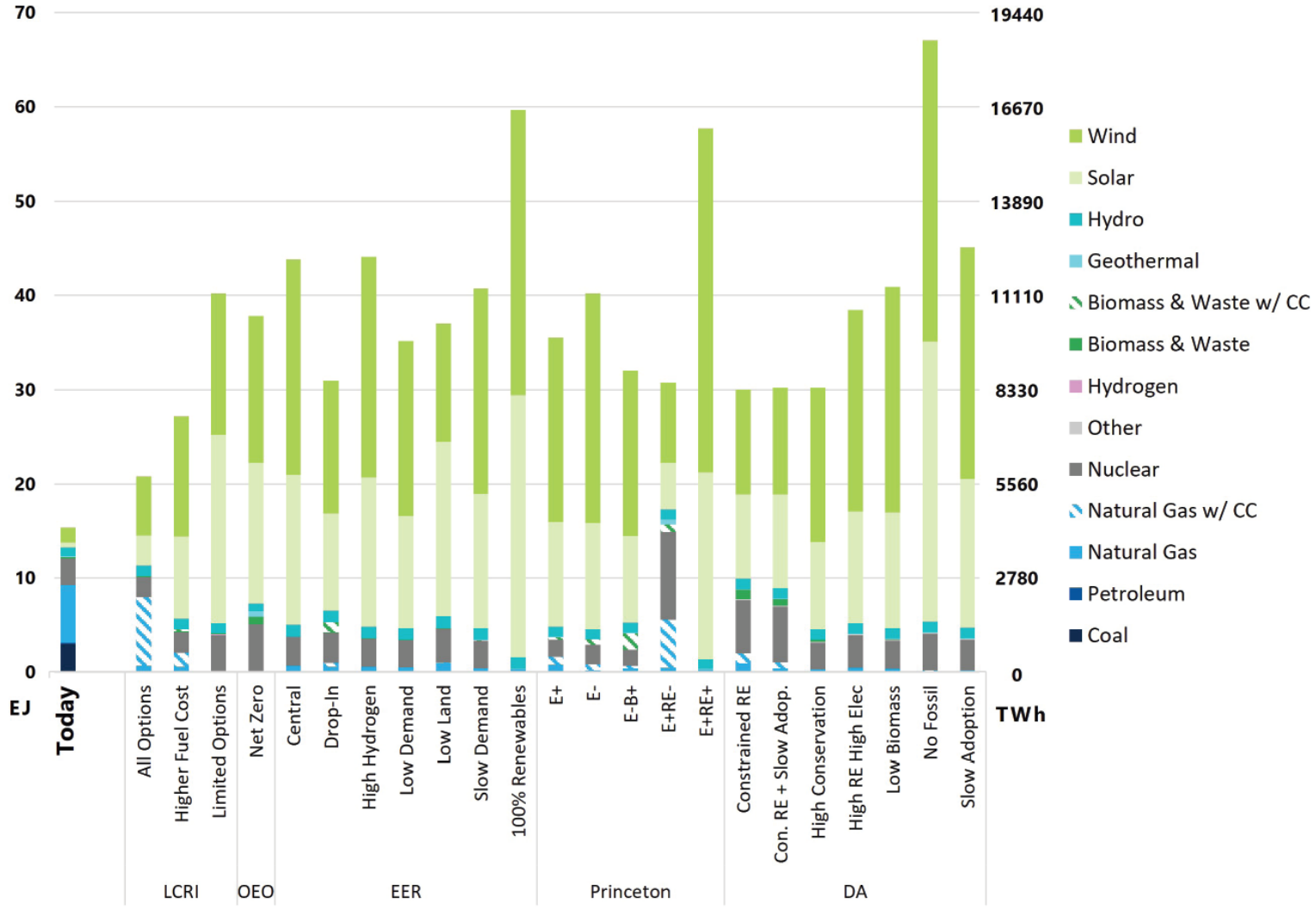
Electricity Annual Generation (EJ, TWh)



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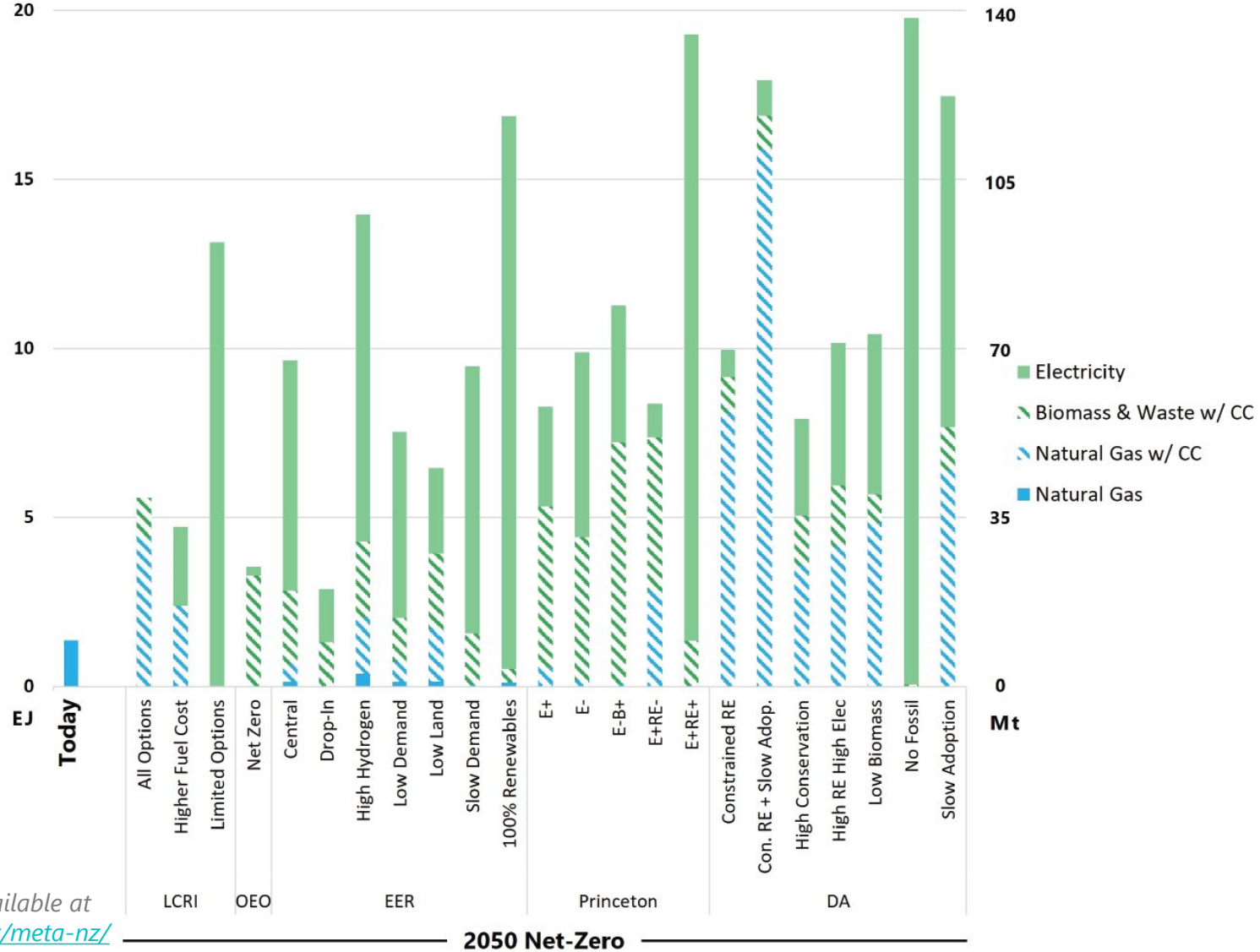
Hydrogen Annual Production (EJ, Mt)



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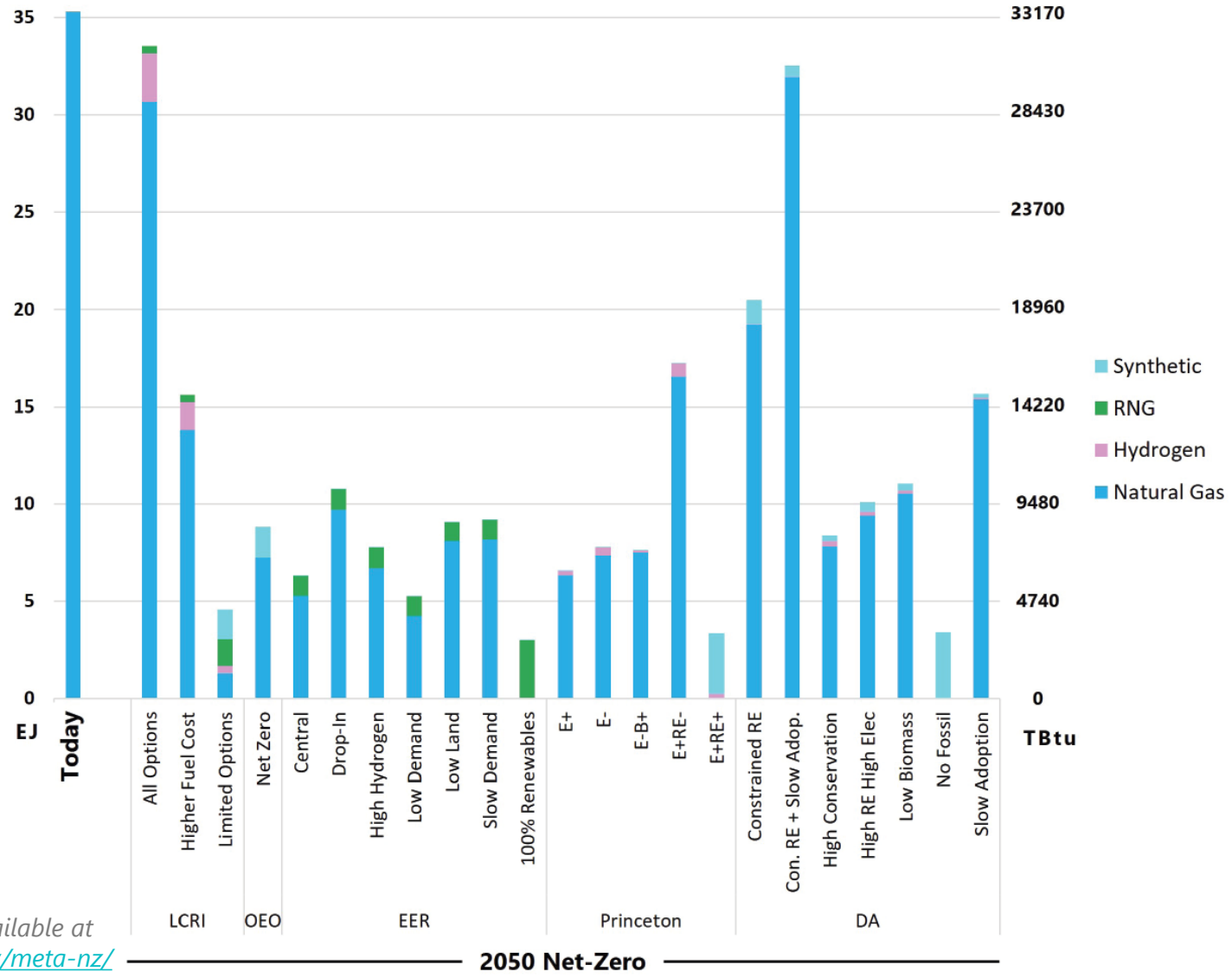
Pipeline Gas Annual Supply (EJ, TBtu)



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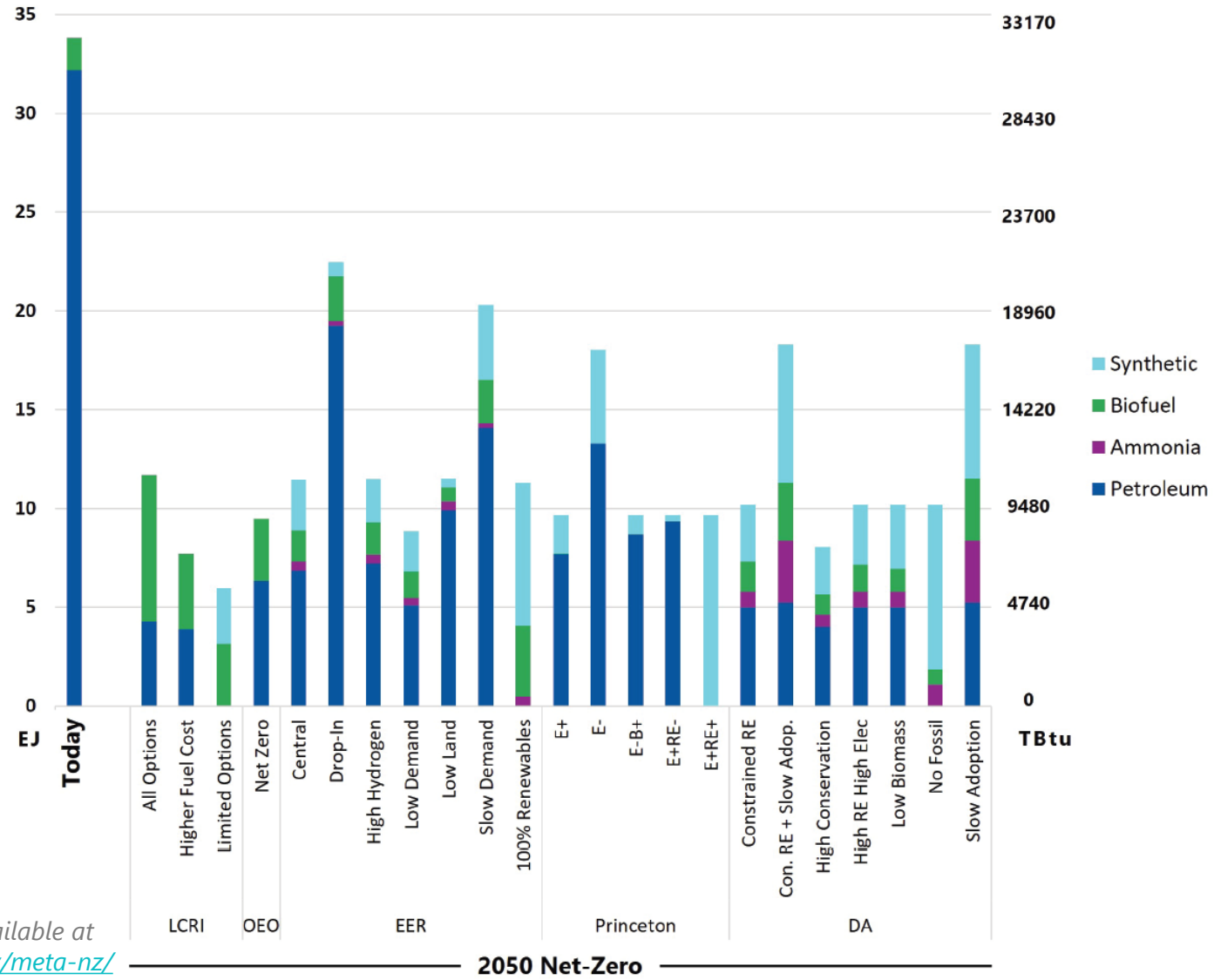
Liquid Fuels Annual Supply (EJ, TBtu)



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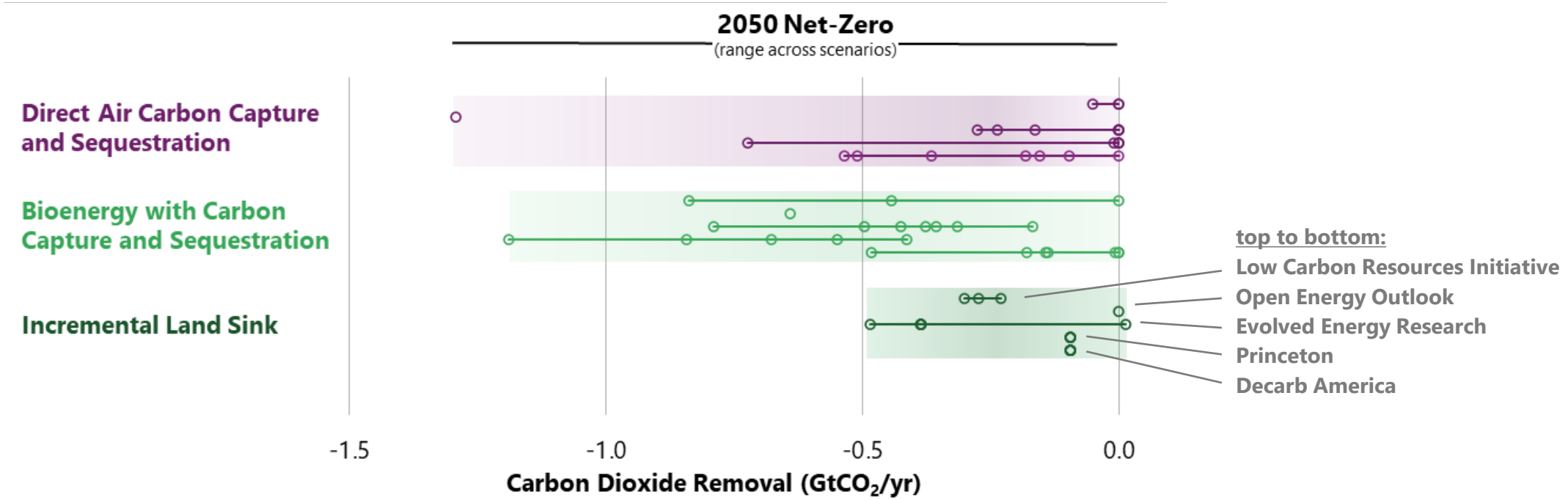
Annual Carbon Dioxide Removal ($GtCO_2$)



current annual CO_{2e} emissions = +6.3 GtCO2e

Notes:

Incremental land sink characterizes the change in the carbon land sink from today's levels.

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