

REM 2024 Denver



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New electricity-generating technologies & Google

1. Why new electricity-generating technologies?
2. Which new technologies?
3. Why Google?



Why New Electricity-Generating Technologies?

Our modeling (and others) shows that advanced technologies can significantly reduce 24/7 CFE costs and risks

Key insights from our modeling:

1. Advanced CFE technologies are essential to reducing costs of 24/7 CFE portfolios
2. They can reduce market risks in clean energy portfolios, in particular shape risk and cannibalization risk
3. Some regions cannot reach high CFE concentrations without advanced technologies (e.g. poor RE resources, land use restrictions).



The inclusion of advanced technologies reduces the cost of achieving 90% hourly CFE across global portfolio by 40%.



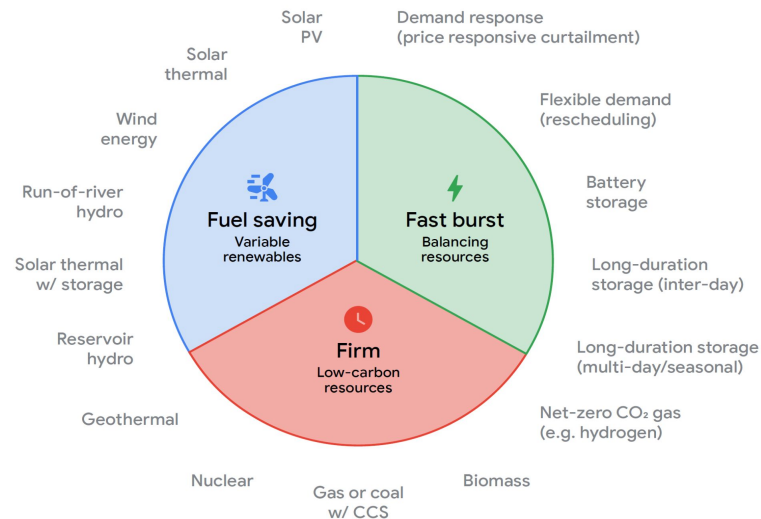
Which New Technologies?

Five technologies we believe will play a critical role in grid decarbonization by 2030 and beyond

Firm generation resources			Clean peaker resources	
1. Next-generation geothermal	2. Carbon capture and storage	3. Advanced nuclear	4. Hydrogen	5. Long-duration energy storage

Source: [The Corporate Role in Accelerating Advanced Clean Electricity Technologies](#)

The full technology portfolio



Source: [Sepulveda, Jenkins et. al. 2018](#)

Why Google:

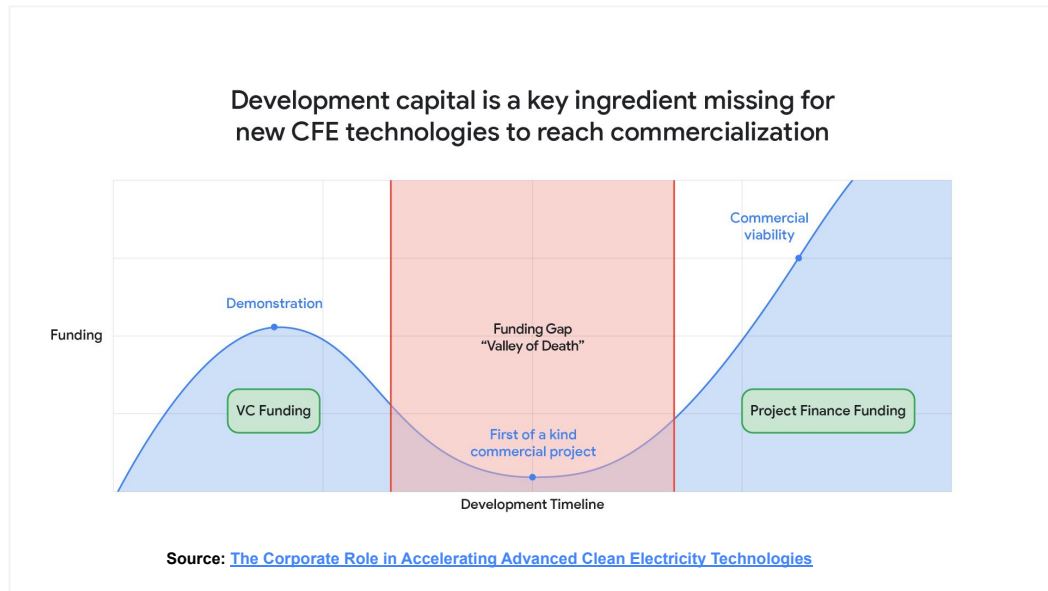
Advanced clean electricity technology risks create a “Valley of Death”

Barriers to commercialization:

- Technology and financing risk
- Development risks
- Commercial structuring challenges
- Lack of enabling infrastructure
- Electricity market design

Clean energy buyers can reduce barriers:

- **Procurement:** Long-term offtake contracts, replicable contracts, designing new market products
- **Investment:** Development capital, Direct corporate investment
- **Technology policy advocacy**



Example

TECHNOLOGY

Next-generation
geothermal energy

Partnership with Fervo Energy
to develop **“always on” clean
energy** for Nevada’s electricity
grid.

A step taken locally to advance
geothermal energy use globally.



Google

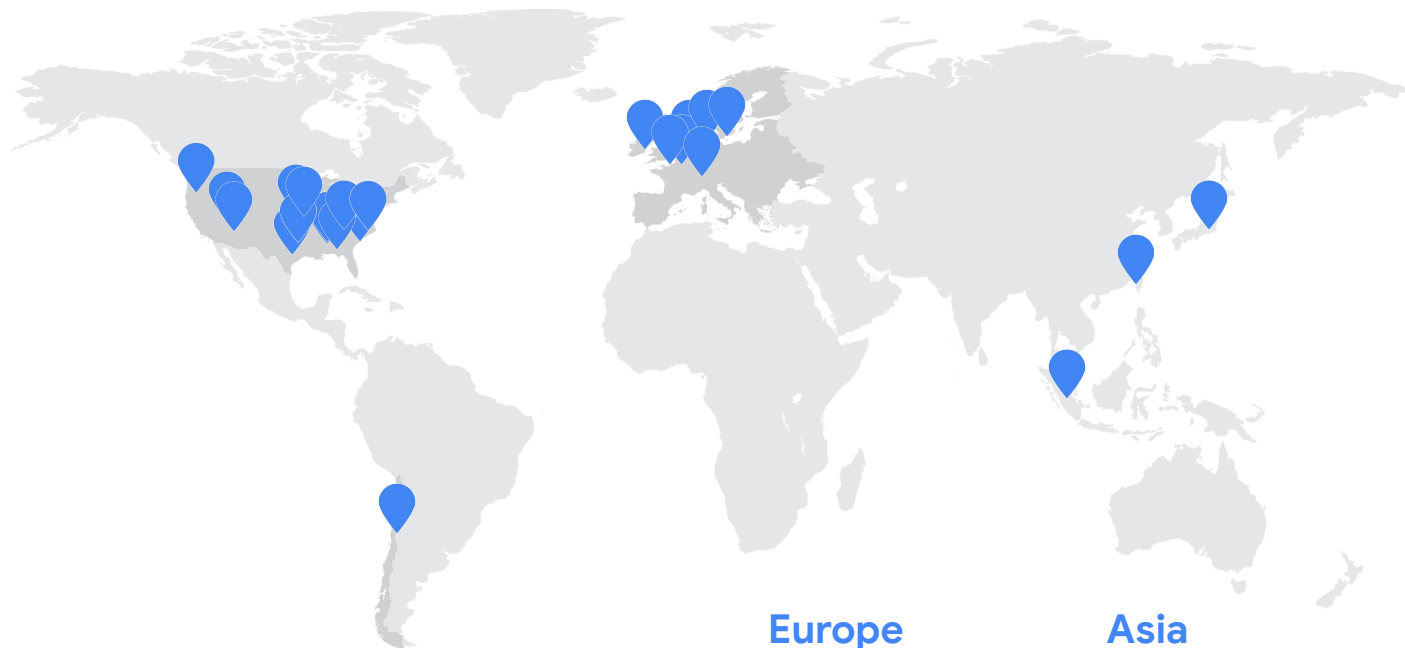
Appendix

28

locations for
owned and
operated
data centers

4

continents



Americas

Berkeley County, South Carolina
Council Bluffs, Iowa
The Dalles, Oregon
Loudoun County, Virginia
Prince William County, Virginia
Montgomery County, Tennessee

Lenoir, North Carolina
Mayes County, Oklahoma
Midlothian, Texas
Douglas County, Georgia
Jackson County, Alabama
Lancaster, Ohio

New Albany, Ohio
Columbus, Ohio
Storey County, Nevada
Henderson, Nevada
Papillion, Nebraska
Quilicura, Chile

Europe

Dublin, Ireland
Eemshaven, Netherlands
Middenmeer, Netherlands
Fredericia, Denmark
Hamina, Finland
St Ghislain, Belgium
Hanau, Germany

Asia

Changhua County, Taiwan
Singapore
Inzai, Japan

Society needs new technologies to avert the worst effects of climate change

Global experts in growing alignment that an array of new technologies will be needed to even come close to 1.5C

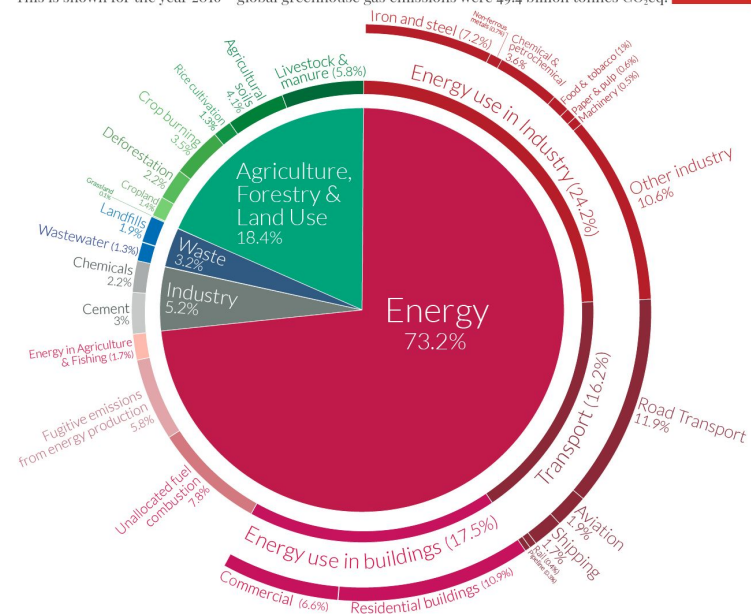
[To reach Net Zero by 2050,] almost half the reductions come from technologies that are currently at the demonstration or prototype phase. (IEA NZ 2050 report)

Politics & assumptions: IPCC, IEA, et al

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

Our World
in Data

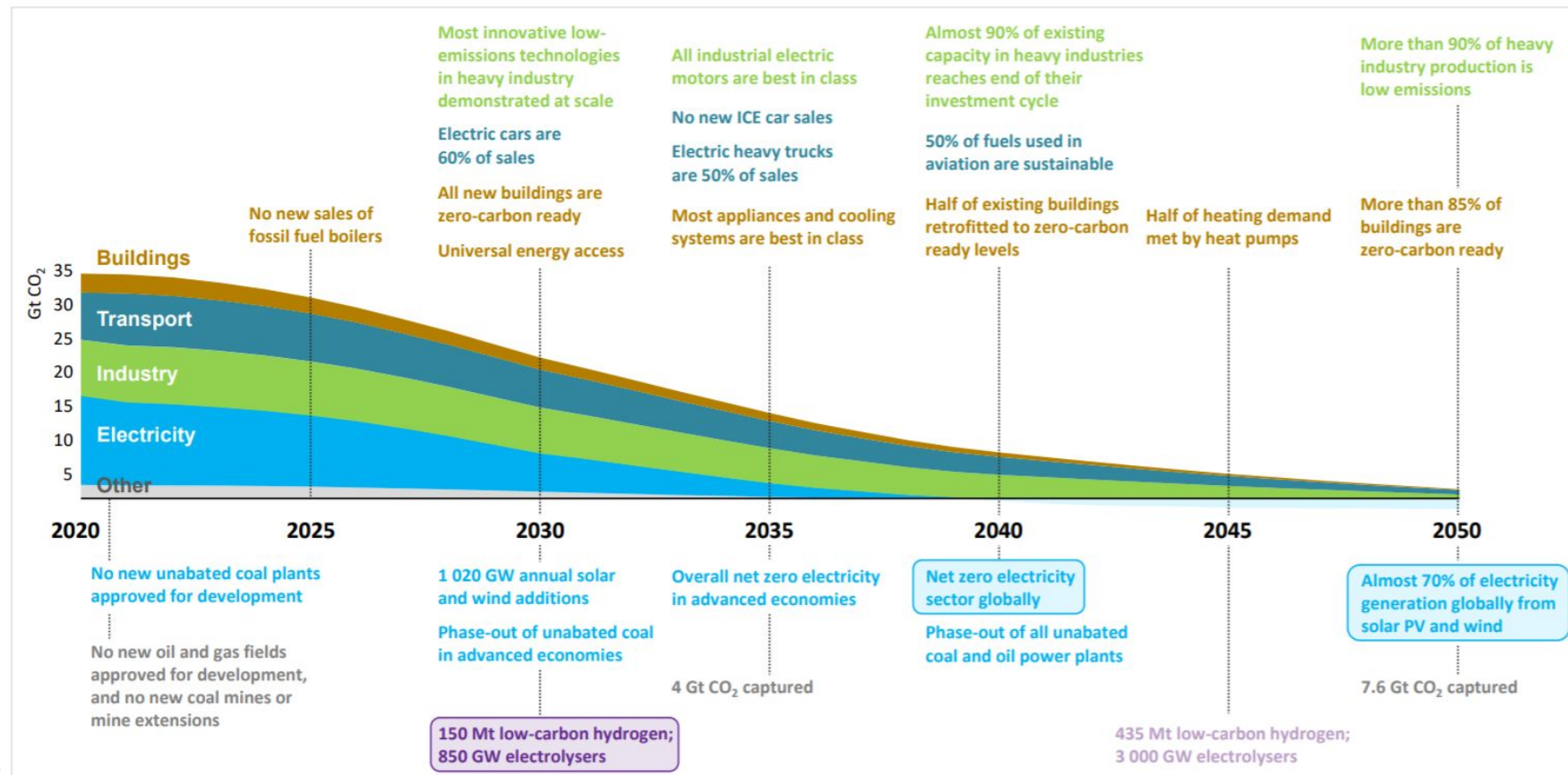


OurWorldinData.org – Research and data to make progress against the world's largest problems.

Source: Climate Watch, the World Resources Institute (2020).

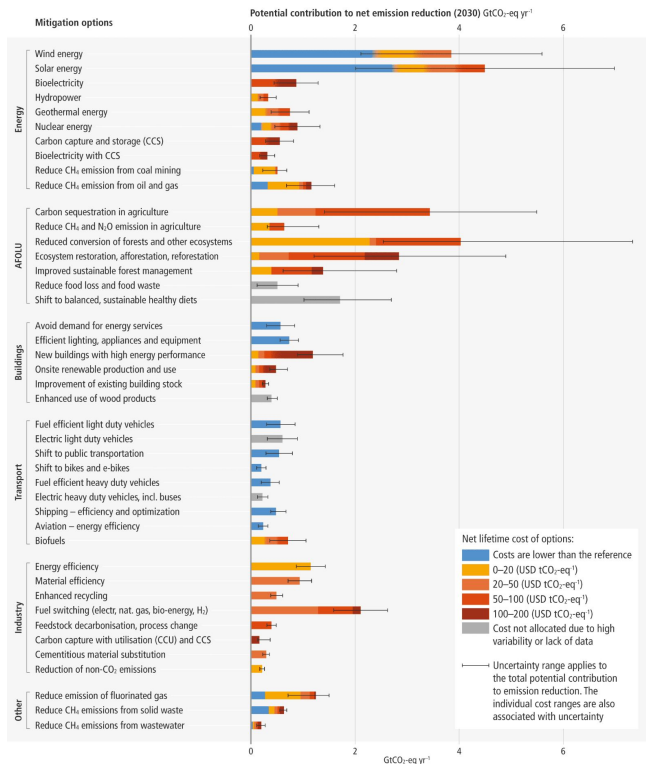
Licensed under CC-BY by the author Hannah Ritchie (2020).

IEA NZ 2050 milestones: out with old tech, in with new



IPCC AR6 (2022): lots of low-hanging fruit, but we must reach higher

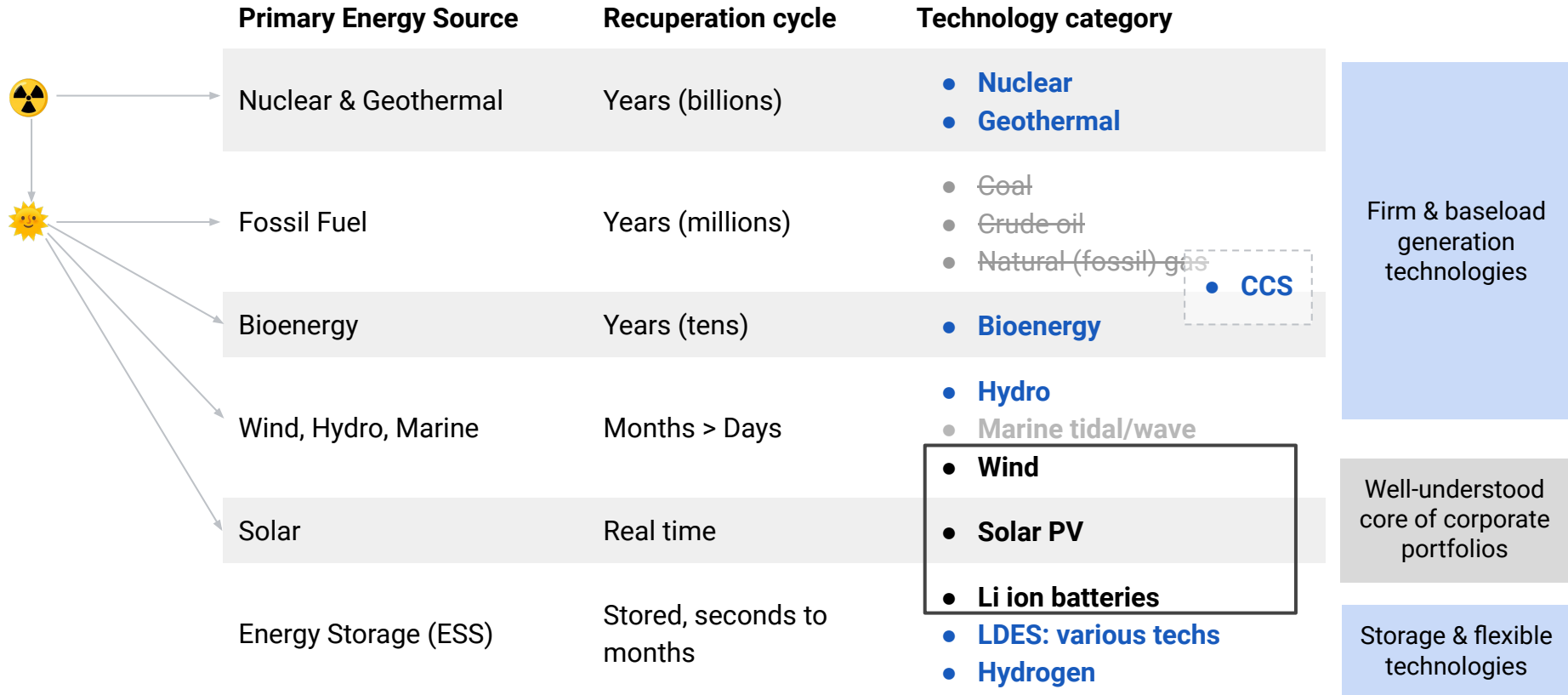
Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.



How to prioritize?

- Deployment vs innovation
- Innovation prioritization
 - Costs & learning potential
 - Scalability & technical potential
 - Externalities
 - Technology risk

Technology classes for 24/7 Carbon-free Energy



TRL and valleys of death: technical & commercial



Google's Approach



Purchasing

Buy more and different types of clean energy deployed locally



Technology

Accelerate technology innovation



Policy

Advocating for policy changes to decarbonize electricity grids

Princeton University report on 24/7 CFE

acee.princeton.edu/24-7

Findings

Deepens reductions in CO2 emissions from a buyer's electricity consumption

Leads to greater system-level emissions reductions

Accelerates deployment of advanced CFE technologies

Drives significantly more retirement of fossil fuel capacity

Comes at a cost premium to 100% RE annual matching

