Tech Transfer Online

UNIDO

VENTURE CENTER

Session 6 :

Commercializing cleantech innovations, Lessons from the FLCTD program

Hiran Vedam, Sandeep Tandon/Nitesh Kaushik

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Commercializing clean tech innovations (as an example of long gestation technologies)

Hiran Vedam

Who's Speaking

Hiran Vedam
PhD

Hiran is a Business Fellow with the Breakthrough Energy Fellowship Program, bringing global experience across the lab-to-market journey. She has worked across the globe, supporting climate tech investors, startups, & early-stage ventures. Formerly an independent consultant, she has led initiatives in technology transfer, entrepreneurship, & research commercialization. She was the chief editor of the AIM Prime Playbook & developed a mentoring framework for science-based startups. Her YouTube channel, World of Deeptech, educates researchers on deeptech commercialization.

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Affiliation

- Co-founder & Chief Catalyst,
  Ashwatta Sustainability Ventures

About Ashwatta

Vision: A sustainable global future driven by breakthrough climate solutions from India

Mission: To identify, de-risk, and scale breakthrough climate tech innovations from India for global impact

Position: From India for the World

About Ashwatta

Training & Coaching

- **Catalyst Program**
  - 3 Day Offline Workshop Covering Lectures, Hands-on Activities and Case Studies
  - 1-1 On-line Coaching for 3-6 months (Customizable)
  - Target: Researcher with IP
- **First Matter Formula ™ (Exclusive Licensee)**
  - Proven market intelligence framework adopted by world-leading investors and climate programs to India
  - Includes training and coaching over 16 weeks
  - Target: Climate Tech Start-ups

Consulting

- **Specific areas of focus**
  - IP strategy
  - Technology de-risking
  - FOAK prototype planning
  - Market opportunity analysis
  - Techno-economic analysis (TEA)
  - Life cycle analysis (LCA)
  - Fundraising
- **Target**
  - Climate Tech Startups

Venture Studio

- Identify breakthrough innovations and collaborate with researchers and build high-impact start-ups

TL;DL

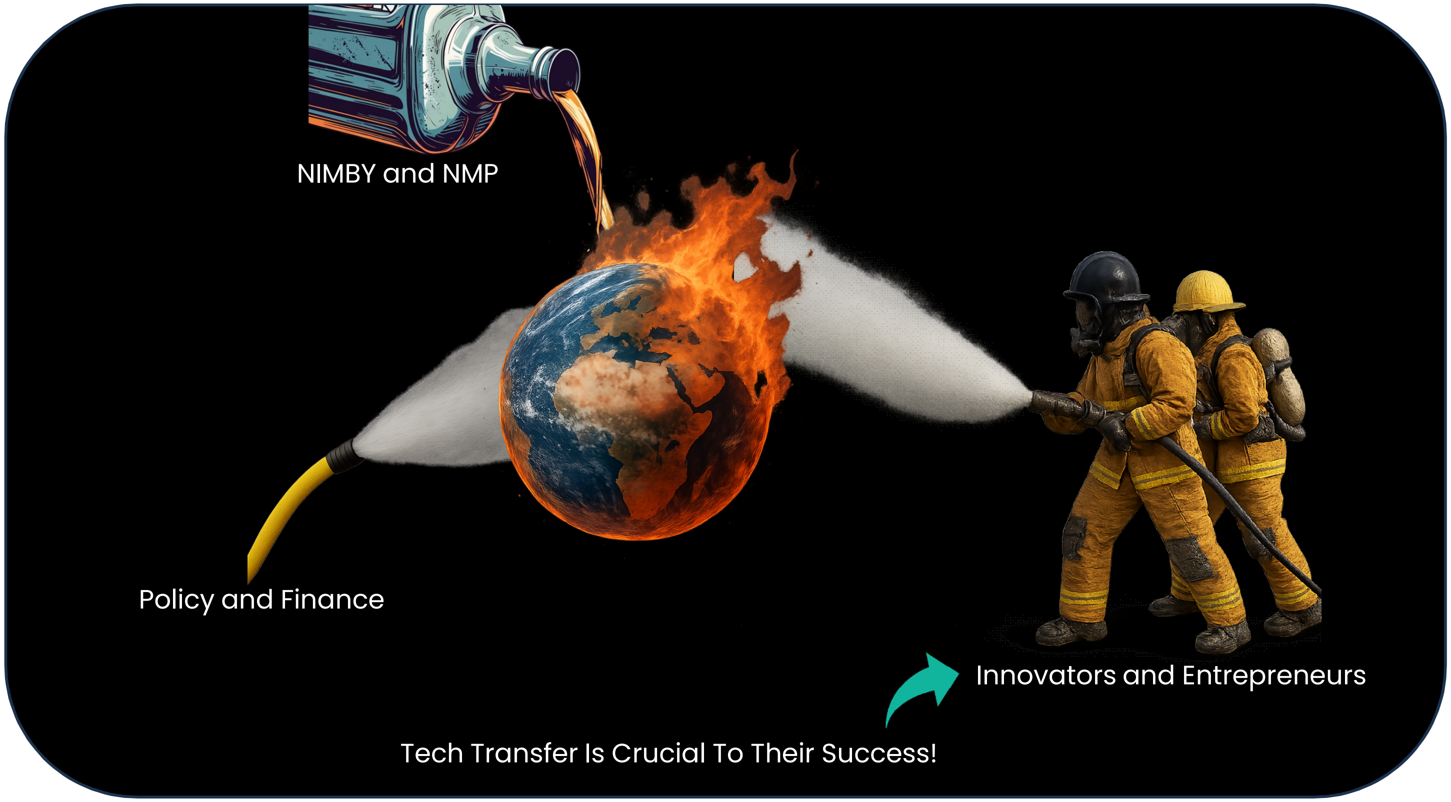
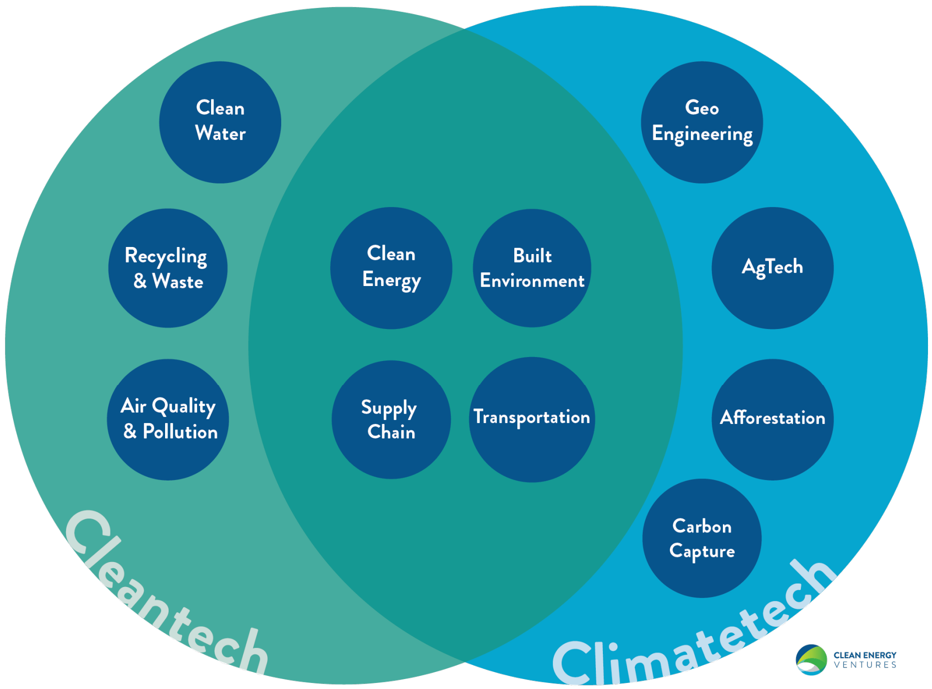
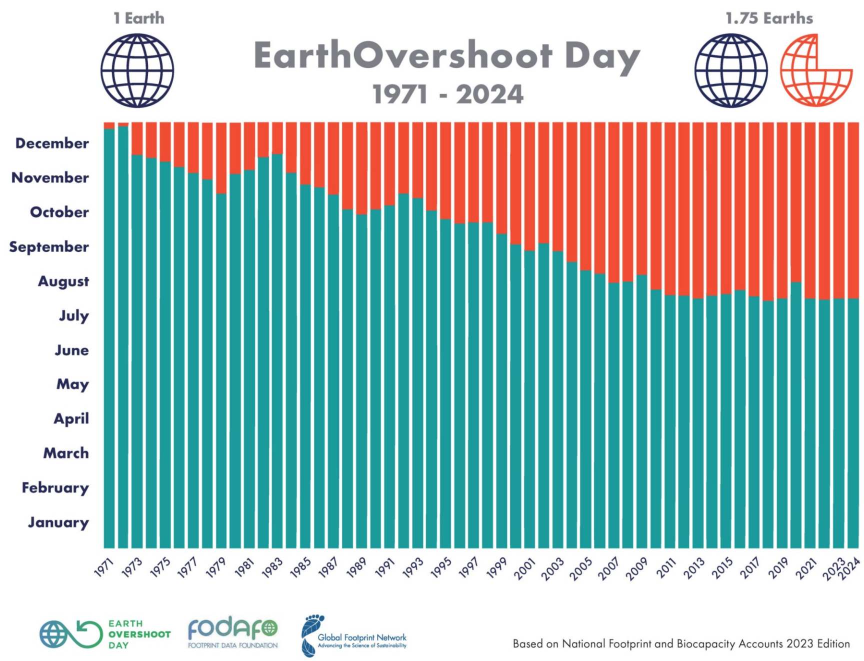


Image Credit: ChatGPT & Canva

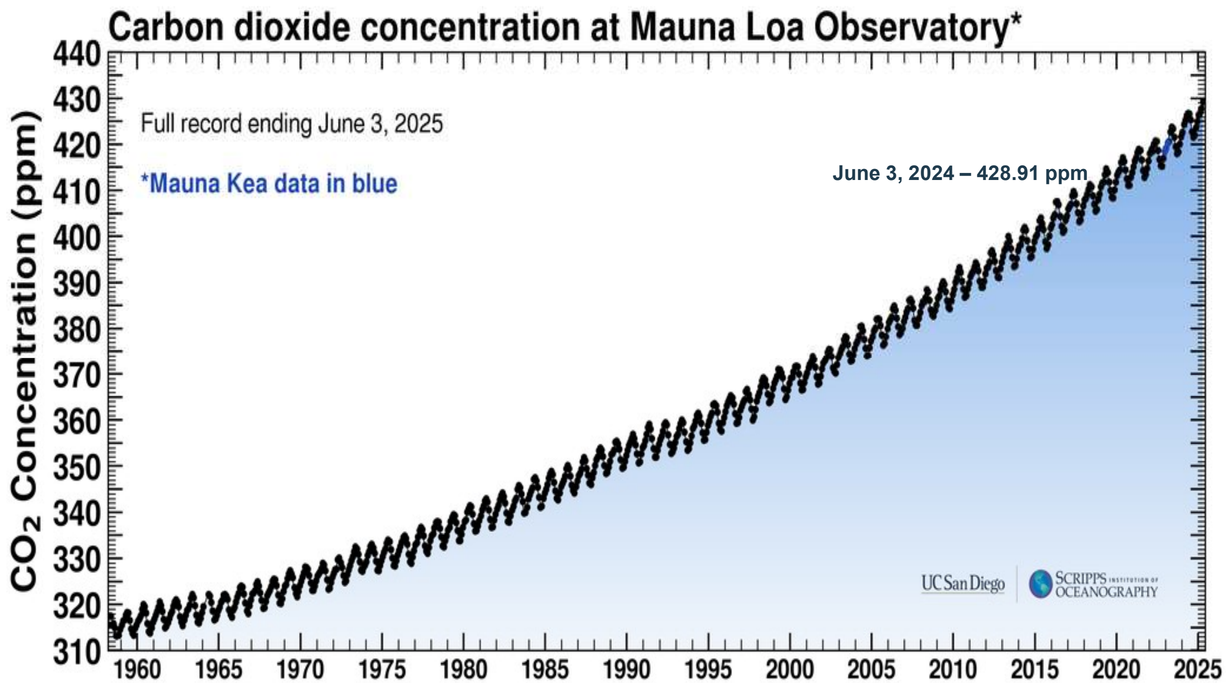


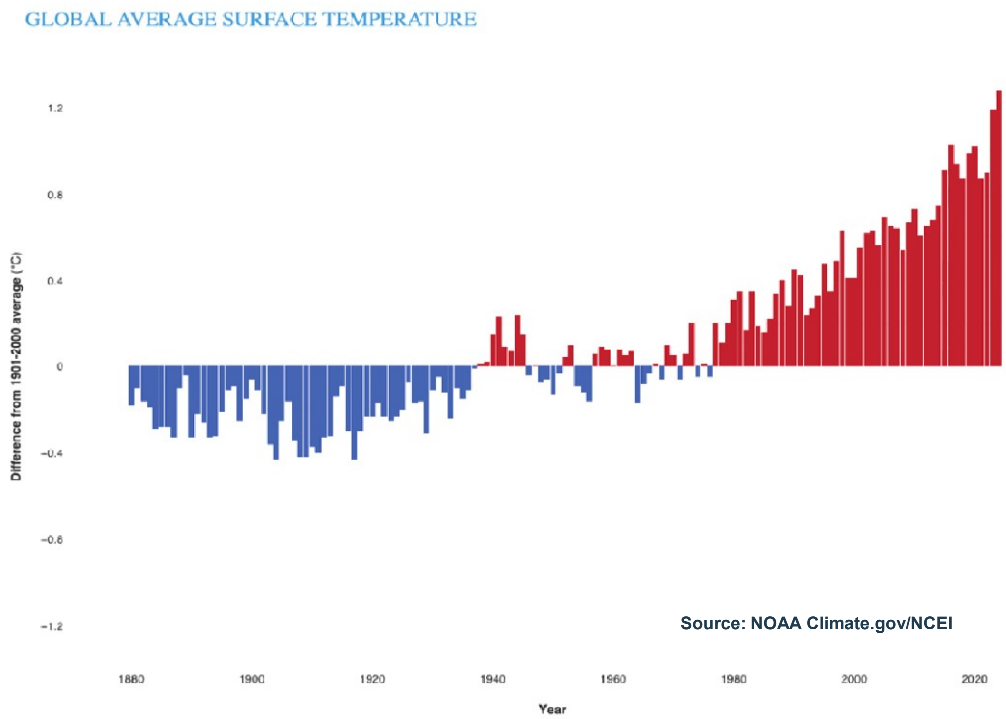
Building a Sustainable Future for All!



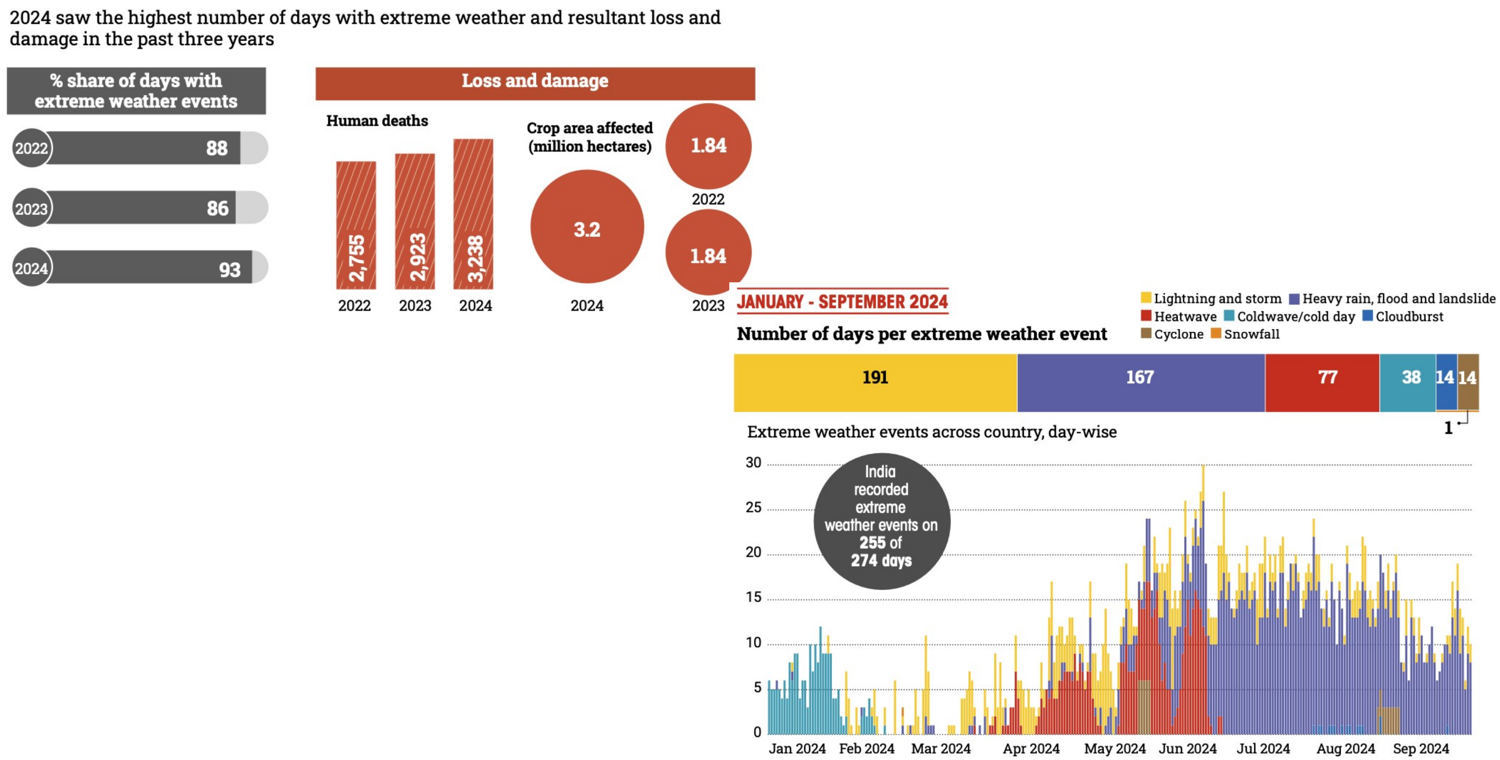
July 24th, 2025

Humanity will have used up nature's entire annual budget of ecological resources and services for 2025


Carbon dioxide concentration at Mauna Loa Observatory*
Full record ending June 3, 2025
*Mauna Kea data in blue
June 3, 2024 – 428.91 ppm
CO2 Concentration (ppm)
440
430
420
410
400
390
380
370
360
350
340
330
320
310
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
UC San Diego
SCRIPPS INSTITUTION OF OCEANOGRAPHY



2024 was the world's warmest year since records began in 1850



Source: https://www.cseindia.org/climate-india-2024-an-assessment-of-extreme-weather-events-12460

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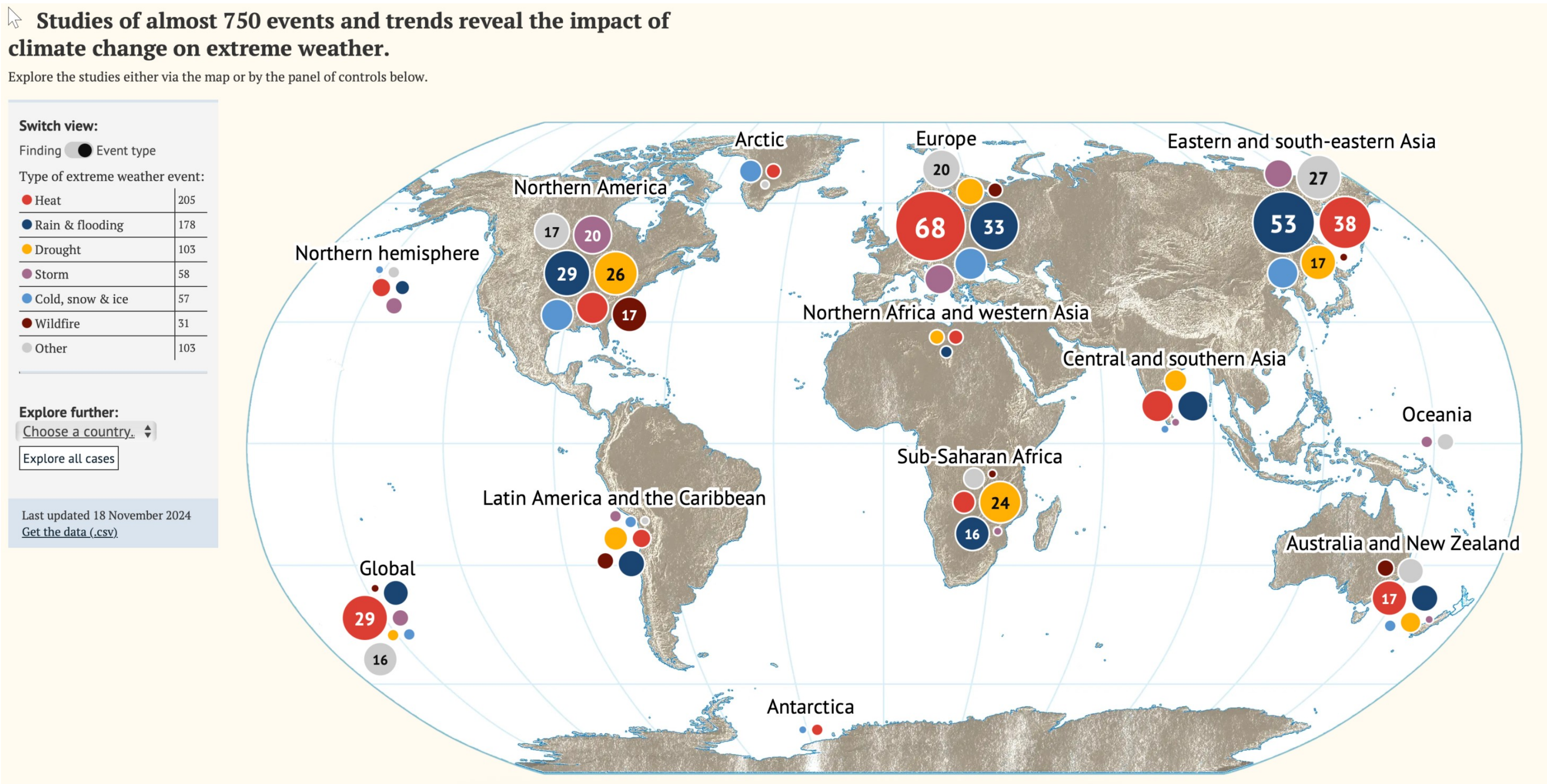

https://interactive.carbonbrief.org/attribution-studies/index.html

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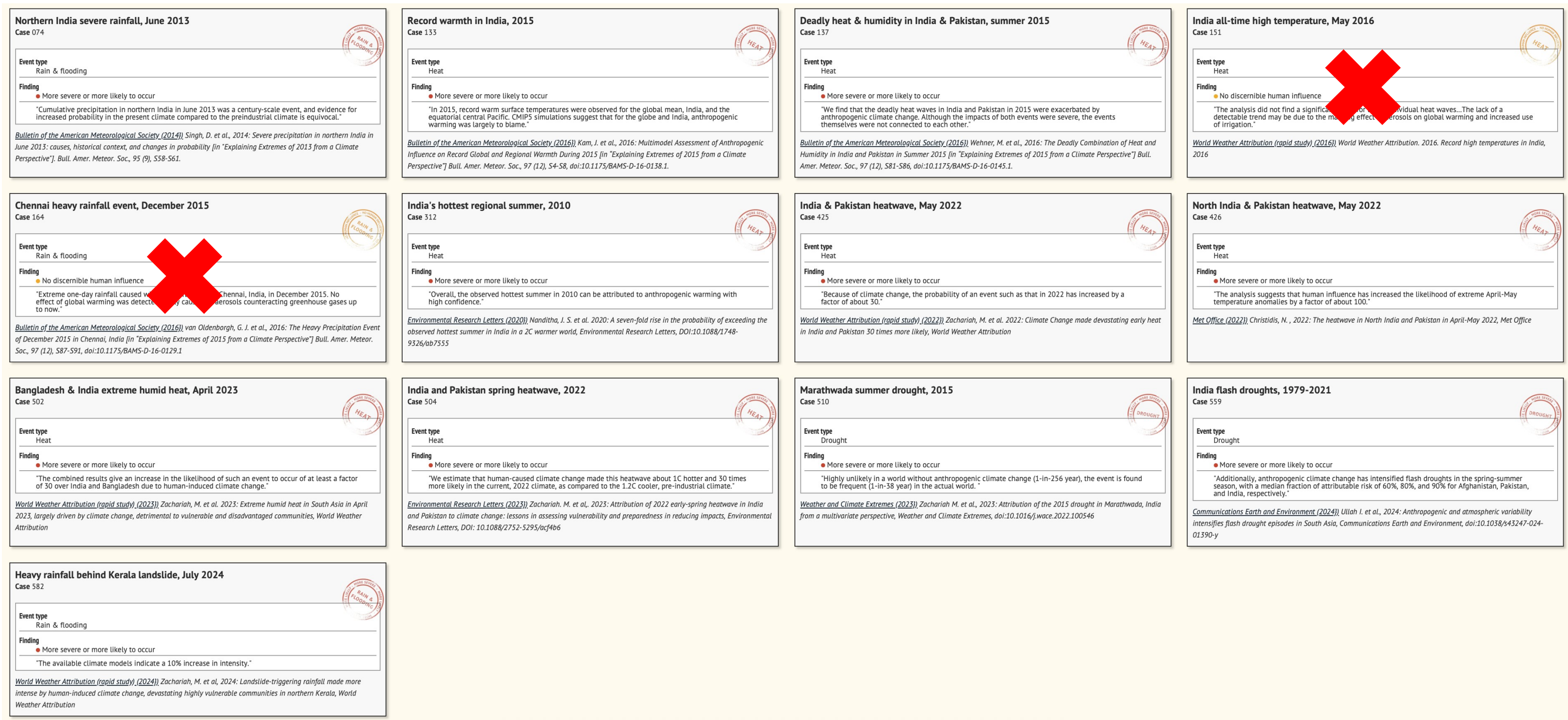


Northern India severe rainfall, June 2013
Case 074

Event type
Rain & flooding

Finding
More severe or more likely to occur

"Cumulative precipitation in northern India in June 2013 was a century-scale event, and evidence for increased probability in the present climate compared to the preindustrial climate is equivocal."

Bulletin of the American Meteorological Society (2014)) Singh, D. et al., 2014: Severe precipitation in northern India in June 2013: causes, historical context, and changes in probability [in "Explaining Extremes of 2013 from a Climate Perspective"]. Bull. Amer. Meteor. Soc., 95 (9), S58-S61.

Record warmth in India, 2015
Case 133

Event type
Heat

Finding
More severe or more likely to occur

"In 2015, record warm surface temperatures were observed for the global mean, India, and the equatorial central Pacific. CMIP5 simulations suggest that for the globe and India, anthropogenic warming was largely to blame."

Bulletin of the American Meteorological Society (2016)) Kam, J. et al., 2016: Multimodel Assessment of Anthropogenic Influence on Record Global and Regional Warmth During 2015 [in "Explaining Extremes of 2015 from a Climate Perspective"] Bull. Amer. Meteor. Soc., 97 (12), S4-S8, doi:10.1175/BAMS-D-16-0138.1.

Deadly heat & humidity in India & Pakistan, summer 2015
Case 137

Event type
Heat

Finding
More severe or more likely to occur

"We find that the deadly heat waves in India and Pakistan in 2015 were exacerbated by anthropogenic climate change. Although the impacts of both events were severe, the events themselves were not connected to each other."

Bulletin of the American Meteorological Society (2016)) Wehner, M. et al., 2016: The Deadly Combination of Heat and Humidity in India and Pakistan in Summer 2015 [in "Explaining Extremes of 2015 from a Climate Perspective"] Bull. Amer. Meteor. Soc., 97 (12), S81-S86, doi:10.1175/BAMS-D-16-0145.1.

India all-time high temperature, May 2016
Case 151

Event type
Heat

Finding
No discernible human influence

"The analysis did not find a significa… …vidual heat waves...The lack of a detectable trend may be due to the ma…g effect…erosols on global warming and increased use of irrigation."

World Weather Attribution (rapid study) (2016)) World Weather Attribution. 2016. Record high temperatures in India, 2016

Chennai heavy rainfall event, December 2015
Case 164

Event type
Rain & flooding

Finding
No discernible human influence

"Extreme one-day rainfall caused w… …Chennai, India, in December 2015. No effect of global warming was detecte… …aerosols counteracting greenhouse gases up to now."

Bulletin of the American Meteorological Society (2016)) van Oldenborgh, G. J. et al., 2016: The Heavy Precipitation Event of December 2015 in Chennai, India [in "Explaining Extremes of 2015 from a Climate Perspective"] Bull. Amer. Meteor. Soc., 97 (12), S87-S91, doi:10.1175/BAMS-D-16-0129.1

India's hottest regional summer, 2010
Case 312

Event type
Heat

Finding
More severe or more likely to occur

"Overall, the observed hottest summer in 2010 can be attributed to anthropogenic warming with high confidence."

Environmental Research Letters (2020)) Naditha, J. S. et al. 2020: A seven-fold rise in the probability of exceeding the observed hottest summer in India in a 2C warmer world, Environmental Research Letters, DOI:10.1088/1748-9326/ab7555

India & Pakistan heatwave, May 2022
Case 425

Event type
Heat

Finding
More severe or more likely to occur

"Because of climate change, the probability of an event such as that in 2022 has increased by a factor of about 30."

World Weather Attribution (rapid study) (2022)) Zachariah, M. et al. 2022: Climate Change made devastating early heat in India and Pakistan 30 times more likely, World Weather Attribution

North India & Pakistan heatwave, May 2022
Case 426

Event type
Heat

Finding
More severe or more likely to occur

"The analysis suggests that human influence has increased the likelihood of extreme April-May temperature anomalies by a factor of about 100."

Met Office (2022)) Christidis, N. , 2022: The heatwave in North India and Pakistan in April-May 2022, Met Office

Bangladesh & India extreme humid heat, April 2023
Case 502

Event type
Heat

Finding
More severe or more likely to occur

"The combined results give an increase in the likelihood of such an event to occur of at least a factor of 30 over India and Bangladesh due to human-induced climate change."

World Weather Attribution (rapid study) (2023)) Zachariah, M. et al. 2023: Extreme humid heat in South Asia in April 2023, largely driven by climate change, detrimental to vulnerable and disadvantaged communities, World Weather Attribution

India and Pakistan spring heatwave, 2022
Case 504

Event type
Heat

Finding
More severe or more likely to occur

"We estimate that human-caused climate change made this heatwave about 1C hotter and 30 times more likely in the current, 2022 climate, as compared to the 1.2C cooler, pre-industrial climate."

Environmental Research Letters (2023)) Zachariah. M. et al,. 2023: Attribution of 2022 early-spring heatwave in India and Pakistan to climate change: lessons in assessing vulnerability and preparedness in reducing impacts, Environmental Research Letters, DOI: 10.1088/2752-5295/acf4b6

Marathwada summer drought, 2015
Case 510

Event type
Drought

Finding
More severe or more likely to occur

"Highly unlikely in a world without anthropogenic climate change (1-in-256 year), the event is found to be frequent (1-in-38 year) in the actual world. "

Weather and Climate Extremes (2023)) Zachariah M. et al., 2023: Attribution of the 2015 drought in Marathwada, India from a multivariate perspective, Weather and Climate Extremes, doi:10.1016/j.wace.2022.100546

India flash droughts, 1979-2021
Case 559

Event type
Drought

Finding
More severe or more likely to occur

"Additionally, anthropogenic climate change has intensified flash droughts in the spring-summer season, with a median fraction of attributable risk of 60%, 80%, and 90% for Afghanistan, Pakistan, and India, respectively."

Communications Earth and Environment (2024)) Ullah I. et al., 2024: Anthropogenic and atmospheric variability intensifies flash drought episodes in South Asia, Communications Earth and Environment, doi:10.1038/s43247-024-01390-y

Heavy rainfall behind Kerala landslide, July 2024
Case 582

Event type
Rain & flooding

Finding
More severe or more likely to occur

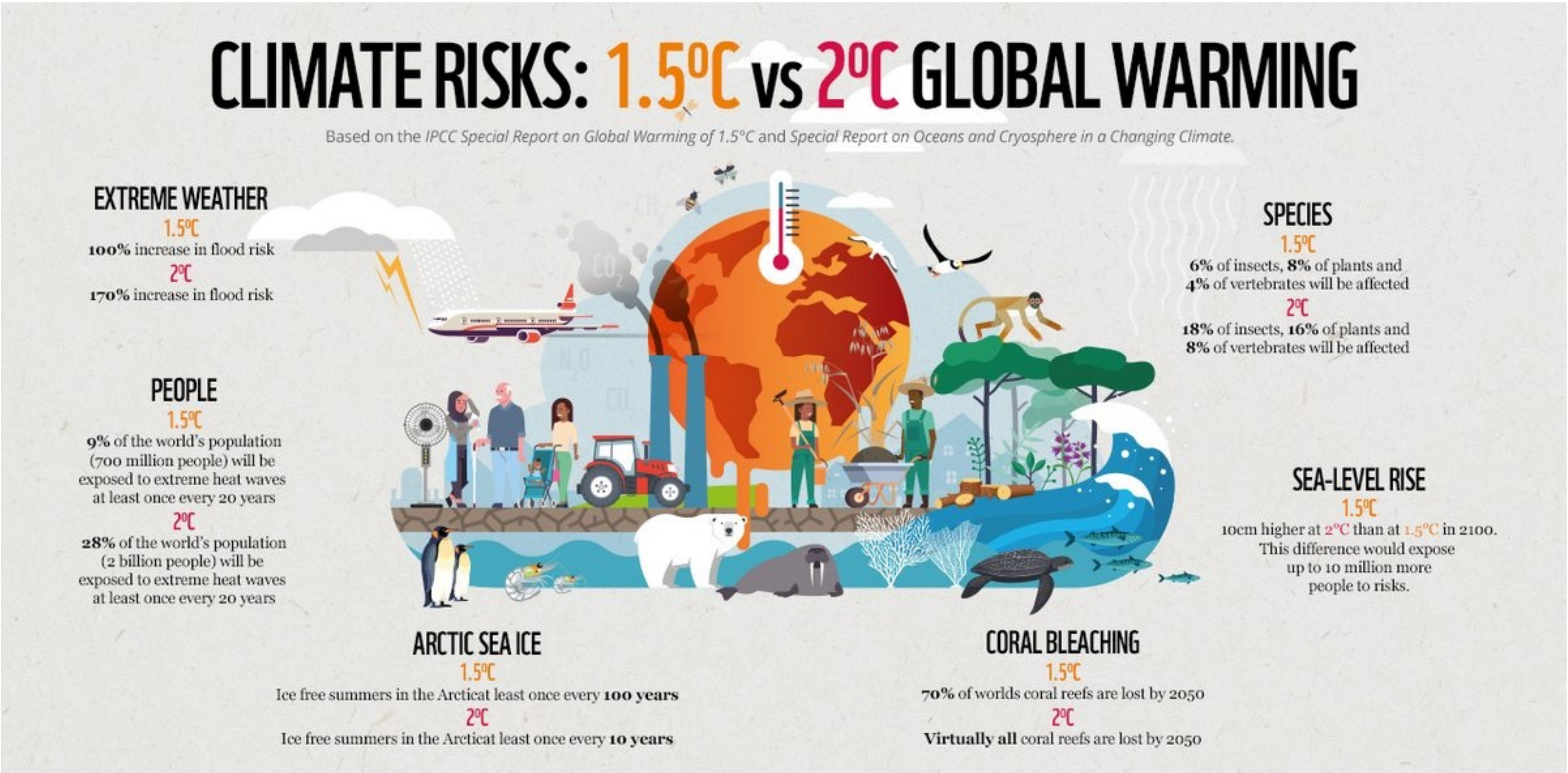
"The available climate models indicate a 10% increase in intensity."

World Weather Attribution (rapid study) (2024)) Zachariah, M. et al, 2024: Landslide-triggering rainfall made more intense by human-induced climate change, devastating highly vulnerable communities in northern Kerala, World Weather Attribution

13 attribution studies focusing on events in India

11 studies found that climate change increased the severity or likelihood of the event

https://interactive.carbonbrief.org/attribution-studies/IND/index.html



Source: https://x.com/WWFEU/status/1421033659222605826/photo/1

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1.0	Electrify Transportation	5.0	Clean Up Industry	9.0	Innovate!
2.0	Decarbonize the Grid	6.0	Remove Carbon	10.0	Invest!
3.0	Fix Food	7.0	Win Politics and Policy		
4.0	Protect Nature	8.0	Turn Movements into Action		

1.0 Electrify Transportation

Key Result:		Status:	Reduction Potential:
1.1	Price	Insufficient Progress	
1.2	Cars	Insufficient Progress	
1.3	Buses	Failing	
1.4	Trucks	Failing	
1.5	Miles	Insufficient Progress	↓ 5 Gt
1.6	Planes	Failing	↓ 0.3 Gt
1.7	Maritime	Failing	↓ 0.6 Gt

2.0 Decarbonize the Grid

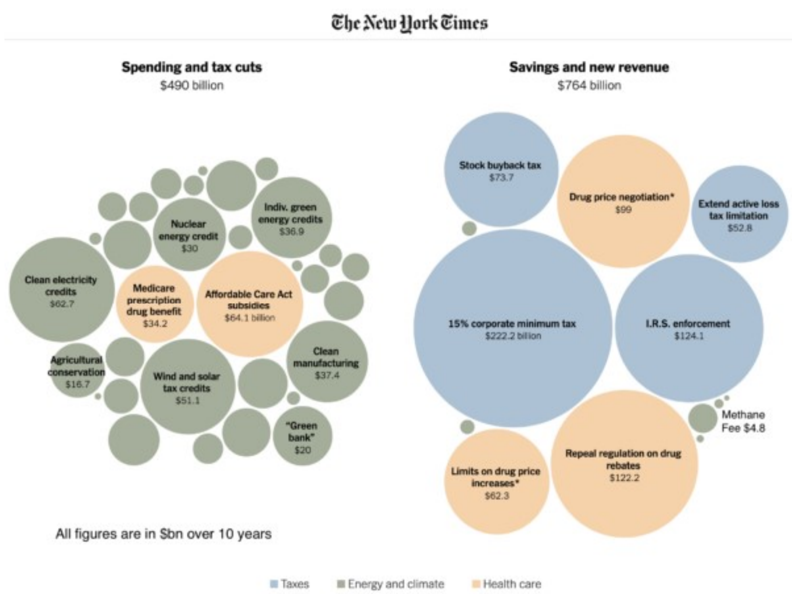
Key Result:		Status:	Reduction Potential:
2.1	Zero Emissions	Insufficient Progress	↓ 16.5 Gt
2.2	Solar & Wind	Achieved	
2.3	Storage	Insufficient Progress	
2.4	Coal & Gas	Code Red	
2.5	Methane Emissions	Code Red	↓ 3 Gt
2.6	Heating & Cooking	Failing	↓ 1.5 Gt
2.7	Cleaner Economy	Insufficient Progress	

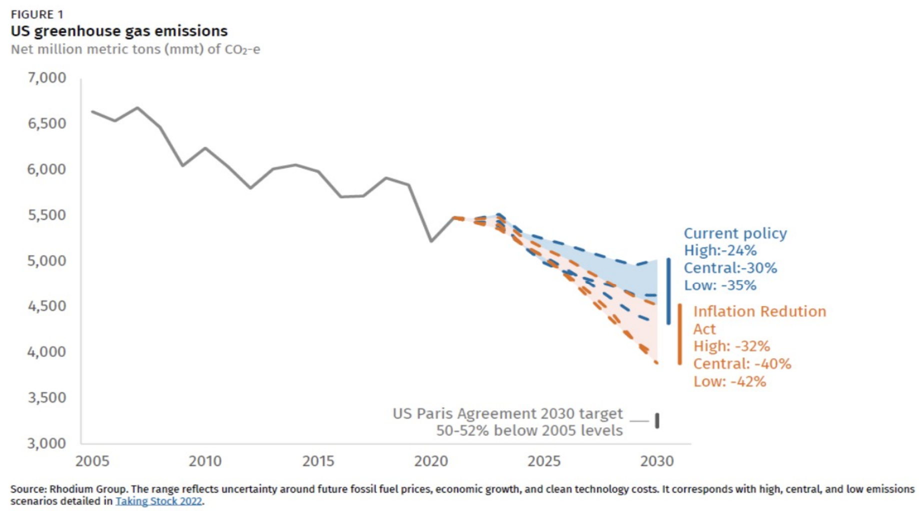
https://speedandscale.com/tracker/

COP29

Key Outcomes
1. **New Global Climate Finance Target**
– $300 billion/year from developed countries through 2035 (Compared to the ask of $1-1.3 trillion)
– Mention of potentially mobilising up to $1.3 trillion/year globally through public/private sources
2. **Article 6 Carbon-Market Infrastructure**
- Article 6.2 that focuses on country-to-country carbon trading adopted -Article 6.4 that standards strengthened to ensure mandatory environmental and human rights safeguards, including Indigenous consent
3. Push for more ambitious, investable NDCs (Countries are supposed to submit their revised NDCs by February 10, 2025). As of now only 25 of the 217 countries have submitted
4. No explicit reference to the “transitioning away from fossil fuels.”

Source: https://www.weforum.org/stories/2024/11/cop29-4-key-takeaways/
Source: https://unfccc.int/NDCREG





https://www.realclimate.org/index.php/archives/2022/08/climate-impacts-of-the-ira/

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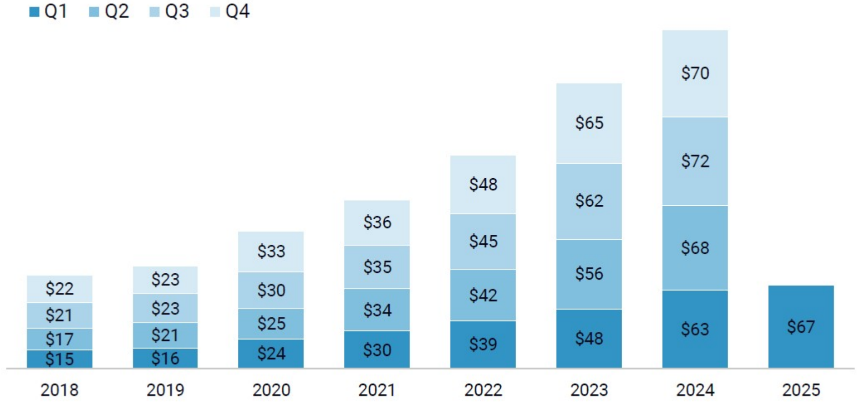
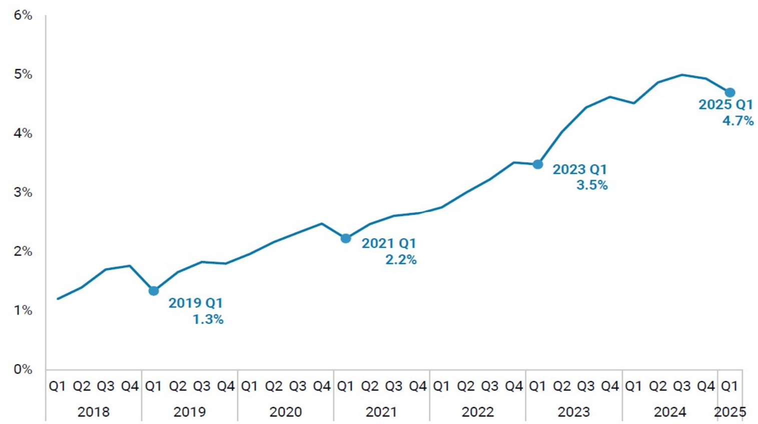
FIGURE 1
Clean investment by quarter
Billion 2023 USD



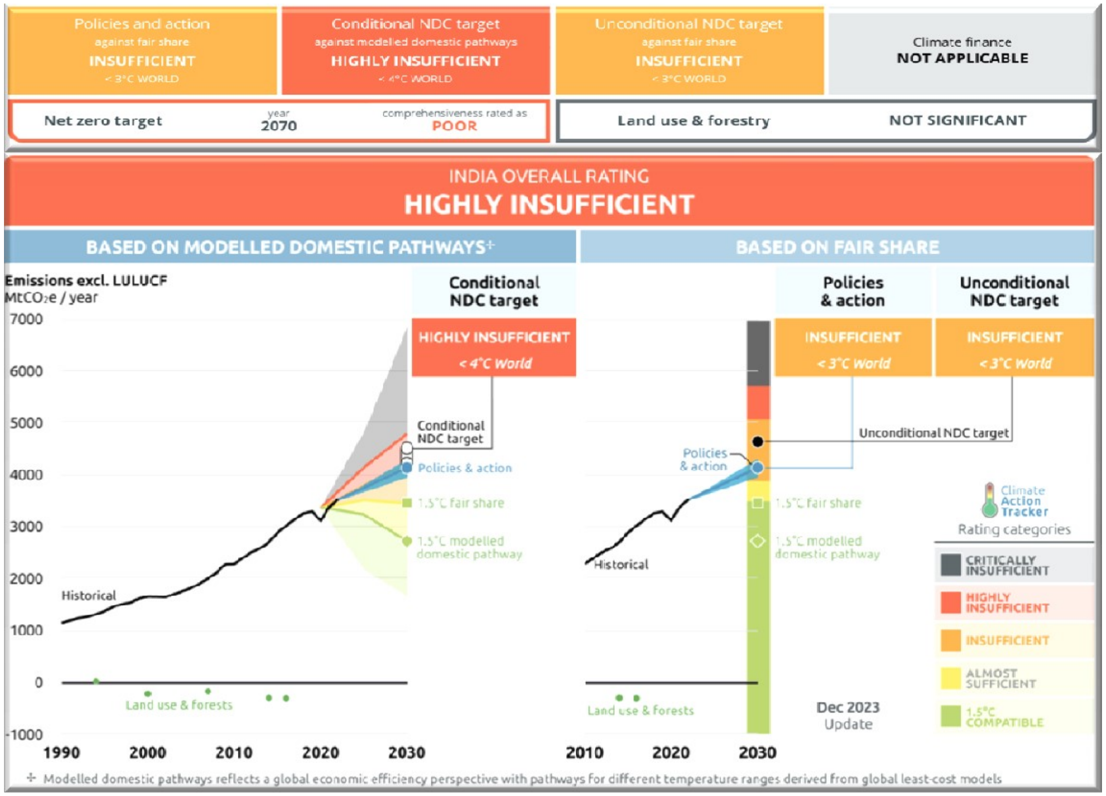
Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

FIGURE 2
Actual clean investment as a share of total US private investment
Annualized basis, total investment in all private structures, equipment, and durable consumer goods



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor and Bureau of Economic Analysis

https://rhg.com/research/clean-investment-monitor-q1-2025-update



https://climateactiontracker.org/countries/india/

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Y02 – Climate Change Mitigation Technologies

Europäisches Patentamt
European Patent Office
Office européen des brevets

Y02: A classification scheme for climate change mitigation technologies

Why we need Y02 | The structure of Y02 | Use of Y02 in Espacenet | Conclusion

1 2 3 4 1 2 3

What is Y02?

Y02 is a **tagging scheme** which enables documents relating to sustainable technologies to be retrieved quickly and accurately, across classification categories. This tagging scheme is included in the EPO's CPC classification scheme, which makes it compatible with both the CPC and the IPC.

Y02 was developed by a specialist team of EPO examiners who combined their expert knowledge in different fields to ensure that it covers all CCMT-related fields. The scheme benefits from the input of external peers (researchers, analysts, UNFCCC negotiators, NGOs, industry), so it is also of relevance for professionals and institutions outside the patent system.

y02

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Ref: https://e-courses.epo.org/course/view.php?id=46

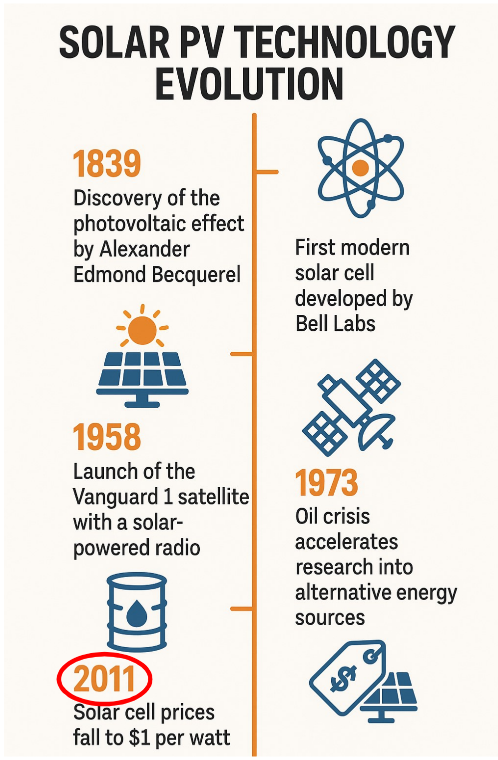
Other Initiatives To Help With Access To Green Technologies

WIPO Green

- Public-private partnership established y WIPO in 2013 for technology exchange that supports global efforts to address climate change by connecting providers and seekers of environmentally friendly technologies.

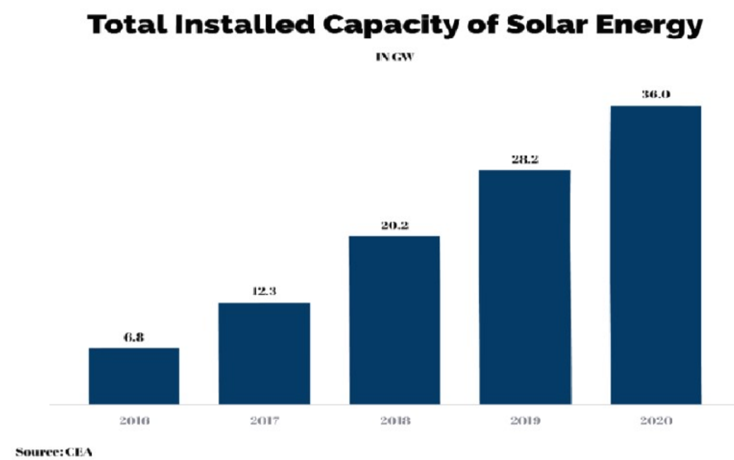
Green Technology Selector

- Online platform by European Bank for Reconstruction and Development (EBRD) to help accelerate the deployment of green technologies by streamlining investment decision-making



Policies from Germany and China!

https://www.infolink-group.com/energy-article/solar-topic-india-pv-regulations-policies-market-outlook + ChatGPT



February 2025 : ₹2.48 to ₹2.6 per kWh (approximately $0.029 to $0.03 per kWh)

https://www.ceew.in/publications/anatomy-solar-power-feed-in-tariff-decline-in-solar-bids-india
https://theindiawatch.com/infrastructure-and-real-estate/demand-for-solar-panel-set-to-grow-in-india

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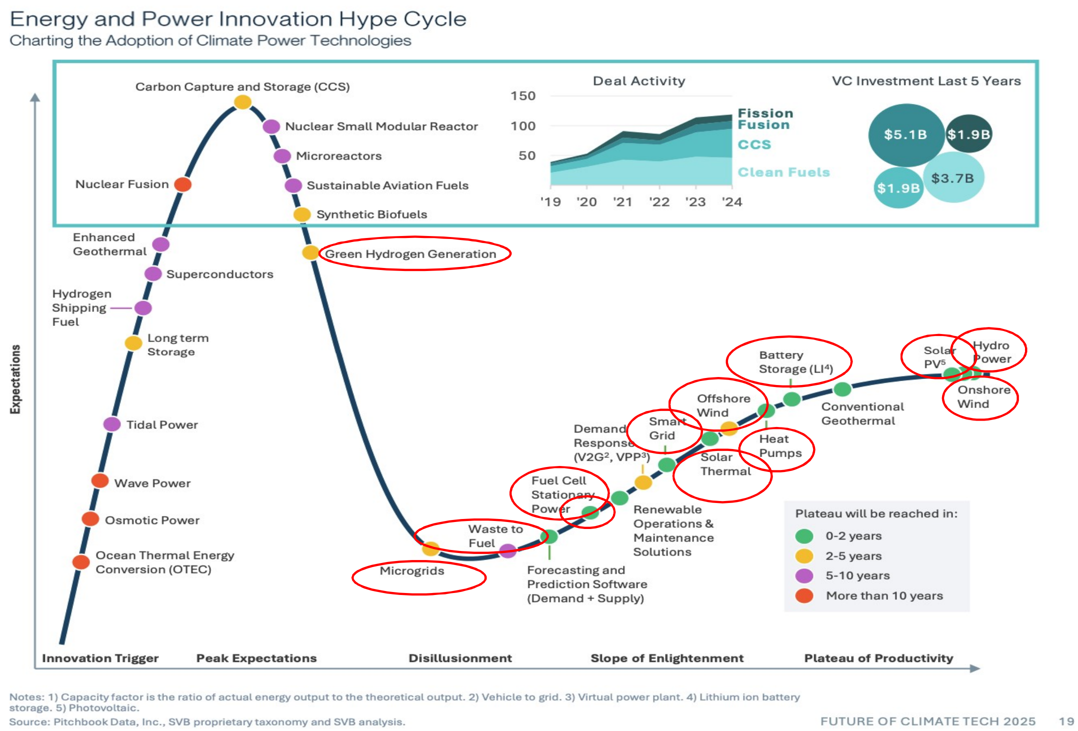
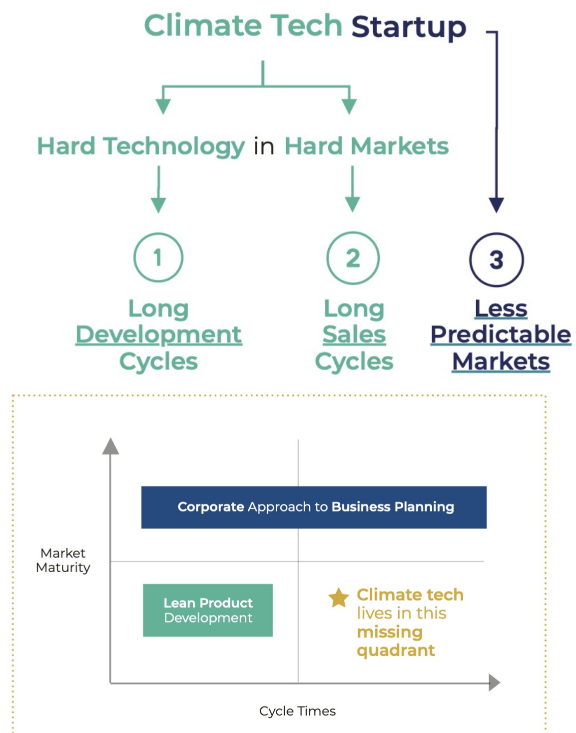


Source: https://www.svb.com/globalassets/trendsandinsights/reports/future-of-climate/2025/svb-climate-tech-report-2025.pdf

Climate Tech - Challenges

Category		Development & Deployment Cycle	Sales Cycle
HARDWARE	**Small** *E.g. EV Charging Station*	Months	Days to Years
HARDWARE	**Med & Large Hardware** *E.g. Electric Semi Trucks*	Years	Days to Years
HARDWARE	**Large Infrastructure** *E.g. Direct Air Capture*	Years+	Months to Years
SOFTWARE	**B2B** *E.g. Carbon Accounting Software*	Weeks	Months
SOFTWARE	**Deeptech B2B** *E.g. Control Systems / AI*	Years	Months to Years
SOFTWARE	**Tech-Enabled Services** *E.g. Nutritional Testing*	Months to Years	Days to Months
OTHERS	**Novel Materials** *E.g. Seaweed Plastic*	Years	Months to Years
OTHERS	**Nature-based Solutions** *E.g. Blue Carbon*	Years	Months to Years
OTHERS	**Commodity Mining** *E.g. Lithium Extraction*	Years	Months



Source: First Matter, Goldilocks Startup

Climate Tech - Challenges

Industry	Indicative Net Margins
Chemical Industry (Basic)	2-3%
Cement Industry	5-10% (Higher in India)
Steel Industry	5-7%
Airline Industry	3-4%
Trucking Industry	2-8%
Shipping	3%-55%

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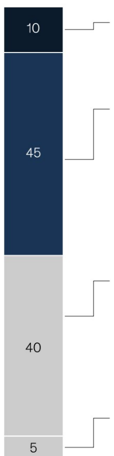
Most high-potential climate technologies are at advanced maturity levels, but only 10 percent are commercially competitive.

Share of total abatement by technology in 2050, %

Example technologies, by category: Clean electrons; Clean molecules; Carbon capture; Circulatory and resources



Stages, latest to earliest		Example technologies, by category
Global deployment	Commercially available and competitive in certain segments/settings	Onshore wind in regions with good grid connections Solar PV[1] in regions with good grid connections Large nuclear Plant-based dairy
In commercialization	Commercially available, but further support (eg, subsidies and system integration) needed for competitiveness	Onshore wind Solar PV Offshore wind Passenger battery electric vehicles Heat pumps Hydrogen alkaline water electrolysis, proton exchange membrane electrolysis Biofuels Forestry avoidance and removals
Early innovation	Demonstrated or proven in large-scale prototypes but not fully deployed at scale	Small modular reactors nuclear Power–gas carbon capture, utilization, and storage Direct air capture with carbon storage Hydrogen aviation E-fuels/power-to-liquid Plant-based beef Concrete recycling
In concept	Proof of concept in laboratories	Nuclear fusion Lithium-air batteries

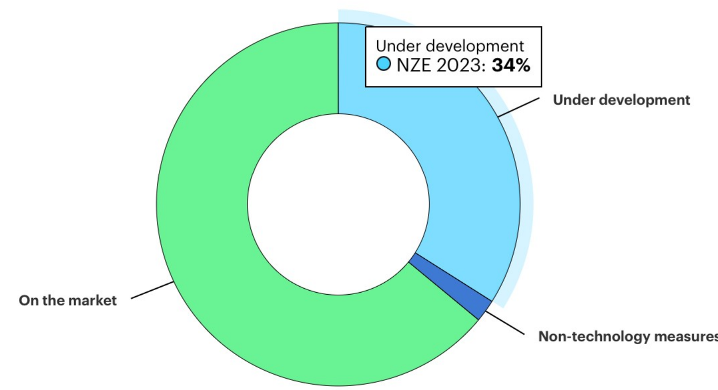
Note: Analysis excludes incumbent nonclimate technologies with abatement potential.
[1]Photovoltaic.
Source: ETP Clean Energy Technology Guide, IEA; *Global Energy Perspective 2023*, McKinsey, Oct 18, 2023

McKinsey & Company

Comparison of CO2 emissions reductions in 2050 relative to base year by technology maturity in the Net Zero Scenario, 2023

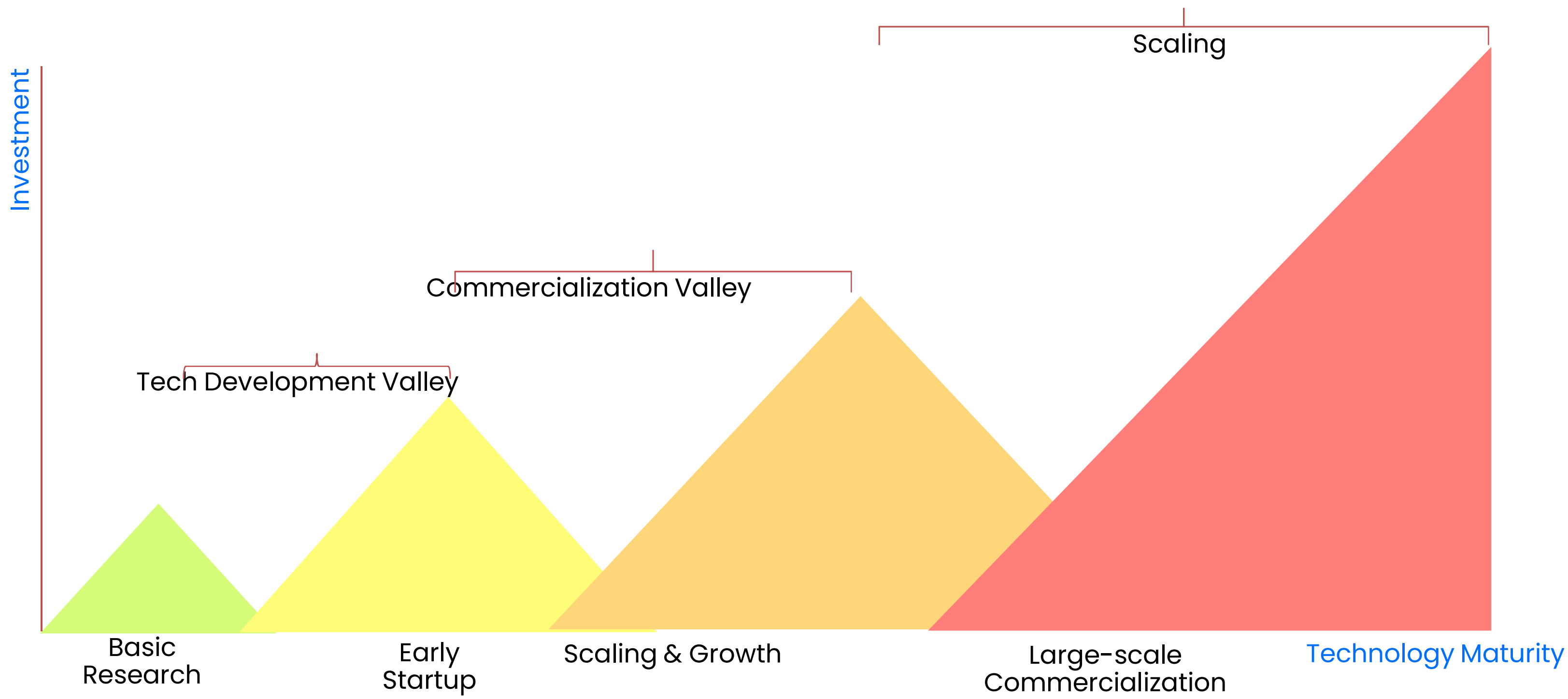
Open

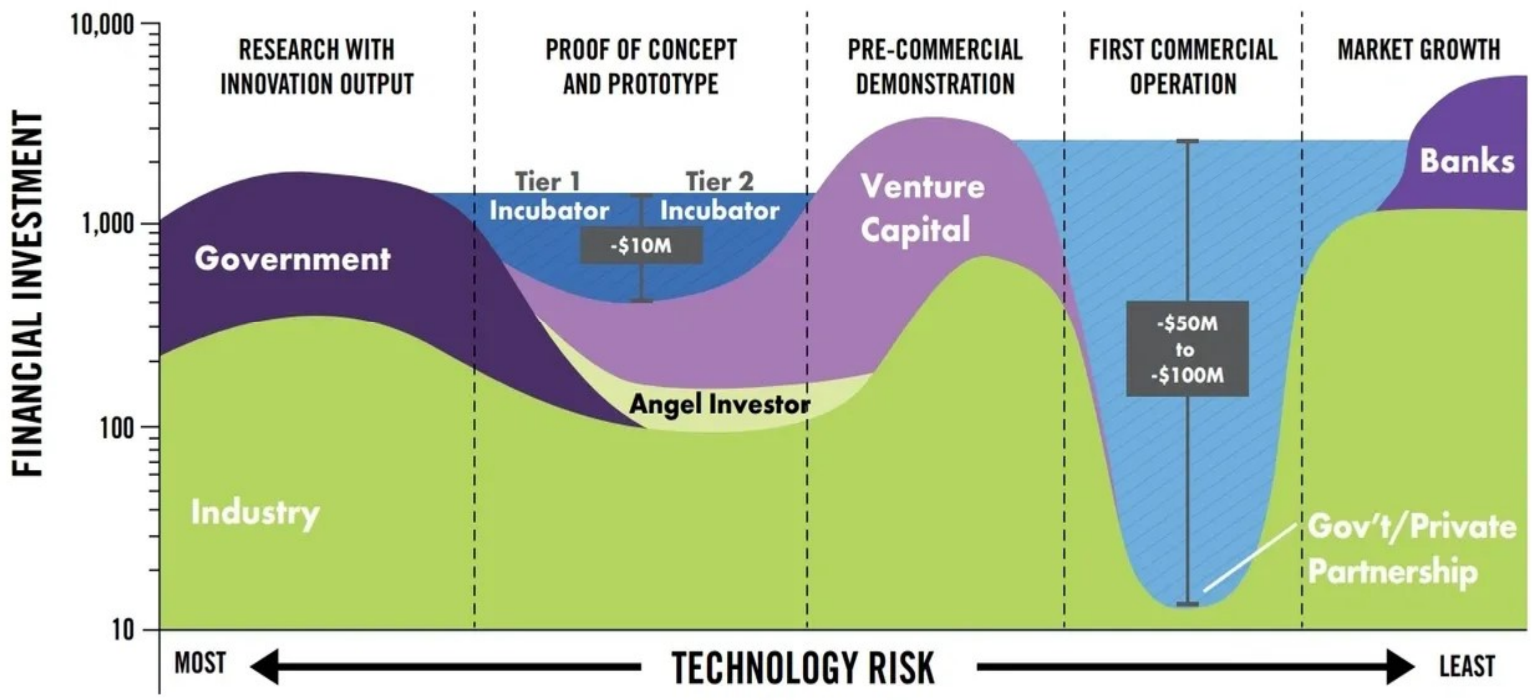
%



IEA. Licence: CC BY 4.0

Climate Tech Path-to-Market





Source: https://www.ctvc.co/project-finance-bankability/

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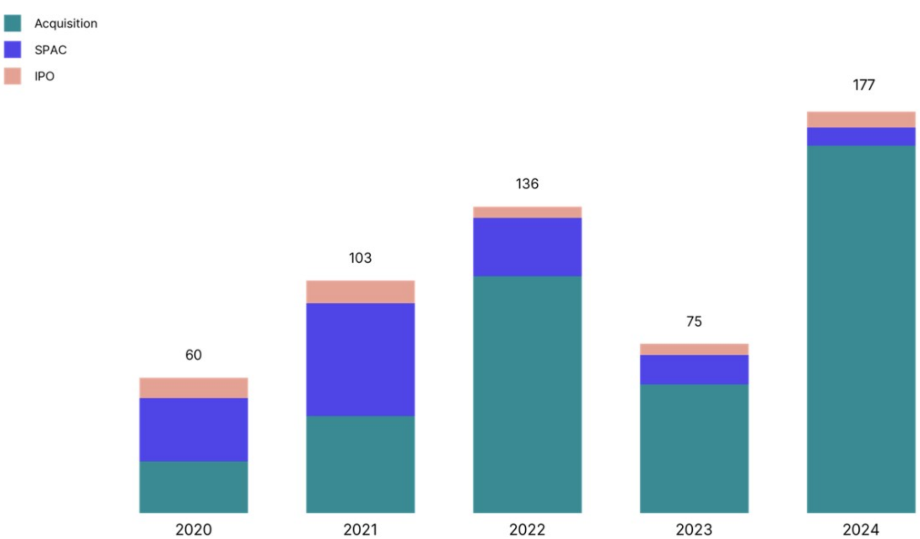
	Grant	Venture equity	Venture debt	Growth / Private equity	Commercial debt	Project Finance
Who	Government Foundations Accelerators / Incubators Catalytic capital	Venture Capital Corporate VCs Angel Investors	Banks Venture Debt Funds	Growth / Private Equity Growth / Private Equity Asset Managers	Banks	Banks Infrastructure Private Credit Investors
Stage	All	Pre-seed / Seed Early	Early Growth	Growth Mature	Growth Mature	Mature
Best for	R&D-focused startups	High-growth startups with scalable business models	High-growth, pre-profit startups looking to extend runway	Mature companies with proven revenue and profitability	Asset-heavy businesses or those with strong credit ratings	Capital-intensive projects with long-term revenue streams
Check size	$10K - $10M+	$500K - $50M+	$1M - $50M	$10M - $500M+	$5M - $500M+	$50M - $1B+
Expected return	0%	20-30%+	10-20%	15-25%	3-10%	6-15%
Dilution	❌	✅	Minimal	✅	❌	❌
Complexity	Low	Medium	Medium	High	Medium	High

Source: Sightline Climate // Note: colored funding sources correspond to the capital stack chart on the next page

Climate exits by type, 2020-2024 (no. exits)



Source: Sightline Climate // Note: Tracked exits are based on M&A, IPOs, and SPAC activity. Only included majority ownership exits at the corporate level (excluded divestitures/spinouts, project or asset sales, or minority buyouts)

Notable acquisitions in Q1'25

Target Company	Acquirer Company	Acquirer Type	Sector	Acquisition Valuation	Time to Exit
Pearl Street Technologies	Enverus	Startup	Grid technologies (Software provider)	Undisclosed	7 years
arcadium lithium	RioTinto	Corporate	Mining & Metals (Lithium)	$6.7bn	1 year
Plantae	80 Acres Farms	Startup	Crop yield (Seed & gene editing)	Undisclosed	5 years
RPD	Arcadia	Startup	Distributed Energy Resources (Renewable retail energy)	Undisclosed	11 years
Scale Microgrids	EQT	PE Buyout	Microgrid developer	Undisclosed	9 years

Source: Sightline Climate

Company	Type	IP Portfolio
Enverus	Enterprise Software	46 Patents
80 Acres Farms	Vertical Farming	6 Patents
Arcadia	Global utility data and energy solutions platform	9 Patents

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Share of VC deal value by stage for companies with patent applications/grants

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022*	Average (2011-2020)
Angel and seed	30.2%	28.5%	25.9%	24.0%	22.6%	22.9%	26.8%	23.7%	24.4%	20.5%	12.3%	6.6%	25.0%
Early stage	45.9%	44.1%	42.3%	42.4%	41.8%	44.1%	47.0%	46.2%	37.7%	34.8%	22.2%	12.7%	42.6%
Late stage	66.6%	62.9%	62.3%	68.0%	58.4%	64.1%	63.8%	68.6%	54.1%	62.8%	47.5%	40.3%	63.2%
Venture growth	83.2%	79.2%	79.9%	82.0%	78.4%	87.1%	79.1%	77.8%	83.4%	74.2%	72.1%	66.8%	80.4%

Source: PitchBook | Geography: US
*As of December 31, 2022

Share of VC deal count by stage for companies with patent applications/grants

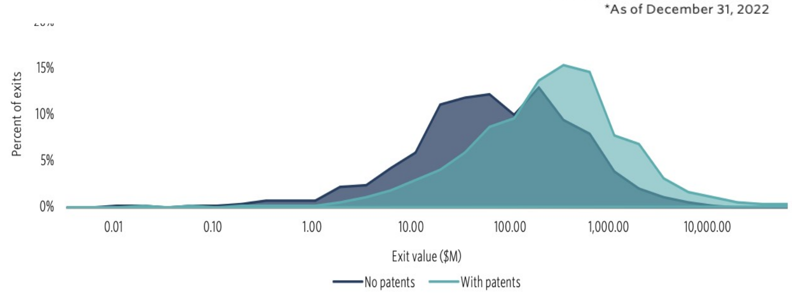
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022*	Average (2011-2020)
Angel and seed	18.7%	18.1%	18.5%	18.2%	18.0%	19.2%	20.1%	20.7%	18.2%	15.7%	10.8%	7.4%	18.5%
Early stage	32.3%	31.0%	31.1%	31.4%	31.6%	30.3%	30.3%	30.7%	26.4%	24.1%	15.4%	8.7%	29.9%
Late stage	53.5%	53.2%	52.6%	53.2%	49.7%	50.2%	49.0%	46.9%	43.6%	45.6%	39.0%	33.1%	49.7%
Venture growth	73.5%	72.3%	72.1%	73.3%	72.3%	69.4%	70.0%	68.0%	68.3%	66.3%	63.6%	58.9%	70.6%

Source: PitchBook | Geography: US
*As of December 31, 2022

Percent of startups with 10 or more patents or patent applications by stage

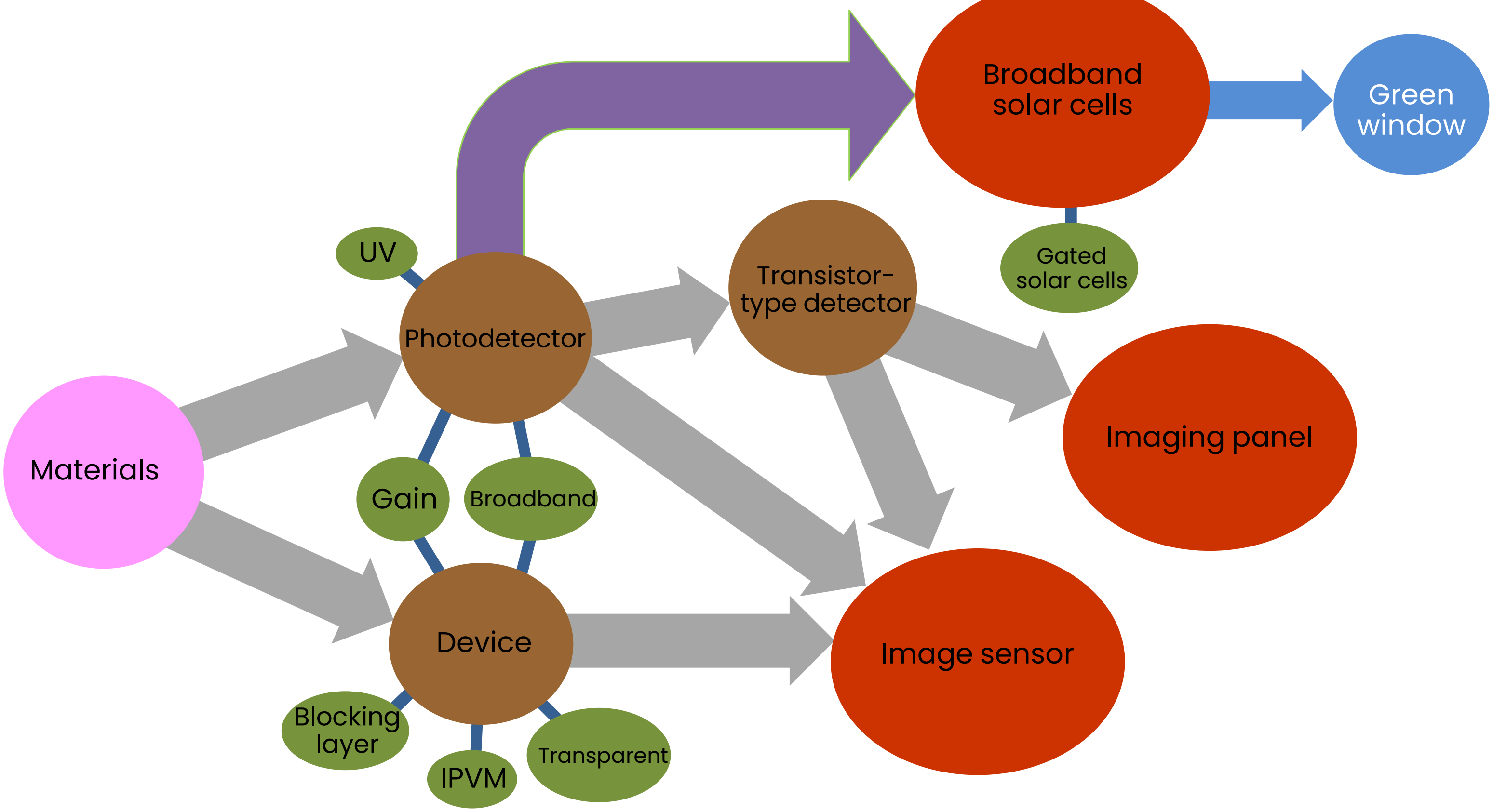
Stage	Percent of startups
Angel and seed	1%
Early stage	3% to 4%
Late stage	10% to 14%
Venture growth	30% to 34%

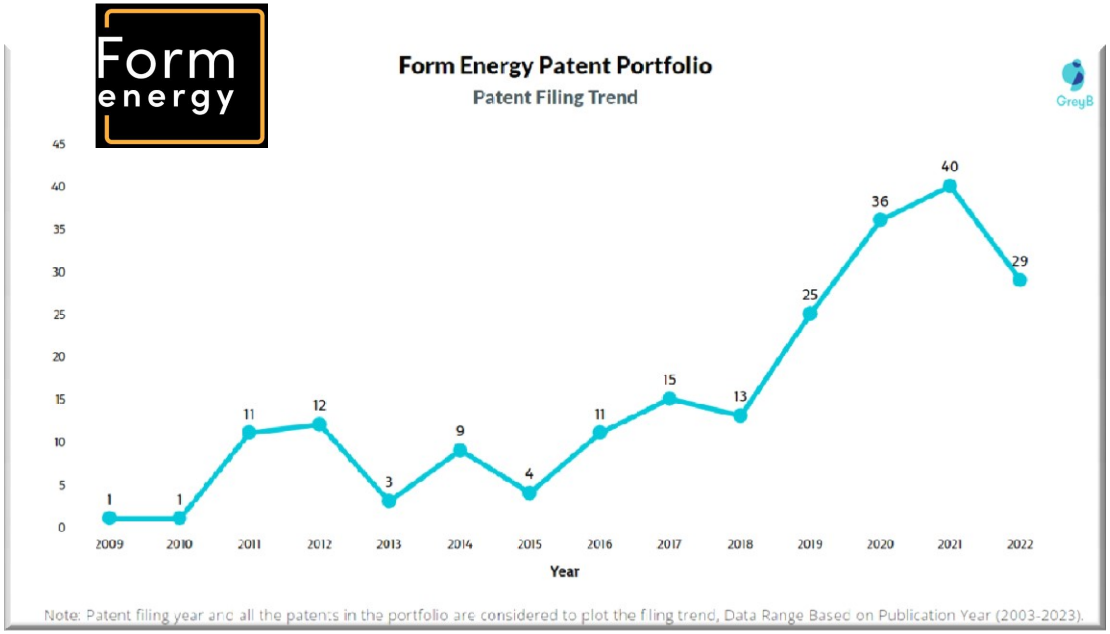
Source: PitchBook | Geography: US
*As of December 31, 2022



Source: PitchBook | Geography: US
*As of December 31, 2022

Source: Introducing PitchBook Patent Research, Q1 2023


Broadband
solar cells
Green
window
UV
Photodetector
Transistor-
type detector
Gated
solar cells
Imaging panel
Materials
Gain
Broadband
Device
Image sensor
Blocking
layer
IPVM
Transparent



Time Period	Primary Research Focus
2012–2016	Core electrochemical components and battery chemistry
2017–2019	(Form Energy Launched in 2017) Integration with renewable energy systems and control mechanisms
2020–2022	Long-duration storage solutions, iron-air batteries, and hybrid systems

Technology Area	Number of Patents
Iron-Air Battery Systems	45
Electrochemical Cell Components	30
Hybrid Battery Systems	25
Renewable Energy System Controls	20
Moisture and Gas Management in Electrochemical Cells	15
Environmental Technologies	10
Other Energy Storage Innovations	57
Total	**202**

ChatGPT – Patent Explorer
https://insights.greyb.com/form-energy-patents/

Interim Takeaways





Tech Transfer Online

What Does It Mean To Commercialization Journey?

Commercialization Journey

Lab

- Proof of Principle
- **TRL 1-5**
- Testing the science
- Exploring applications
- Exploring economics

(Multiple) Pilot

- Proof of Concept
- **TRL 5-7**
- Testing the engineering
- Market specific application
- Market specific economics
- Data validated by partners

(Multiple) Demonstration

- Proof of Value
- **TRL 7-8**
- Testing the economics
- Customer specific application
- Customer specific economics
- Test and validate with partners

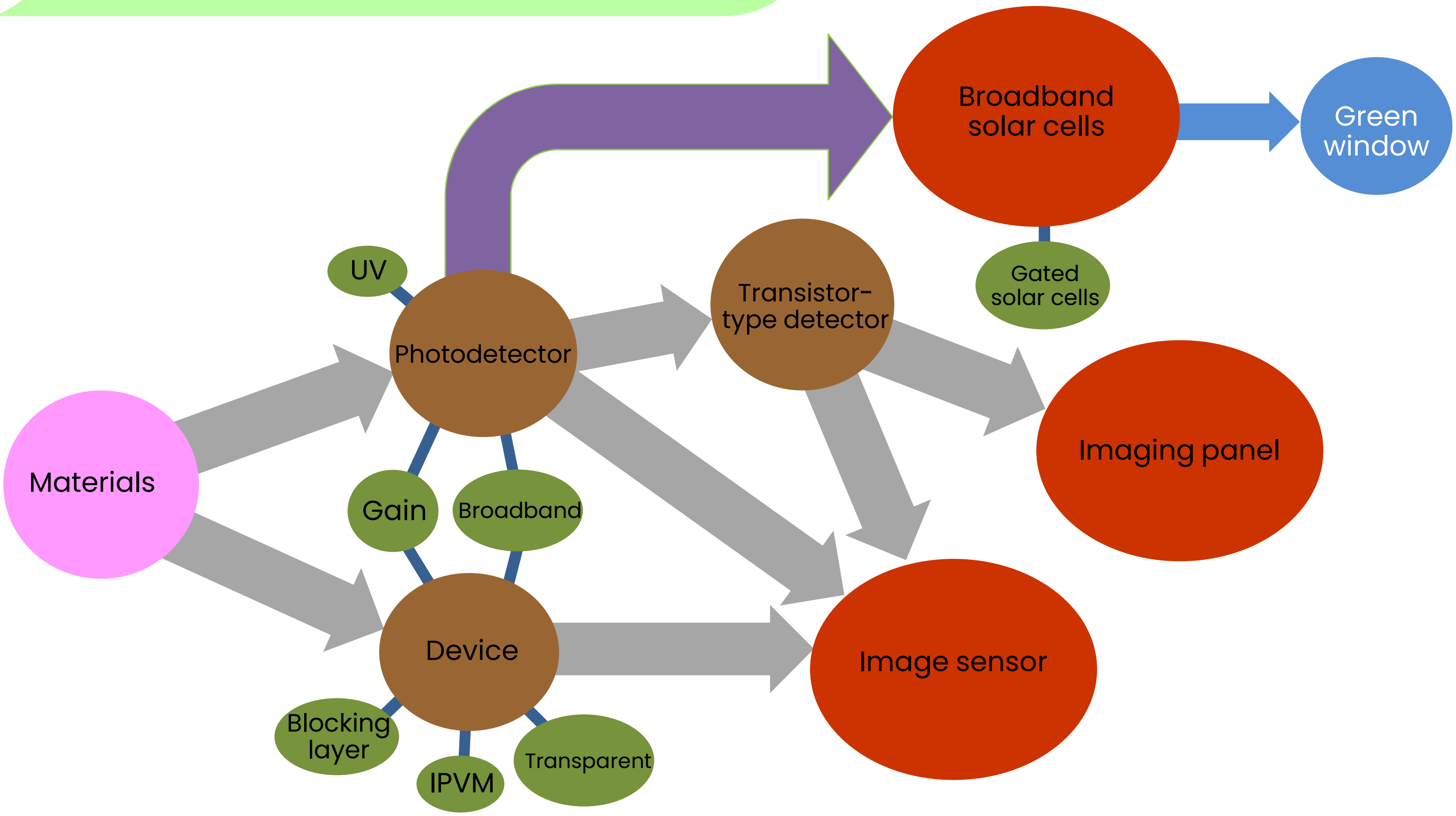
Commercialization

- Business Model & Revenue Growth
- **TRL 9+**
- No testing
- Proof of business model
- Customer value creation
- Profitability
- Sales to customers

Partnerships

- Co-development, Collaboration, Expertise
- Laboratory Infrastructure – Material, Space, Equipment, Analytics
- Testing and Validation
- Capital Equipment
- Supply Chain
- Design & Fabrication
- Engineering
- Space
- Utilities
- Logistics, Warehousing, Distribution
- Market Access
- Investment, Finance and Revenue
- Grant Funding

Image Credit: ChatGPT & https://mtec.edu/programs/custom-design-and-fabrication/


Broadband solar cells
Green window
Gated solar cells
UV
Photodetector
Transistor-type detector
Imaging panel
Materials
Gain
Broadband
Device
Image sensor
Blocking layer
IPVM
Transparent

Cambridge Display Technologies (CDT)

- Fluorescent P-OLED Tech from Cambridge licensed to CDT Ltd. in 1992
- Core P-OLED patent expiring in 2010
- Initial focus – manufacturer of displays
- Very little capital but strong IP portfolio
- Shift of focus to partnership model (1999)
  - Licensing
    - Multiple partnerships in each area
    - Royalty based on sales and no upfront payment
  - Joint Development
- Manufacturing Development Center (2000)
  - Process package license (Know-how)
- Acquired Opsys IP portfolio (Phosphorescent P-OLED tech) (2002)
- IPO (Dec 2004)
  - Raised over US$200m of investment and been granted 100 patents.

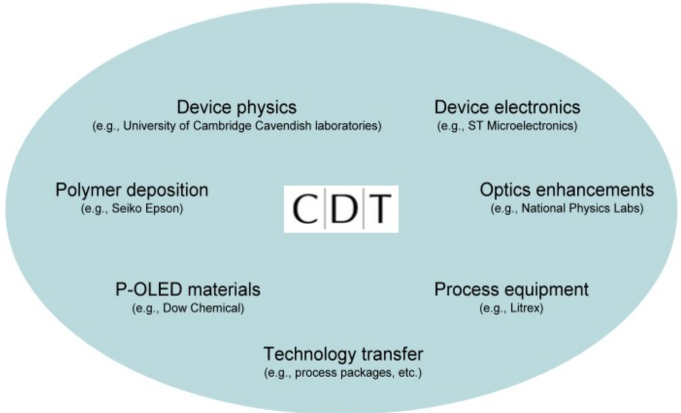
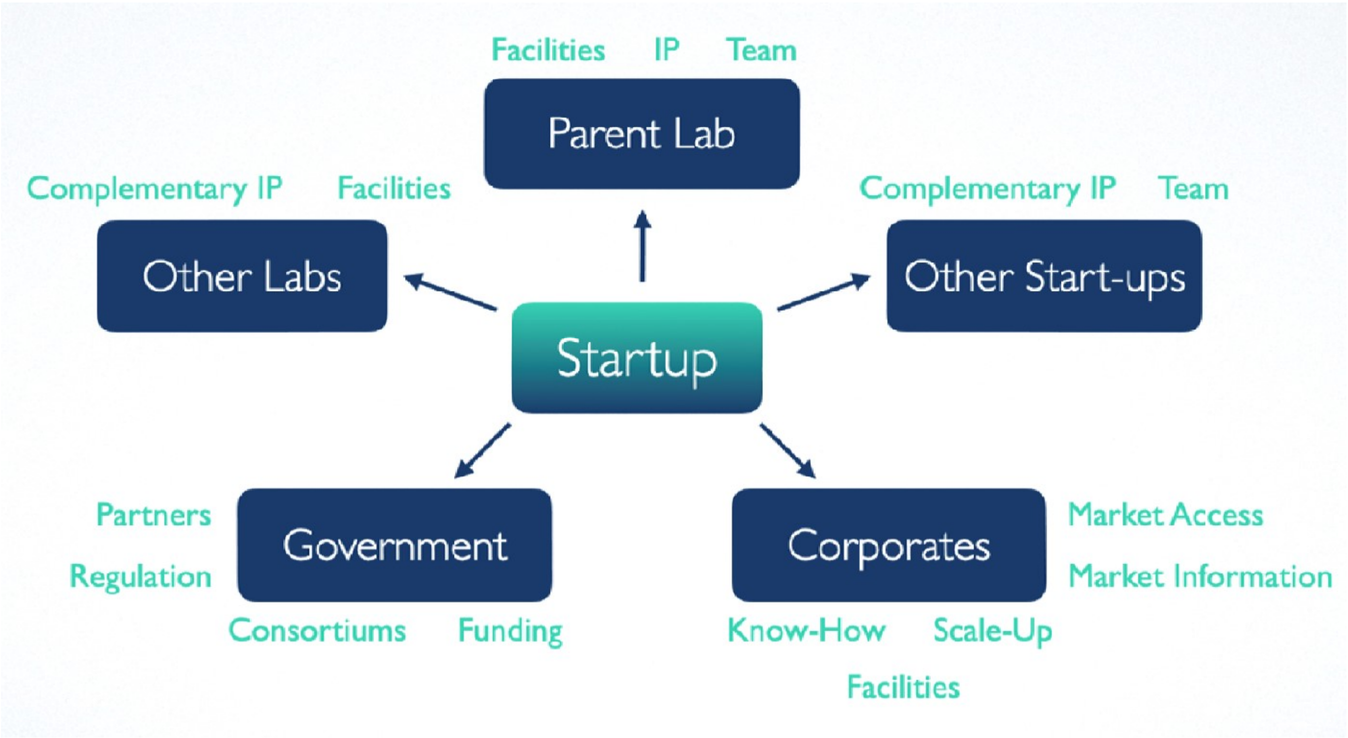


Fig. 3 CDT's Business model as of 2003 showing example partnerships (Source: CDT Ltd).

Source: https://doi.org/10.1142/S0219877007001107


Facilities
IP
Team
Parent Lab
Complementary IP
Facilities
Other Labs
Complementary IP
Team
Other Start-ups
Startup
Partners
Regulation
Government
Consortiums
Funding
Corporates
Market Access
Market Information
Know-How
Scale-Up
Facilities

Tech Transfer Online

Table 4. Partnerships and complementary resource access of case firms

	NanoMagnetics	Apaclara	Metalysis	Q-Flo	Oxonica Materials	Carbon 8 Systems	CDT
Strategy requires close collaboration with clients/coproducers	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Coproducers secured?	No	Yes	Yes	No	Yes	Yes	Yes
Partnership with parent university	No	Yes (Bristol)	No	Yes	No	Yes	Yes
Complementary resources from parent	N/A	– Lab facilities – Assistance of university researchers	– IP (at start)	– Lab facilities	N/A	– Use of lab facilities – Partnerships	– R&D assistance
Other academic partners	Yes	No	Yes	No	No	Yes	Yes
Complementary resources from other academic partners	– Use of lab facilities – Assistance of university researchers	N/A	– Assistance by personnel – Complementary R&D (including scale-up), postprocessing, metal characterization and modeling)	N/A	N/A	– Complementary R&D	– Assistance by personnel – Complementary R&D
Corporate partners	No	Yes	Yes	No	Yes	Yes	Yes
Complementary resources from corporate partners	N/A *Note: While IBM was not a partner, it still provided proof of value*	– Codevelopment – Potential market access	– Scale-up capabilities – Complementary R&D – Complementary IP – Market access[13]	N/A	– Market access	– Complementary R&D	– Complementary R&D – IP – Manufacturing capabilities – Market access
USO partners	No	No	Not currently, though worked briefly with Inertius	No	No	No	Yes
Complementary resources from other USOs	N/A	N/A	– Attempted complementary R&D	N/A	N/A	N/A	– Complementary R&D – Complementary IP
Government partners	No	No	No	No	No	Yes	Yes
Complementary resources from government	N/A	N/A	N/A	N/A	N/A	– Access to partners	– Access to partners

IP, intellectual property; N/A, not applicable; R&D, research and development; USO, university spin off.

R&D Management **43**, 2, 2013.

Viridos
(Formerly Synthetic Genomics)

- Founded in 2005 with a mission to leverage synthetic biology to revolutionize bioengineering and create sustainable solutions across sectors including energy, health, and agriculture
- 2009 – 2021 : Significant funding from ExxonMobil ($600M)
  - Explored broad synthetic biology applications but struggled to convert platform tech into scalable commercial products
  - Narrowed focus to develop algae-derived biofuels that could be a drop-in replacement for gasoline, diesel, or jet fuel.
  - 2010 – First self-replicable synthetic cell (Science publication)
  - Faced challenges around algae biofuel yield, scale, and cost
  - Reputation as a cutting-edge but speculative biotech company that had limited investor and partner appeal
- 2021: Rebrand to Viridos, Repositioning
- 2023: Raised $25M Series A led by Breakthrough Energy Ventures with United Airlines and Chevron
- Significant breakthrough - Engineered microalgae strains that produce oil at rates seven times higher than wild strains
  - Can be cultivated in saltwater, allowing production in arid regions without competing for freshwater or arable land
- Over a 100 patents, no commercial sales yet

Interim Takeaways

It is a long and twisted path with changing priorities

Requires significant investment

Requires strategic partnerships

IP & Know-how takes investment and grant support to build

Know-how is an important commercializable asset

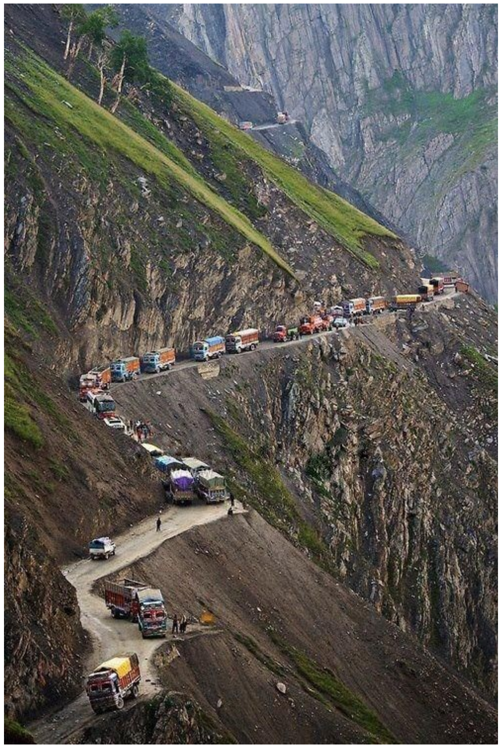


Image: Zojila Pass, Srinagar to Leh

What Does This Mean To Tech Transfer?

Tech Transfer Online

Tech Transfer in Commercialization

IP Policy

Lead Generation → Term sheet and Contracts → Technology Transfer → Compliance → Long-term relationship

Lead Generation

- Tech Offer
- Marketing
- Responding to enquiries
- Converting them to potential licensee

Term sheet and Contracts

- NDA
- Termsheet
- Full agreement
- Negotiation
- Closing

Technology Transfer

- Tech package
- Know-how transfer
- Setting Boundaries
- Ensuring best efforts

Compliance

- Upfront and minimal payments
- Notification of patent prosecution deadlines
- Royalty calculations
- Dispute resolution
- Adjusting to changing circumstances and rigid patenting timelines

Long-term relationship

- Converting the Licensee to repeat customer

Lead Generation

- IP Policy
  - Need transparent policy that is updated and publicly available
  - Ecosystem specific
    - What works in Mumbai doesn't necessarily work in Tirupati or Gandhinagar
  - Upfront payment & Business Plan to get basic details of the technology?
    - Does the revenue justify the friction?
    - How can anyone create a business plan if there is not enough details about the tech?
  - Non-exclusivity trap
    - When does non-exclusivity make sense? When does exclusivity ?
  - Perpetual vs. limited time license
  - What agreements need to be done in hard copies and what is allowable to maintain momentum?
    - Stamp papers, seal and stamps, electronic signatures, DocuSign etc
  - KPIs for tech transfer officers - # of enquiries or # of successful closes

Lead Generation

- Tech offers and websites
  - Marketing document
    - Identify your customers and speak to their needs
  - User friendly and easy to use search tools
  - List updated contact details
  - Update patent information frequently and remove old patents
    - Unless it is a fundamental patent
  - Include details of public information (Published papers, Published patent application numbers)

Be proactive! Listen! Make it frictionless to do business with you!

Term Sheets And Contracts

- Licensing vs. assignment
- Non-exclusive vs. exclusive license
- Option agreements
- Know-how licensing
  - Important for climate tech
- Perpetual vs. limited-time license
- Restricted license (come back when you have an investor)
- Sub-licensing restrictions
  - Think about the impact of restrictions
- Ownership of improvements
  - Mis-aligned KPIs
- Payments
  - Taking equity
  - Keep the time-line for commercialization in mind
- Royalty stacking

Term Sheets And Contracts

- Key Challenges
  - Long negotiations
  - Lack of clarity on decision making process
  - Balancing the interests of PI, host organization and licensee
  - Misaligned expectations about maturity of the technology
  - Misaligned incentives of TTO
    - What You Measure Is What You Get (WYMWYG)

Tech Transfer

- Challenges
  - Documents and data dump
  - PI not accessible
  - Student/post-doc/RA who did the work left
  - Student who did the work did not document SOP
  - Experimental setups dismantled/mothballed/repurposed
  - Data and SOPs missing/mis-placed
  - Boundaries blur between know-how transfer vs. consulting

Compliance

- Technology bundles
- Payments
  - On-time invoicing and timely payment tracking
  - Equity tracking
- Technology transfer
  - Ensuring timely transfer of know-how and balancing requirements on both sides
- Prosecution
  - Timely notifications to licensee, patent agent and PI
- Registration of rights
- Tracking of assignment of license
- Keeping track of sub-licensing, improvements and obligations related to it
- Managing non-compliance
  - Timely action & Flexibility
- Dispute Resolution and Escalation
- Warranty and Indemnification
- Claw backs

Keep the big picture in mind!

Long Term Relationship

- License + JDA
  - Background vs. foreground
  - FTO considerations
- Joint IP ownership
  - Generally, a bad idea
- Pipeline agreements
- Additional technologies to license

Take Aways

- Right policies around technology transfer can accelerate the lab-to-market of critical climate tech solutions
- Considerations
  - Long commercialization timelines
  - Ecosystem factors
  - Accessibility of technologies
  - Pathways to maintain momentum during negotiations and accelerate exception handling
  - Partnership with licensee
    - Planning for know-how transfer
    - Terms that allow licensee navigate the long commercialization path
    - Accommodating changing and evolving strategy of the licensee

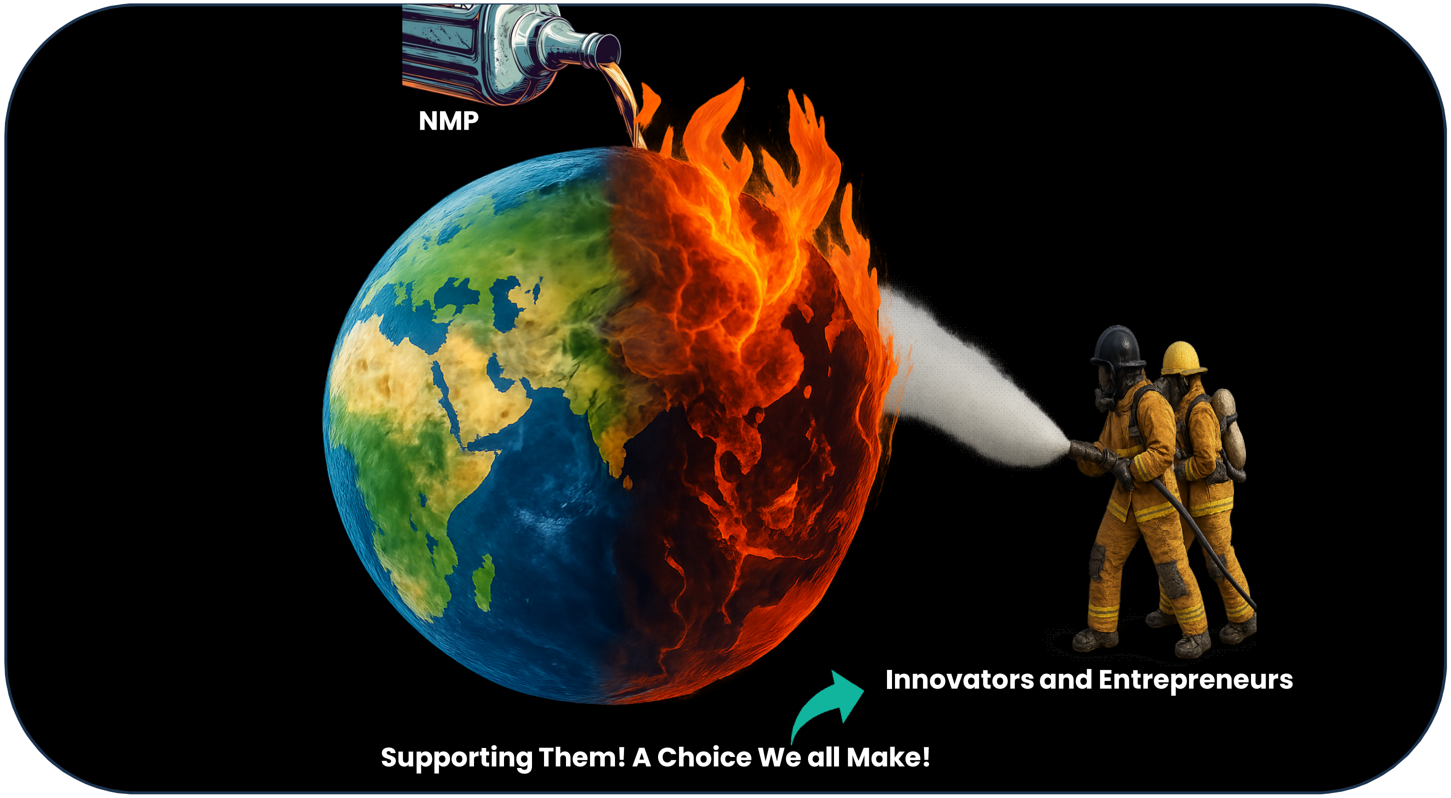


Image Credit: ChatGPT & Canva

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