

# US Energy Transition Report

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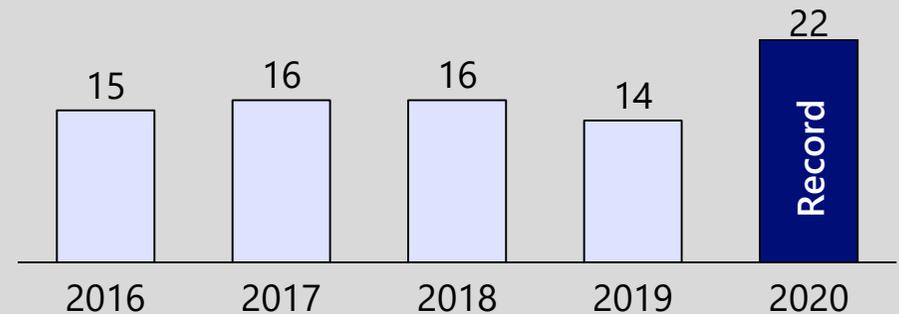


# US Climate Change Impacts in 2020

## NRIA's View

As global warming and climate change accelerates from increasing greenhouse gas (GHG) emissions, the US will continue experiencing climate disasters causing billions of dollars in catastrophic damage. In this summary report, NRIA studied how the US is combatting climate change through **promotion and investment in the Energy Transition**, and the **emerging clean technology opportunities** involved in reducing GHG emissions.

## 22 Billion-Dollar Climate Disasters in 2020...



... cost the nation \$95 billion USD in damages

\$95B

### Disasters in 2020:

- Record-breaking 30 named tropical cyclones
- Record-breaking US wildfire season, burned more than 10.2 million acres
- Historic Midwest Derecho in August 2020 caused widespread damage to millions of acres of crops
- Many other severe storms, flooding, droughts, and heat wave events

# Why should we, as business leaders, focus on the US energy transition?

## Key Issues

## NRI's Viewpoint

### 1 Why Energy Transition?



- There are other global crises, so why energy transition in particular?

- Climate change is a **crisis which can no longer be ignored**, evident by the **increasing global climate disasters** and its damages
- Through the Paris Agreement, nearly 200 countries agreed to **making finance flows** consistent with a pathway to **limit global temperature rise to 2 degrees Celsius**
- To achieve this goal will be a **global effort, with trillions of dollars in investment**, and collaboration for innovation in new technologies

### 2 Why Now?



- Why is now the time to focus on energy transition?

- The **years to irreversibility is rapidly approaching**, with the World Economic Forum predicting the Earth could cross the global warming threshold as soon as 2027
- After COVID, governments are putting in **stimulus packages including Green Policies**, with many countries pledging for carbon neutrality by 2050
- Globally there has been a **shift in consumer sentiments towards Sustainability including ESG and SDGs**, and governments as well as companies are responding to positively capture this transition

### 3 Why USA?



- Why should we focus on the US market compared to Japan or other markets?

- President Biden has a **drastic goal of zero-carbon electricity by 2035 and reaching net-zero emissions by 2050**
- To achieve the targets, **Biden administration is targeting a massive \$2 trillion dollar infrastructure investment** including expansion of clean technologies
- The US **leads the world in clean technology innovation and venture investment**

# The energy transition is an opportunity for businesses to contribute to solving a global crisis, while capitalizing on a growing need for society

## Key Takeaways from this Summary Report

### 1. Key Trends in the US Energy Transition

Recent energy transition trends	COVID reduced energy consumption and GHG emissions in 2020. US will continue to increase renewable energy, but must invest in other technologies to achieve carbon neutrality by 2050.
Governmental policies promoting energy transition	California and New York are the leading states with policies promoting deployment of emerging clean technologies. Federal policies are currently lacking, but support is expected to grow.
Private company initiatives	Private companies in oil & gas, power & utilities, and industrials are among the sectors investing in the energy transition through internal R&D, partnerships, venture investment, and acquisitions.
Key investment trends	Financial institutions are increasing investment in the energy transition as part of SDG goals, along with issuance of green bonds. Pension funds and private equity are also increasing investment.

### 2. Emerging Clean Technologies

Clean Technology Landscape	There are several key technology areas emerging and currently in development (hydrogen, CCUS/DAC, etc.), with hundreds of clean tech companies competing and innovating in each area.
Deep Dive into Hydrogen	Hydrogen fuel and technology will be required to achieve carbon neutrality, but has several challenges in technology maturity, cost, and supply chain.

## Related NRI Service Offerings

**NRIA's service offerings can support businesses to further understand the energy transition trends, and to build a strategy for participation and contribution:**

- Trend Watching
- Industry & Technology Research
- Market Analysis
- Strategy Consulting
- New Business Development
  - Innovation strategy
  - Alliance & strategic partnerships
- M&A Consulting
  - Target company selection
  - Due diligence & financial valuation
  - Post merger integration

## 1. US Energy Transition Trends

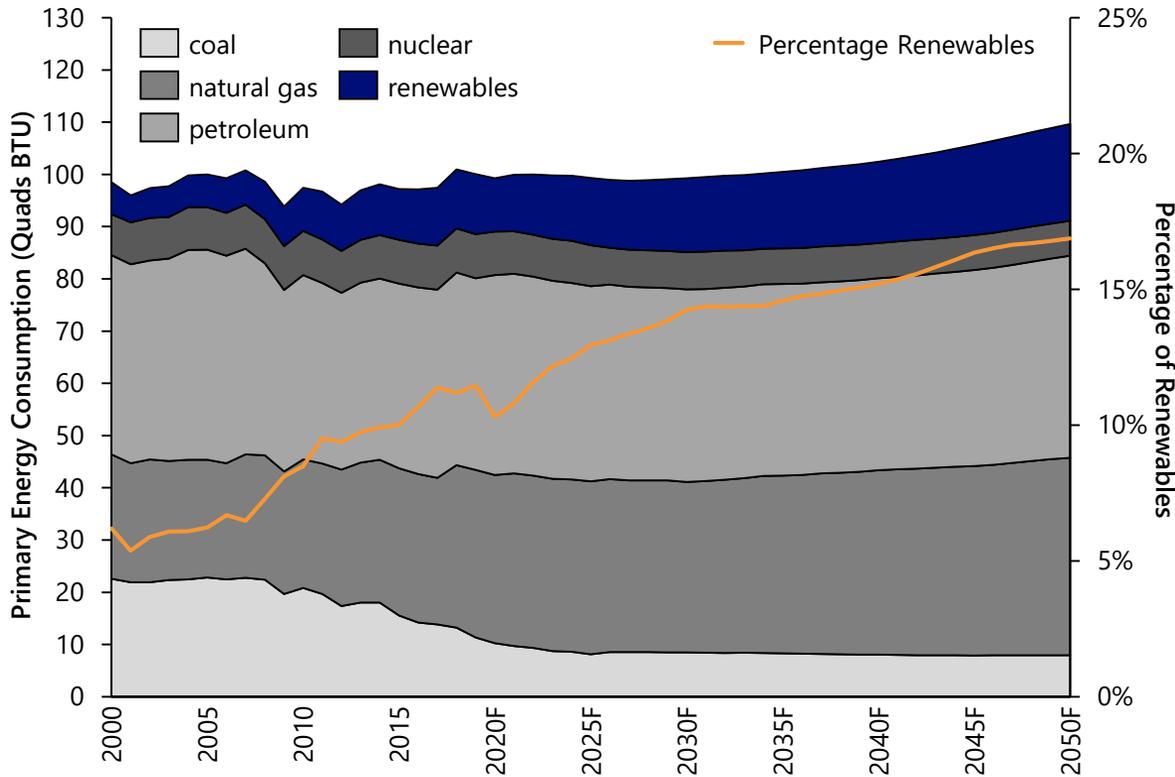
## 2. Emerging Clean Technologies

## About NRI America

## Recent energy transition trends

Despite the increase in renewables to 17% of primary energy consumption by 2050, energy-related CO2 emissions are only expected to decline by 4%

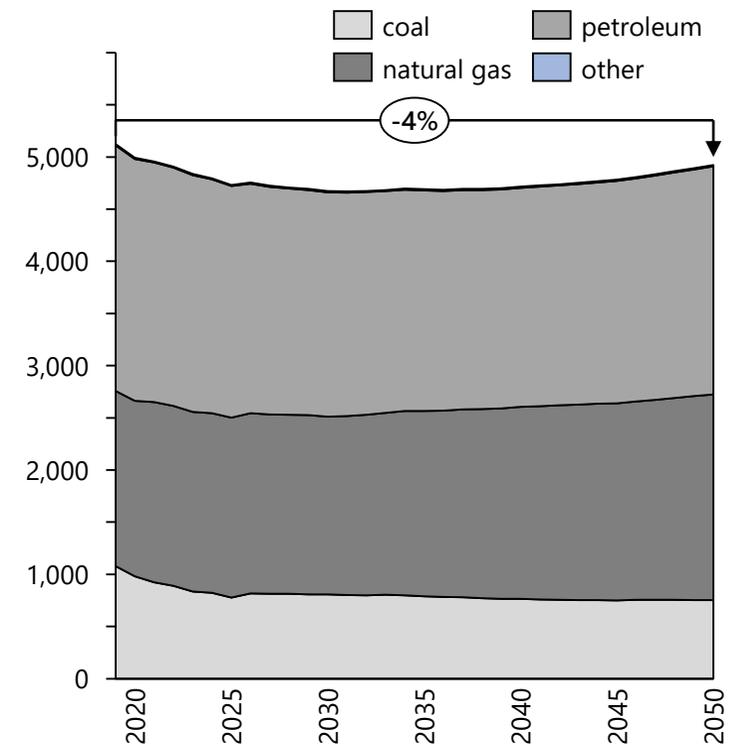
Primary Energy Consumption Forecast in USA (to 2050)



As of 2020, US does not have a federal target for renewables, but rather Renewable Portfolio Standard (RPS) policies at the state level

Energy-Related CO2 Emissions Forecast (to 2050)

Units: MMmt CO2



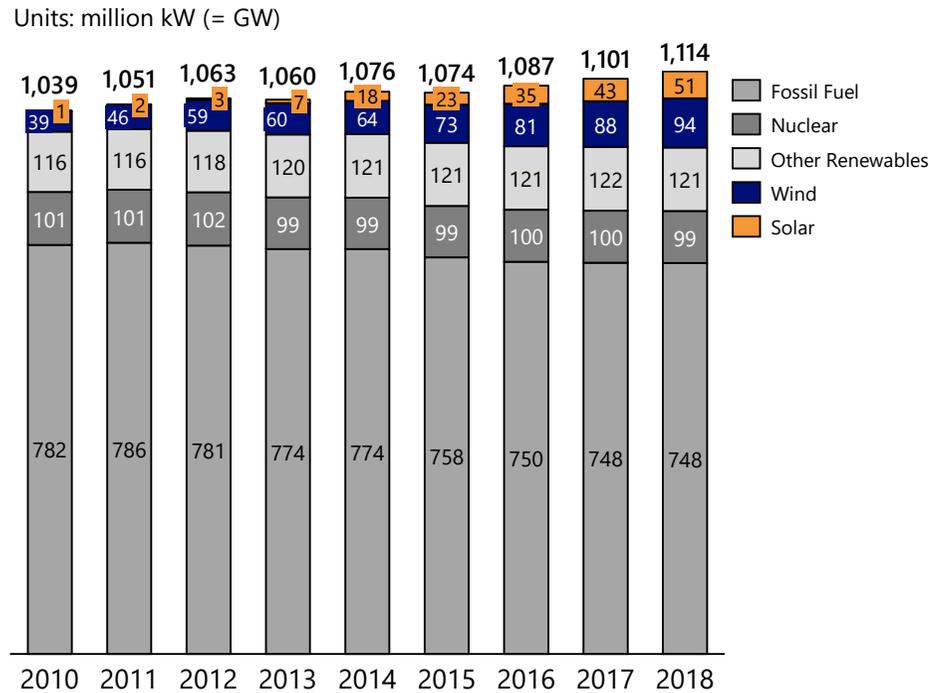
As of 2020, US does not have any federal targets for GHG emission reduction

## Recent energy transition trends

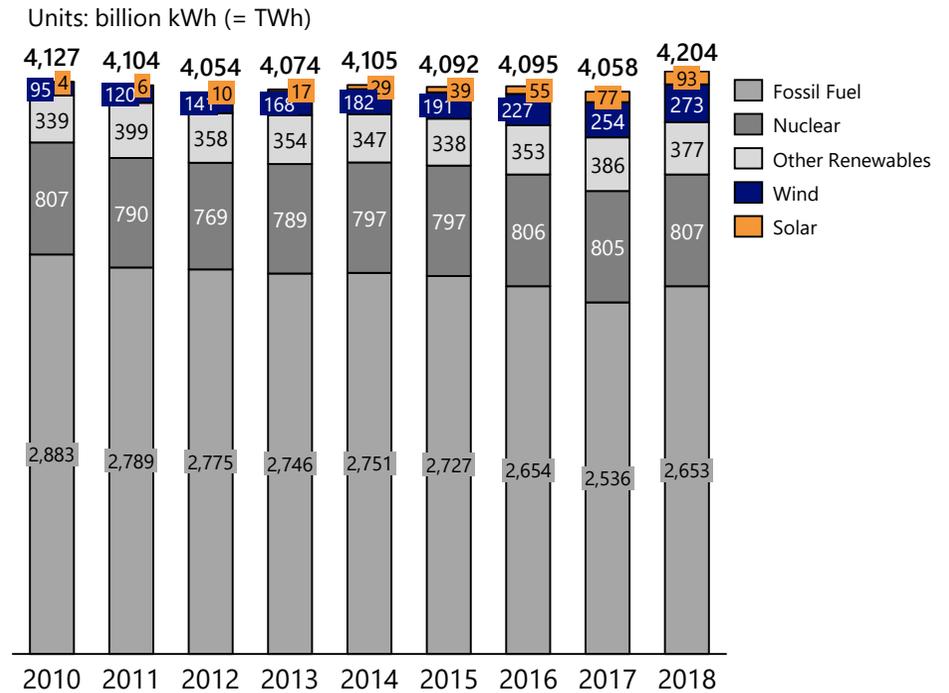
# Driven by environmental considerations, US is accelerating the introduction of renewable energy, such as solar and wind power in the electricity sector

- Although the percentage is still small, both wind and solar power are expanding in the electricity sector

### Energy Mix for Electricity Generation (Capacity)



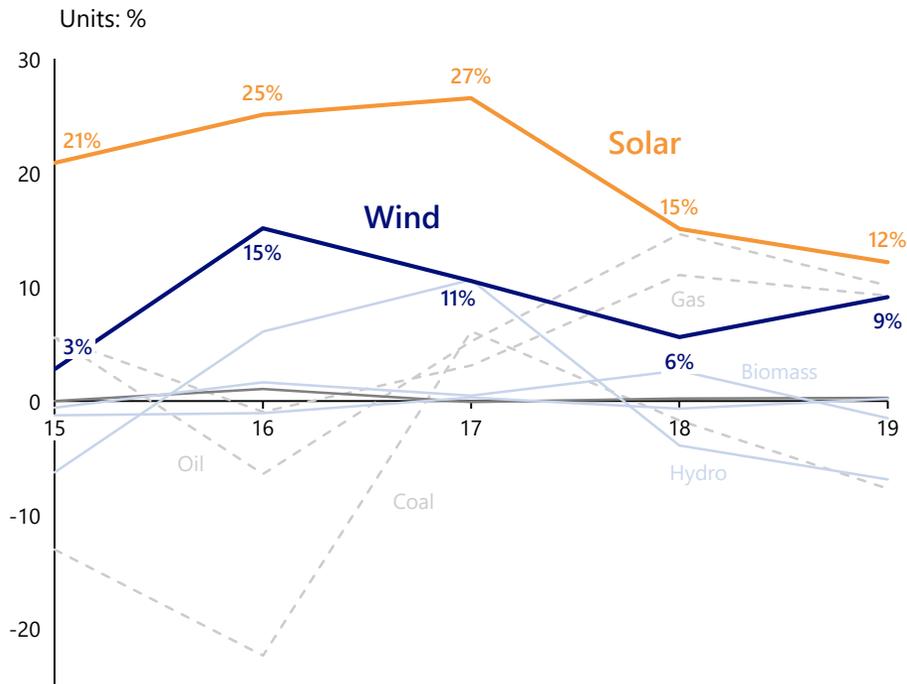
### Energy Mix for Electricity Generated (Energy)



## Recent energy transition trends

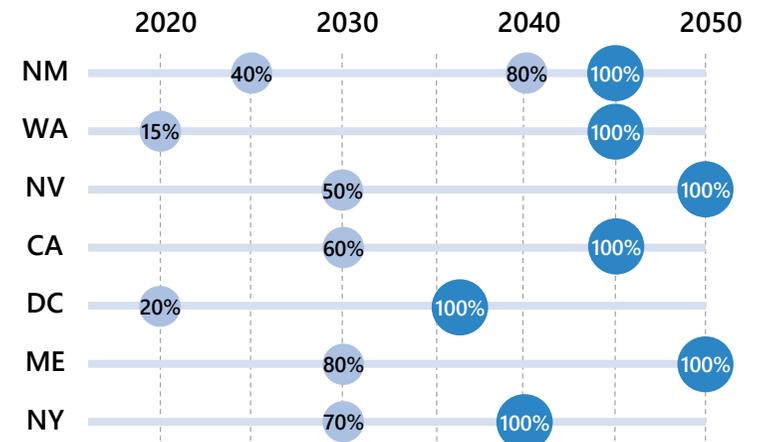
Even prior to COVID-19, generation from renewable sources has been increasing compared to traditional sources, mainly due to RPS policies

Year-to-year Generation Growth by Source in the US



## Renewable Portfolio Standard (RPS) Policies

- 30 states have RPS policies which regulate the portion of energy from renewable energy source
- RPS policy includes renewable sources such as hydro, wind, solar, etc.
- Each state has a different target % considering its environment, but it progressively gets stricter
- As of 2021, an increasing number of states will replace all conventional energy sources with renewable to 100% by 2050 or earlier

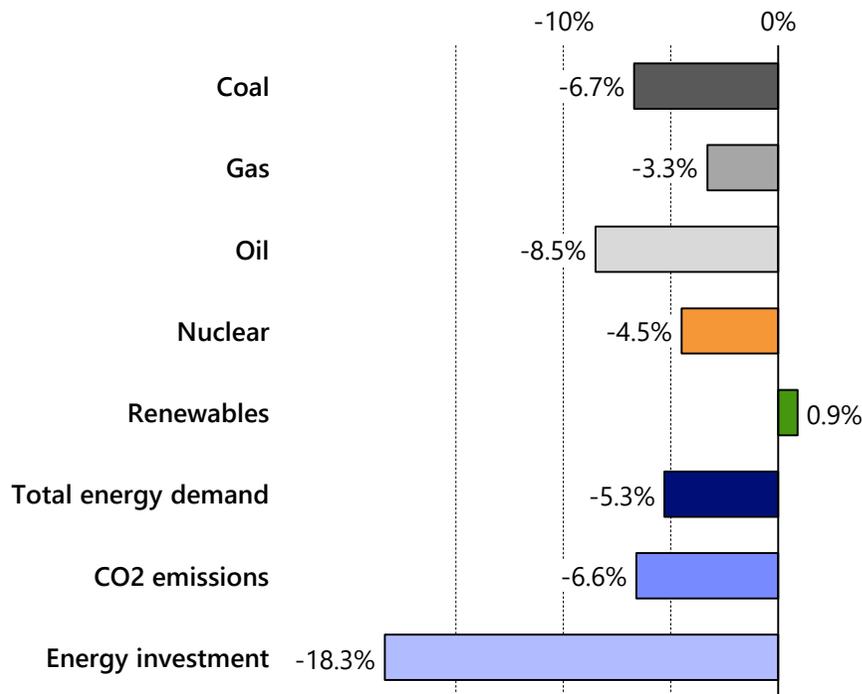


## Recent energy transition trends

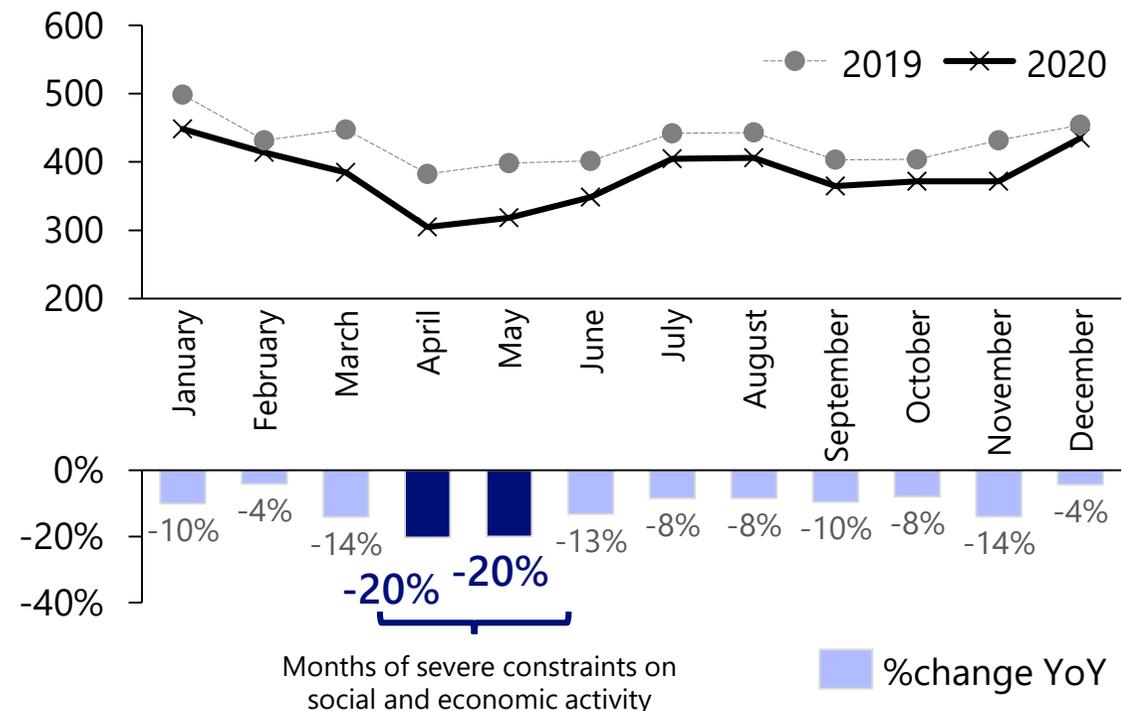
# The COVID-19 pandemic has shown that with behavioral changes, a reduction in CO2 emissions are achievable

- The COVID-19 pandemic has imposed unprecedented constraints on social and economic activity, dramatically reducing energy demand and CO2 emissions
- Although the pandemic is seen as an anomalous event that resulted in a temporary change in the global energy demand and emissions, many states and governments are considering green deals to ensure this achievement becomes permanent

### Global Estimated Energy Demand (2020 relative to 2019)



### Monthly CO2 Emissions in USA



## Governmental policies promoting energy transition

# President Biden announced intentions for new aggressive targets for US green development, increasing the potential for rapid technology advancement

- Prior to assuming office, Biden has announced the \$1.7 trillion “Clean Energy Revolution” plan which is under consideration towards implementation

### Key Takeaways from Joe Biden’s climate and energy plan

- 1 Rejoining the Paris Agreement and committing the US to reaching net-zero emissions by 2050
- 2 Target zero-carbon electricity generation by 2035
- 3 Efficiency upgrades and retrofits for buildings, targeting a 50% reduction of carbon footprint by 2035
- 4 Ensuring a “just transition” for fossil-fuel workers and creating new job opportunities in clean energy
- 5 Reversing environmental deregulation from the Trump administration

### Anticipated Impacts

\$1.7 trillion investment over the next 10 years for clean energy

Accelerated development of wind and solar industries, and energy storage technology

Investment in on-site clean power generation, and advanced grids

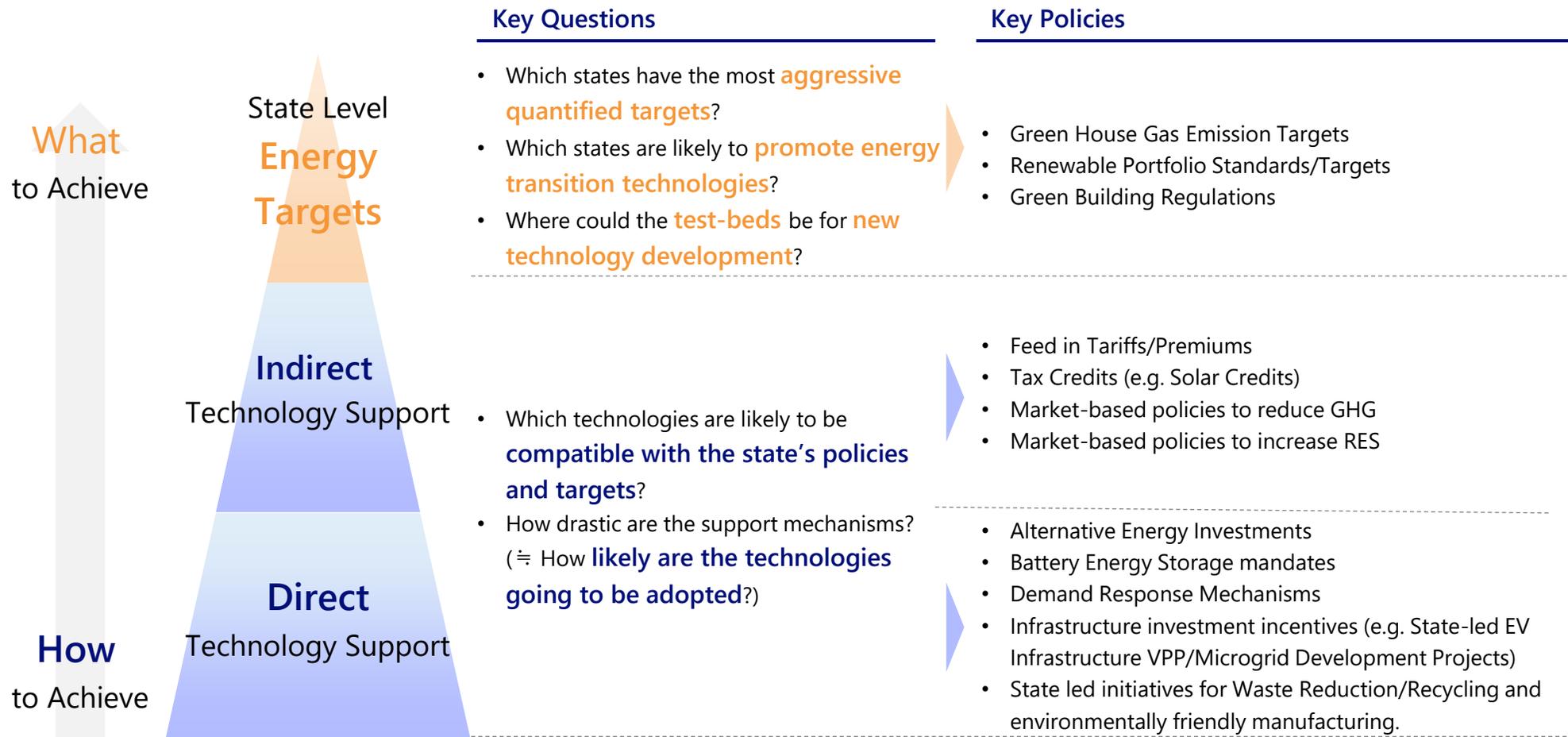
Creating millions of new jobs in infrastructure, auto, transit, and power sectors

Aggressive actions to limit emissions and accelerate carbon capture technology

## Governmental policies promoting energy transition

# The regulatory climate by state was analyzed to evaluate which states have the most support measures that will support the realization of energy transition

### Summary of Key Questions analyzing the Regulatory Climate of the States



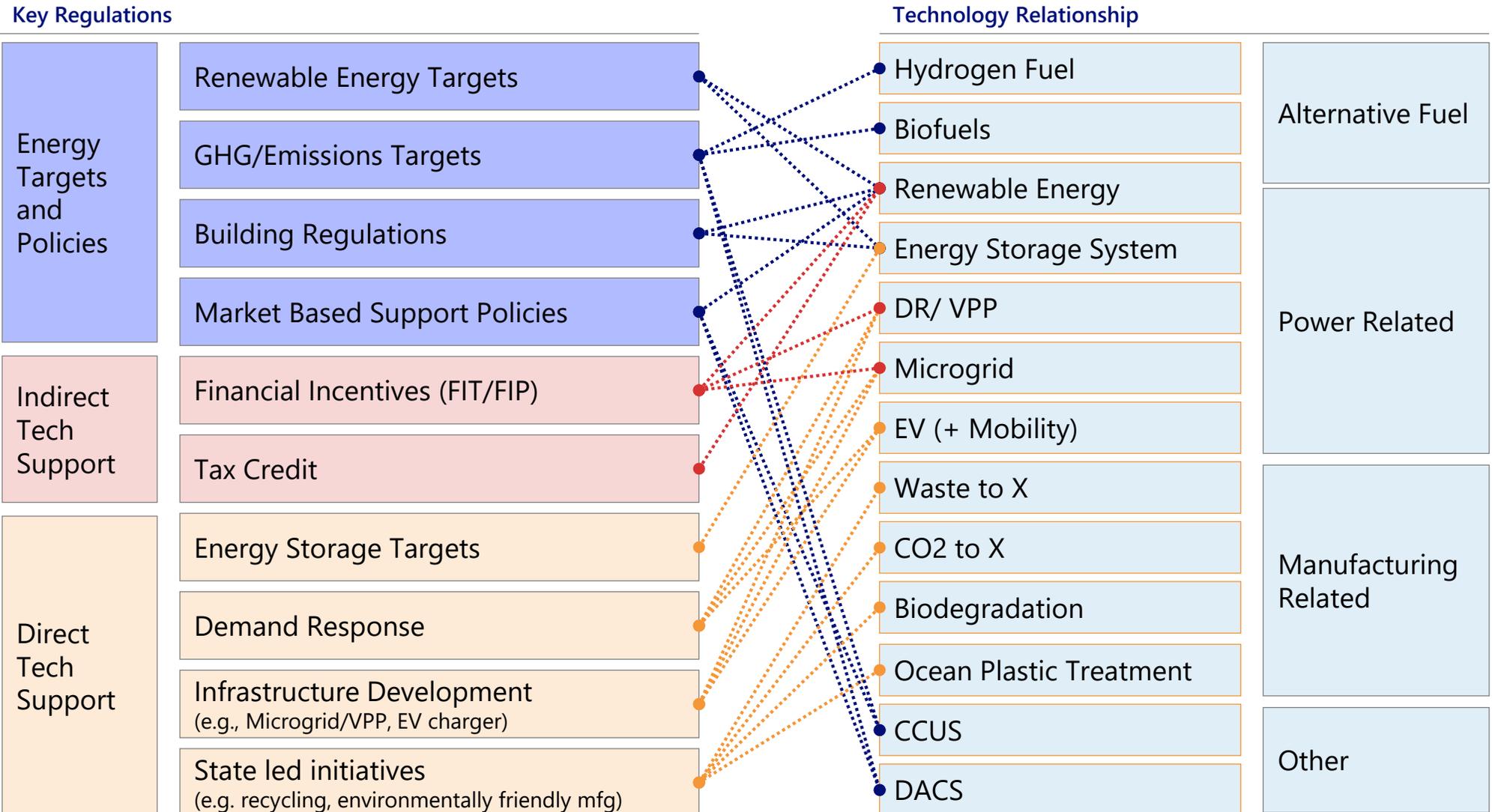
## Governmental policies promoting energy transition

# CA and NY are more aggressive in targets and policies for energy transition

		Energy Targets				Indirect Technology Support Mechanisms		Direct Technology Specific Support Policy			
		Renewable Energy Targets	GHG/ Emissions Targets	Building Regulations	Market Based Support Policies	Financial Incentives (FIT/FIP)	Tax Credits / Incentives	Energy Storage Targets	Demand Response	Infrastructure Development (e.g., Microgrid/VPP, EV charger)	State led initiatives (e.g. recycling, environmentally friendly manufacturing)
USA	CA	✓ RPS	✓ AB32/SB32	✓ Building Energy Code and Solar Requirement	✓ Cap and Trade	△ ReMAT (Currently Suspended)	✓ (Sales and use tax / Property tax Exemption)	✓ AB2514	✓ DRAM/ CAISO Markets	✓ Clean Transportation Program/ DRAM(ADR)	✓ CalRecycle
	NY	✓ RPS / CES	✓ S6599	✓	△ Carbon pricing proposed by NYISO	✓	△ (Property tax exemptions)	✓ Energy Storage	✓ NYISO	✓ Microgrid (NY Prize)	✓ REV Demo
	TX	✓ RPS	✗	✓ Building Energy Code	✗ (HB4599 rejected)	△ (Solar in Austin only)	△ (Property tax exemptions)	✗	✓ ERCOT	✓ Microgrid	✓
	WA	✓ RPS / I-937	✓ SB6001	✓ HB1257	✗ (I-1631 rejected)	✓	✓ (Sales and use tax exemption)	✗	△ Utility led programs	✓ EV Charging	✓ Energy Storage

# Governmental policies promoting energy transition

The relationship between regulations and clean technologies are mapped below



## Private company initiatives

Companies are investing in clean technologies and the energy transition for potential opportunities in new markets (past 5 years of investments)

Sample Industries and Companies		Alternative Fuels		Power Related					Manufacturing Related				Other			
		Hydrogen Fuels	Biofuels	Renewable Energy	Energy Storage System	DR/VPP	Microgrid	EV(+ Mobility)	Waste to X	CO2 to X	Biodegradables	Ocean Plastic Treatment	CCUS	DACS	Circular Economy (waste reduction)	Amine gas treatment
Oil & Gas	Shell	●	●	●	▲	▲	▲	●	▲		▲		●			
	ExxonMobil		▲	▲									●	▲		▲
Power & Utilities	NextEra Energy	●		●	●	▲		▲								
	Sempra Energy	▲		●	▲	▲	●	▲		▲			●			
Industrial (Chemical)	BASF			▲	●			▲	●	▲	▲		▲		▲	▲
	3M			▲	▲		●	●	▲	▲						

### Investment Types:

Demo Projects, Portfolio Expansion, Joint Ventures, M&A, Partnerships, and Venture / Startup

Symbol	Known size (\$ 000's)
▲	NA
●	0 to 100

Symbol	Known size (\$ 000's)
●	101 to 1,000
●	>1,001

The largest known investments were in **Power Related Technology** (Renewable Energy, Energy Storage, and EV) and CCUS

## Key investment trends – Financial institutions & SDGs

Major financial institutions typically address multiple SDGs, with majority focusing on Affordable & Clean Energy (7) and Climate Action (13)



Summary of SDGs Activities by Financial Institutions (Examples of Companies in the UN and FSA Reports)

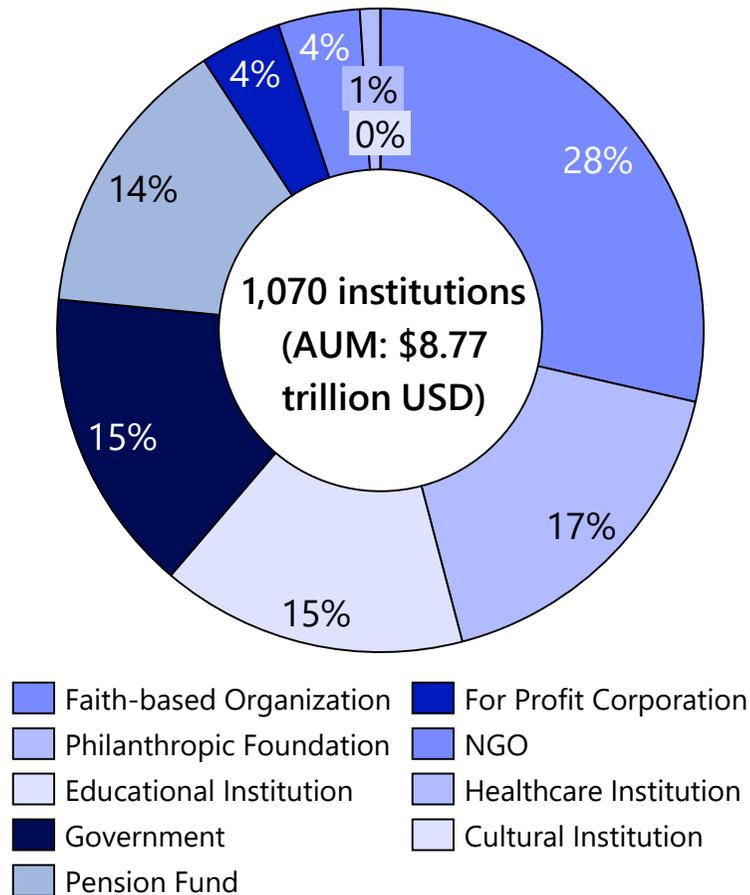
Company Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Barclays				○			○	○		○			○				○
BNP		○		○		○	○	○	○			○	○	○			
BNY					○		○	○	○				○				
Citi				○	○		○	○	○		○		○				
CS				○	○		○	○			○		○		○		
Fidelity	○	○	○	○	○	○	○	○		○		○	○	○	○	○	○
GS	○			○	○	○	○	○		○	○	○	○				
HSBC		○	○	○		○	○					○	○		○		
ING							○	○	○			○	○				
Kempen			○			○	○	○				○	○			○	
ML	○				○	○	○				○		○	○	○		
PB				○			○	○					○		○		
Rabo		○					○	○			○	○	○		○		○
SC	○	○	○	○	○	○	○					○	○	○		○	
Scotia	○		○	○	○		○	○					○				
Seker		○			○		○	○					○				○
SocGen				○			○	○	○	○	○		○				○
UBS			○				○	○		○	○	○	○				○

#	SDG Category
1	No poverty
2	Zero hunger
3	Good health & wellbeing
4	Quality education
5	Gender equality
6	Clean water & sanitation
7	<b>Affordable &amp; clean energy</b>
8	Decent work & econ growth
9	Industrial innovation & infra
10	Reduced inequalities
11	Sustainable cities & comm
12	Responsible cons & prod
13	<b>Climate action</b>
14	Life below water
15	Life on land
16	Peace, justice, & strong insti
17	Partnerships for the goals

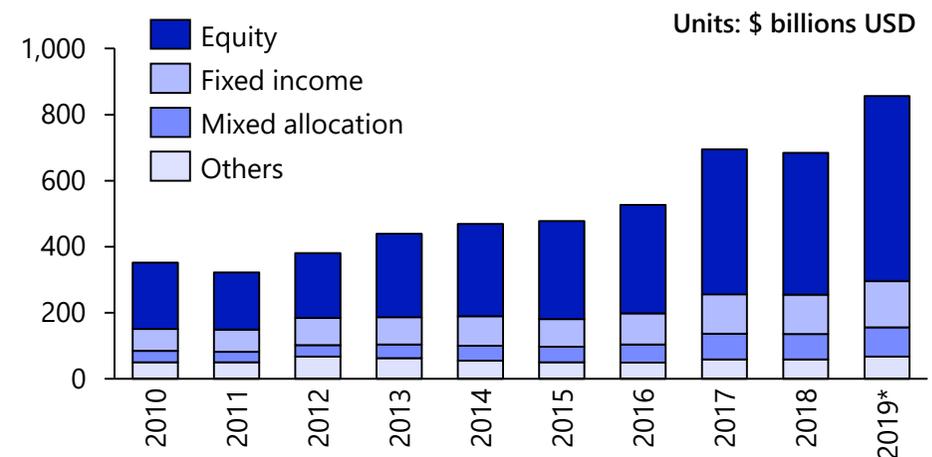
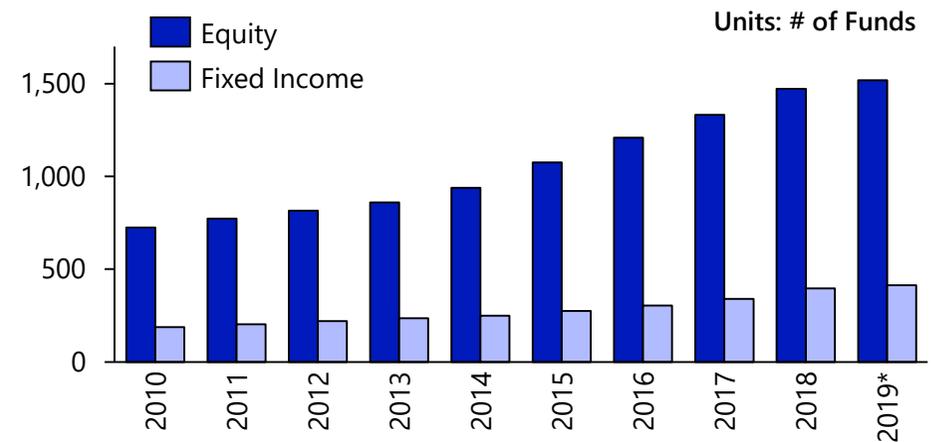
## Key investment trends – Pension funds

Institutional funds, including pension funds, are aiming to divest from fossil fuels to invest more in ESG funds and green investments

Institutions committed to divesting from Fossil Fuels



Growth of ESG Dedicated Funds (from IMF)



Source) International Monetary Fund (IMF), Fossil Free

\*Note: Up to October 2019

1. US Energy Transition Trends

**2. Emerging Clean Technologies**

**2-1 Clean Technology Landscape**

2-2 Deep Dive in Hydrogen

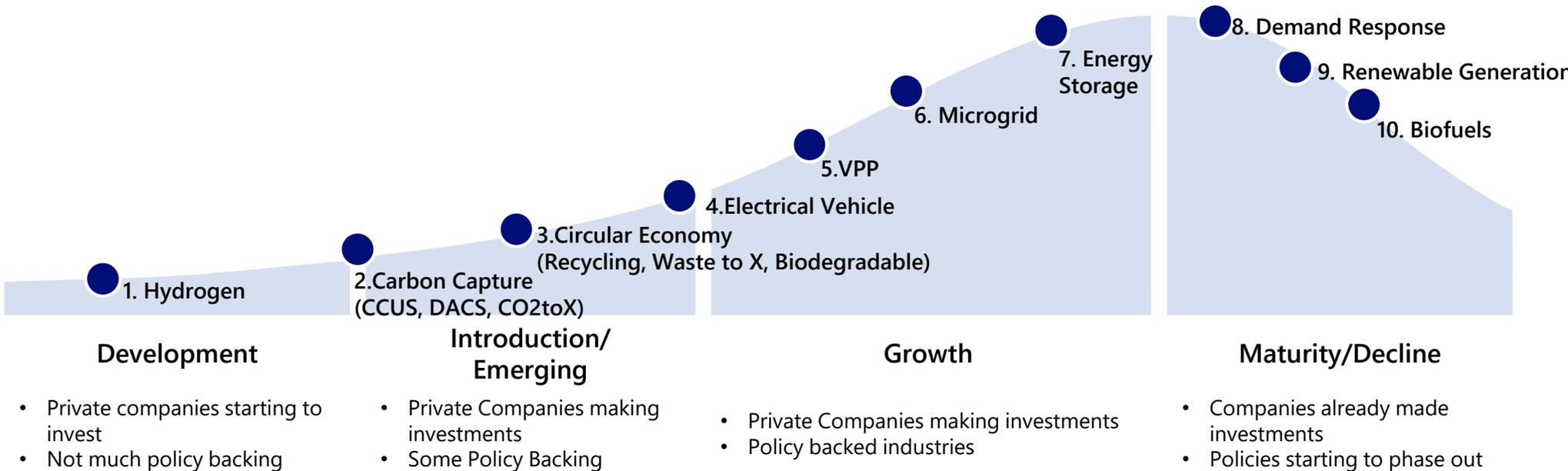
About NRI America

# Clean technologies, especially in the electricity sector are beginning to mature while new technologies including Hydrogen are gaining rapid traction

### ■ Our current analysis considers

- 1. Support by Government/Policies
- 2. Focus & investment industry
  - A) By Oil & Gas Companies, Electric Companies, Chemical Manufacturing Companies
  - B) By Financial Institutions

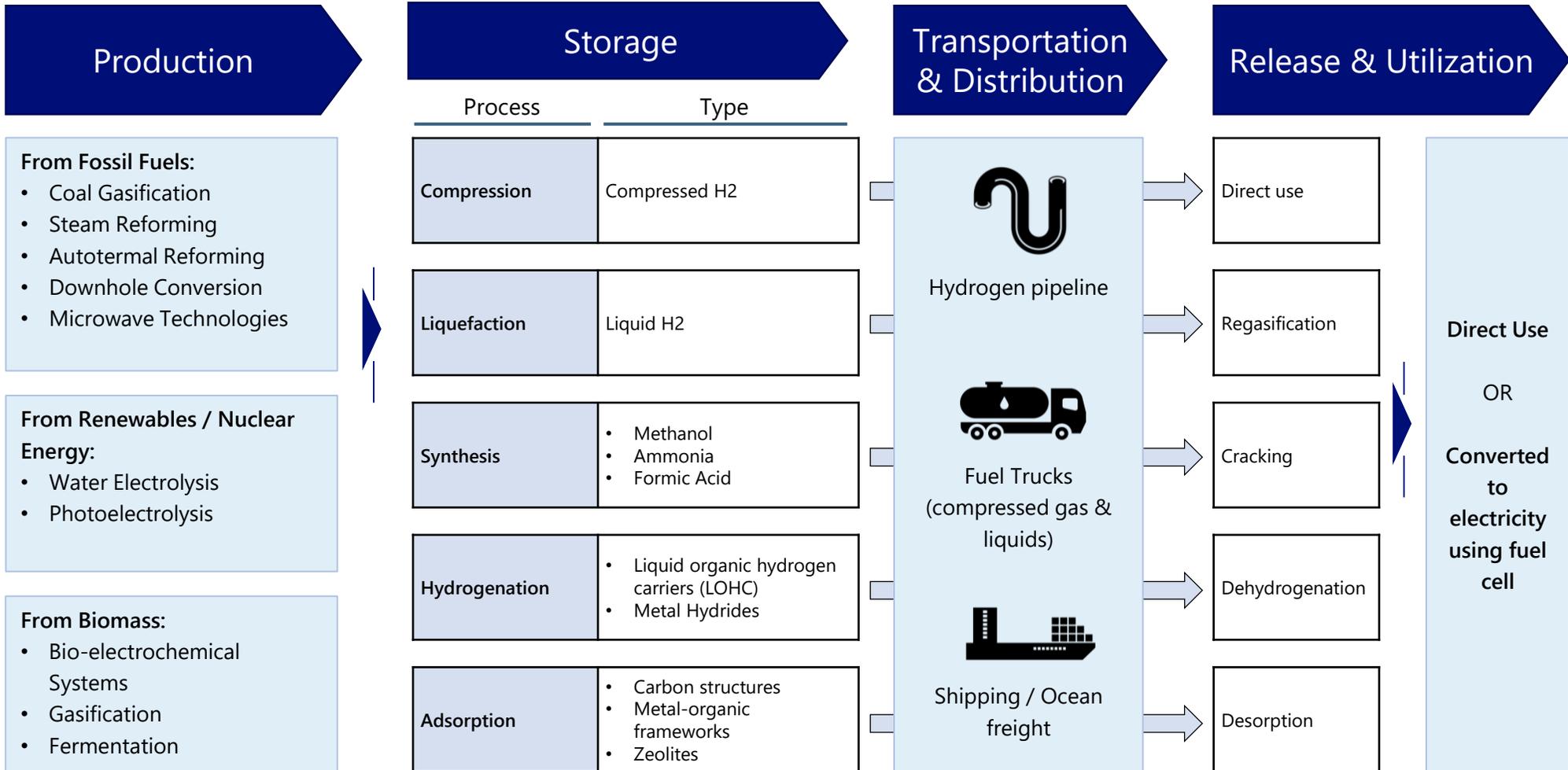
### Product & Technology Maturity Map





# The cost of producing green hydrogen and the lack of infrastructure in the supply chain remains a challenge, but is an investment opportunity for growth

- The hydrogen storage value chain includes production, conversion and processing into transportable products, transportation, and energy conversion into end-use products

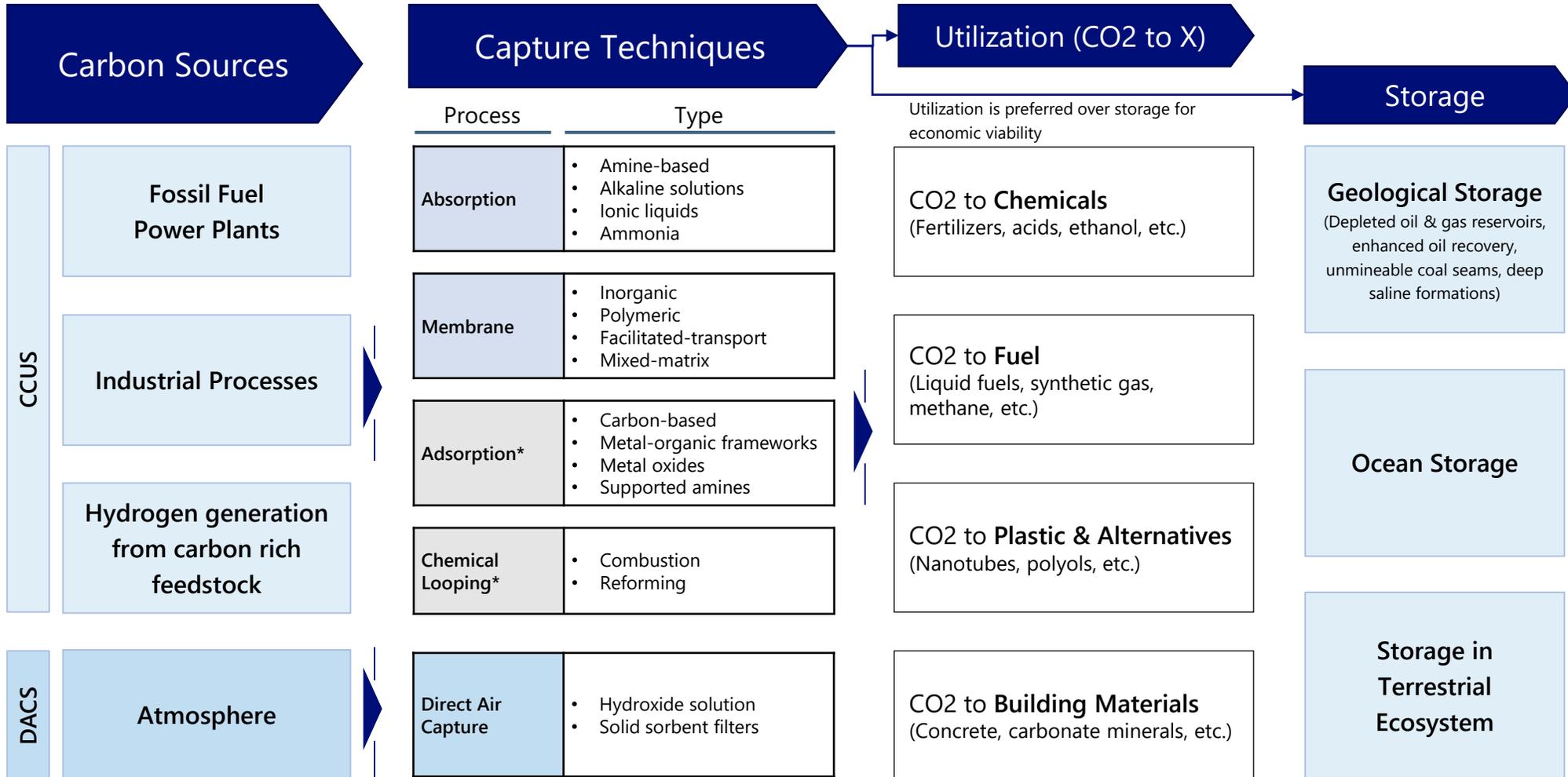




# Clean Technology Landscape – Carbon Capture

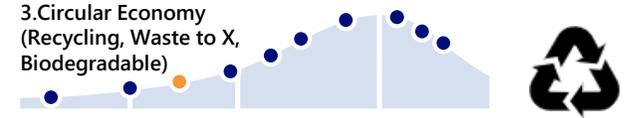
## Carbon Capture's main challenges are cost and limited end use of carbon

- CCUS - Capturing of CO2 broadly involves the direct removal of CO2 from carbon sources, with the selection of capture technology varying depending on the source of CO2 and the industrial processes that generate CO2
- DACS – Direct Air Capture technology pulls in atmospheric air, then extracts the CO2 through a series of chemical reactions

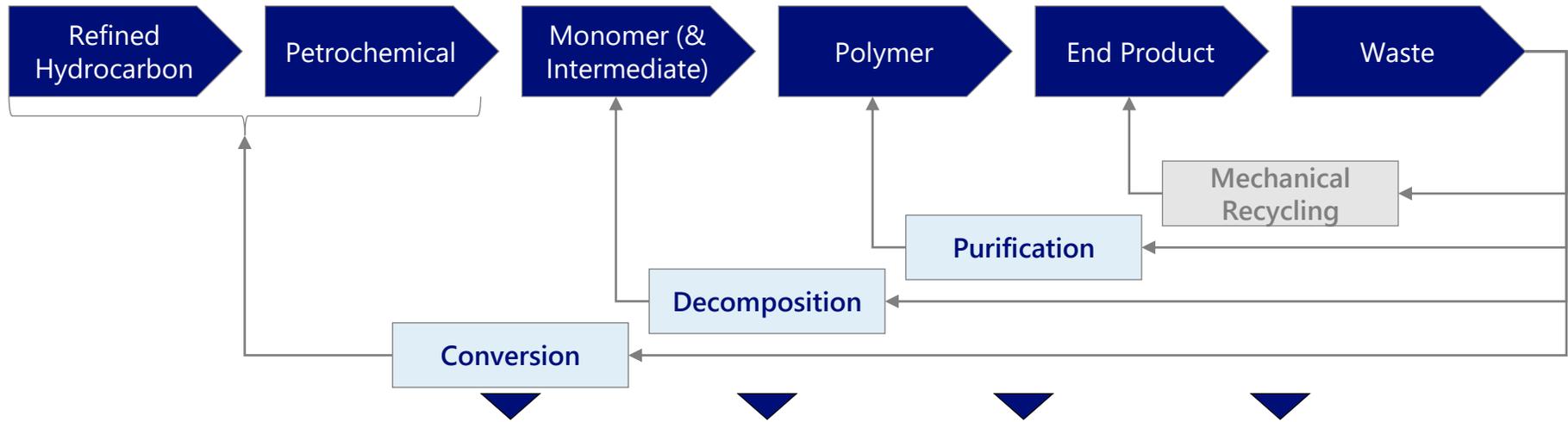


Source) NRI

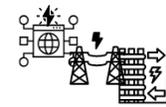
\*Note: Adsorption and Chemical Looping are less advanced technologies in development



# Advanced recycling technologies to accelerate the Circular Economy can be broken down into three key segments



<b>Process</b>	Similar to decomposition but further broken down into liquid or gaseous hydrocarbons	Breaking of molecular bonds to recover monomers or oligomers	Dissolves plastics into solvents and separated whilst extracting additives and dyes	Cascade process where plastics are ground and heated and repurposed
<b>Recycled Product</b>	Oxygen, Ethane, Propane, Naptha, Butane, Gas Oil	Paraxylene, Etheylene, Propylene, Benzene, MEG, TPA, Styrene	PET, PE, PP, PS, EPS	PET, PE, PP, PS, EPS (Lower Grade)
<b>Commercialization</b>	Early Commercial to Commercialized	Lab	Early Commercial to Lab/Pilot	Commercialized



# Decentralization of the energy system and higher level of competition in retail markets lead to new solutions in energy resource management (ERM)

## Solutions and Prerequisites

ERM Solution	Prerequisites for Solutions			
	Decentralization of Energy System			Higher Level of Competition in Retail Market
	DER Penetration (incl. CHP, diesel engines)	PV / Wind / BESS Penetration	EV Penetration	
Microgrid	✓	✓		
BESS (Behind-the-meter)		✓		✓
Energy Management		✓	(✓)	✓
EV			✓	✓
DERMS		✓	(✓)	
Blockchain		✓	(✓)	✓

**Deregulation and higher level of competition** (indicated by a large blue arrow pointing from the Microgrid row to the Higher Level of Competition column)

**Penetration of non-synchronous generation** (indicated by a blue arrow pointing from the DER Penetration column to the PV / Wind / BESS Penetration column)

**Further penetration of non-synchronous generation in distribution grids** (indicated by a blue arrow pointing from the PV / Wind / BESS Penetration column to the EV Penetration column)

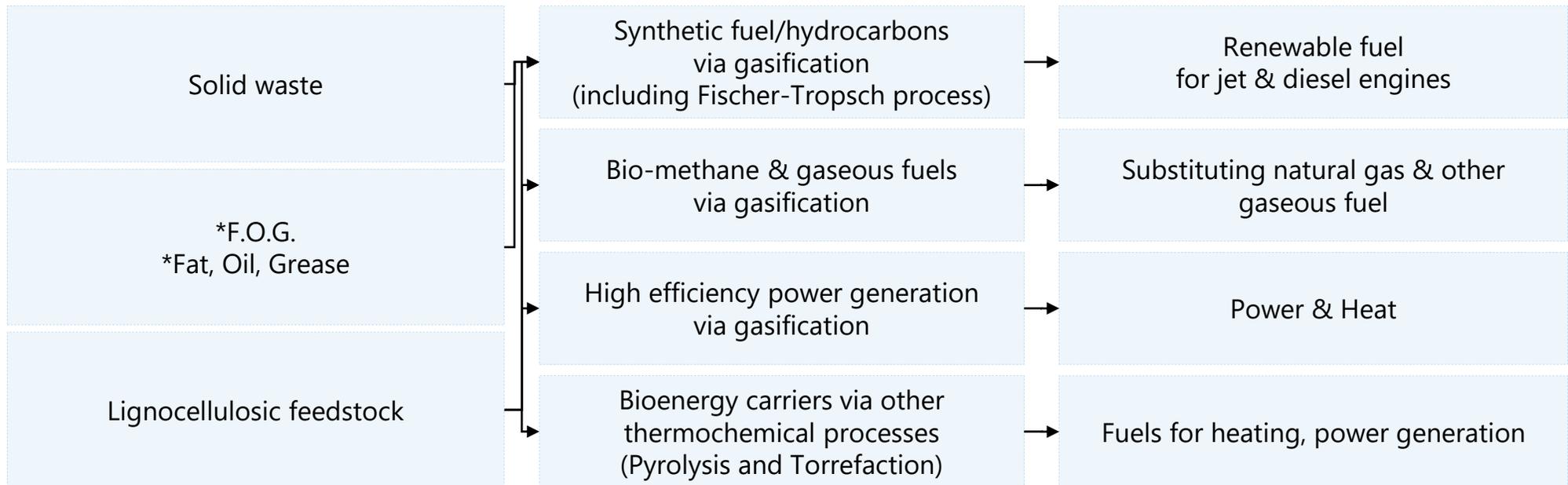
# Biomass can be converted to biofuel in two types of processes, the thermo-chemical process and biological / biochemical process (not shown)

- Major airline companies are partnering with companies using the thermo-chemical process (United Airlines, Cathay Pacific, Japan Airline for Fulcrum, JetBlue, Qantas Airlines for SG Preston)

Thermo-chemical



- Process to transform the physical properties of feedstock into fuels with better homogeneity, accessibility, transportability, & energy density
- Process to transform the chemical properties of feedstock and produce intermediate products, providing ease of conversion
- Process to produce electricity, heat (or both through co-generation) & transport fuel as well as other products



# NRIA developed a database of approx. 1,000 startup and venture companies headquartered in US and Canada, contributing to the energy transition

### Technology

### List of Companies

#### Hydrogen



Terrestrial Energy, BayoTech, Syzygy Plasmonics, Heliogen, Planetary Hydrogen, HyPoint, PowerUp Energy Technologies, Alakai Technologies, Ballard Power, Hydrogenics, Renaissance BioScience, Accordant Energy, ReCarbon, Ionomr, Utility Global, Charm Industrial, Sulfagenix, Trelys, Bomax Hydrogen, Electro-Active Technologies, Waxelene, Hydra Energy, Junkless, Hydrogen In Motion, Solar Hydrogen Trends, Peroxygen Systems, Steelhead Composites, HyVIDA Brands, NEOEx Systems, Jungle Control, Soozie's Doozies, Sublette GTL, Cogent Energy Systems, ZeroAvia

#### Carbon Capture



Blue Planet, Global Thermostat, Carbon Engineering, CarbonCure Technologies, Svante, Graviky Labs, LanzaTech, Ecotierra, Bee Consultants, 1PointFive, CleanO2, Earthly Labs, Advanced Extraction Systems, Partnering in Innovation, Advanced Data Cooling Technologies, Powerspan, CO2 Solutions, Novomer, Pond Technologies, Quantiam Technologies, Solidia, Wormser Energy Solutions, Empower Materials, Opus 12, Pachama, , Prometheus Fuels

#### Circular Economy



BioCellection, Urban Mining, Enevo, Roadrunner Recycling, Redwood Materials, Reclim, PureCycle Technologies, Biocellection, Agylix, Li-Cycle, Vartega, NDB, PureCycle, Genecis, Axine Water Technologies, Aquacycl, Green Dot Bioplastics, Trivium Industries, rts, Mi Terro, Struxure, Ettitude, PureCycle Technologies, Toadfish, Arqlite, Glyph, AMP Robotics, Buffy, Goodfair, AquaSprouts, Circular Systems, Renewal Mill, Remoov, Clek, Hemp Plastic, Naja, Routine, Thousand Fell, Nimble, Polystyvert, Reliable One Resources, Rejoule, Rheaply Project Repat, Glanris, Rockwell Razors, Oklo, ByFusion, Net Your Problem, Day Owl, Effa Brush, ChopValue, Solgaard, Otherland, Zabble, Infinite Cooling, Smarter Sorting, PulpWorks, ReDeTec, Knotzland, GreenMantra Technologies, DryLet, Genusee, Magnomer, GreenMantra Technologies

#### Electrical Vehicle



Fermata Energy, Amply Power, EV Connect, FreeWire Technologies, Savari, Empower Energies, ChargeHub, HEVO Power, Electra Vehicles, Swtch, OpConnect, Evmatch, Elegus Technologies, ELIX, Brightfield, Chargerquest, Netzero Solar, Netzero Solar, ChargeWheel, New Dominion Enterprises, Power Hero, WAVE, EV Energy Group, ChargeLab, ampUp, ChargeNet, XL Hybrid, ARDA Power

# NRIA developed a database of approx. 1,000 startup and venture companies headquartered in US and Canada, contributing to the energy transition

### Technology

### List of Companies

#### VPP/DERMS, Demand Response, Microgrid



Swell Energy, Recurve, Orison Energy, AutoGrid, UtilityAPI, Opus One Solutions, eNow, Powerhive, LO3 Energy, Advanced Microgrid Solutions, Scale Microgrid Solutions, Inspire, Innowatts, Modern Energy, LevelTen Energy, Powerhive, Blue Planet Energy Systems, BoxPower, Blue Frontier, Blueprint Power, SimpTek, Shifted Energy, Switched Source, Solstice, Intertie, Tumulow, Drone Energy, ConnectDER, David Energy, EnergyX, Dugo, EnerAllies, Correlate, Shyft Power Solutions, Sapient Industries, WattBuy, Calico Energy, THG Energy, Logical Buildings, MicroEra Power, EnerConnex, Brilliancy, BOSS Controls, Nhu Energy, Microgrid Labs, 60Hertz, Zerise, Elektrifi Technologies, LightSail Energy, Temporal Power, Blue Power Systems, Heila Technologies, Blue Planet Energy Systems, Flair, Leap

#### Energy Storage



ESS (Energy Storage), Form Energy, Quidnet Energy, Crusoe Energy Systems, Hydrostor, Peak Power, Deep Isolation, Arable Labs, NuMat Technologies, Caban Systems, NOHMs Technologies, StorEn Technologies, Cadenza Innovation, Imprint Energy, Neothermal Energy Storage, Alumina Energy, Blue Planet Energy, Ocean Motion Technologies, Pajarito Powder, Urban Electric Power, NanoGraf Technologies, Cuberg, Coreshell Technologies, Lionano, TROES, South 8 Technologies, igrenEnergi, Besstech, Kuhmutem, Millibatt, Electric Power Systems, Titan Advanced Energy Solutions, Integrated Storage Technologies, Novele

#### Renewable Generation



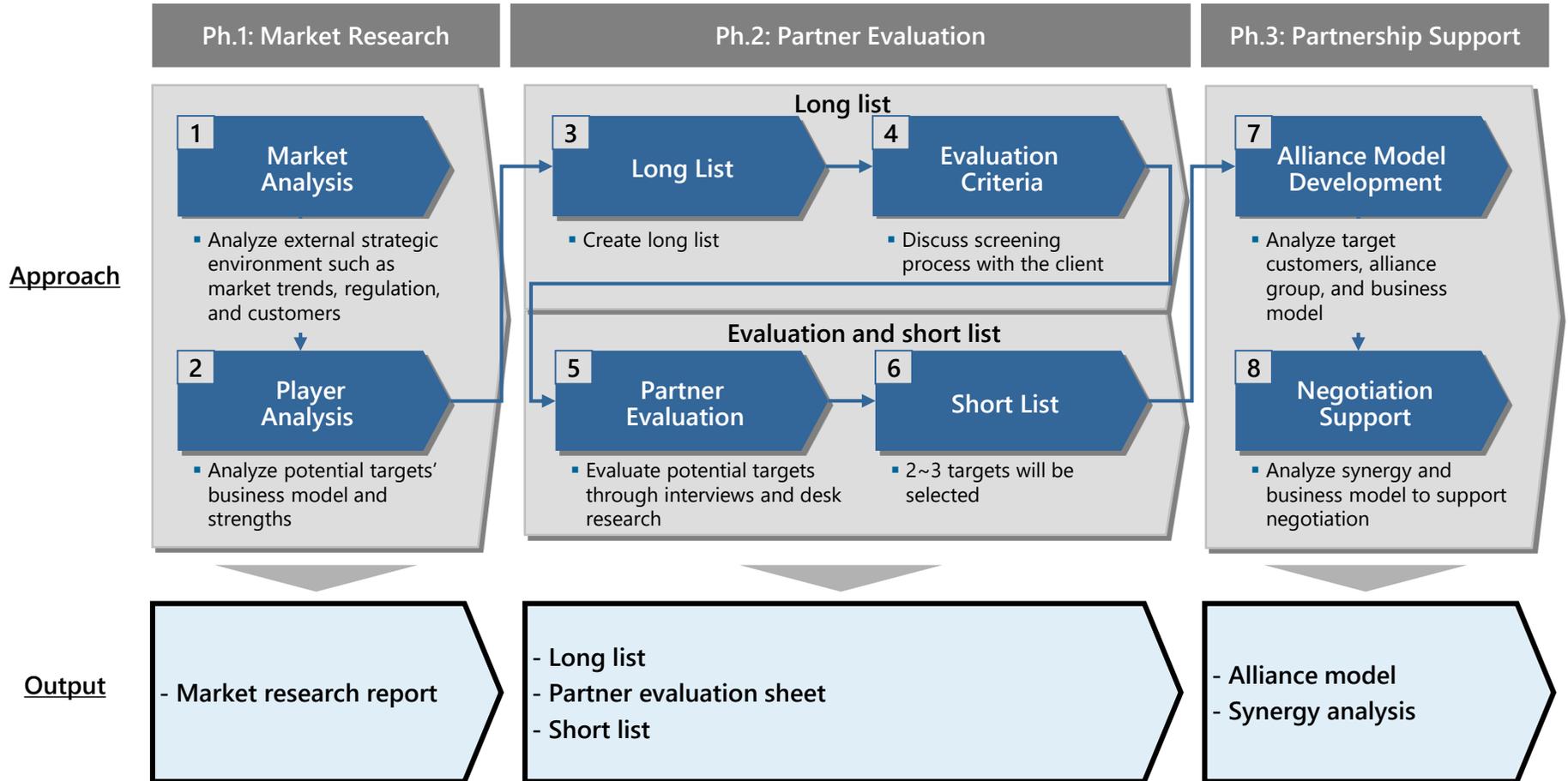
Point Load Power, Ayas Renewables, Champlin, Dandelion Energy, Arcadia, GoSun, Eavor, Morgan Solar, QD Solar, Pick My Solar, Span, Green Energy Exchange, CoverCress, Ossiaco, GreenFire Energy, Pani Energy, Raptor Maps, EnergyBot, Spiers New Technologies, Blackburn Energy, Net Zero Enterprises, AlgiKnit, Element Energy, Helion Energy, OffGridBox, Drift, Optimus Technologies, Uncharted Power, UniEnergy Technologies, CalWave Power Technologies, Arterran Renewables, Camus Energy, Virimodo Empower Generation, GreenLancer, PVComplete, Sistine Solar, Zymochem, Aerospec Technologies, Packetized Energy Technologies, Biome Renewables, S2A Modular

#### BioFuel



Nature's FYND, TerViva,, ZeaKal, Fulcrum BioEnergy, Midwest AgEnergy, NEXT Renewable Fuels, SynSel, Manta Biofuel, Forge Hydrocarbons, Capro-X, EntoBio, SabrTech, Afingen, Primary Ocean, BLK LDG, Cellufuel, Nexus Bioenergy, De Novo DNA, Kyoku, AecopaQ, Elixir Bio-Tech, PRRenewables Solutions, SynShark, Promus Energy, BioEconomy Solutions, Carbo Analytics, Pellet Technology USA, Nova Synthetix, Commonwealth Biofuels, Catalyst RNG, Ward Energy, Midstream Methanol, Kombucha Biomaterials, Virent, Red Rock Biofuels, OptiEnz Sensors, SG Preston, Emerald Biofuels, SkyNRG, Sanivation, Arbiom

# NRIA can support businesses to understand the target clean tech market, find and evaluate potential partners or targets, and develop partnerships



1. US Energy Transition Trends

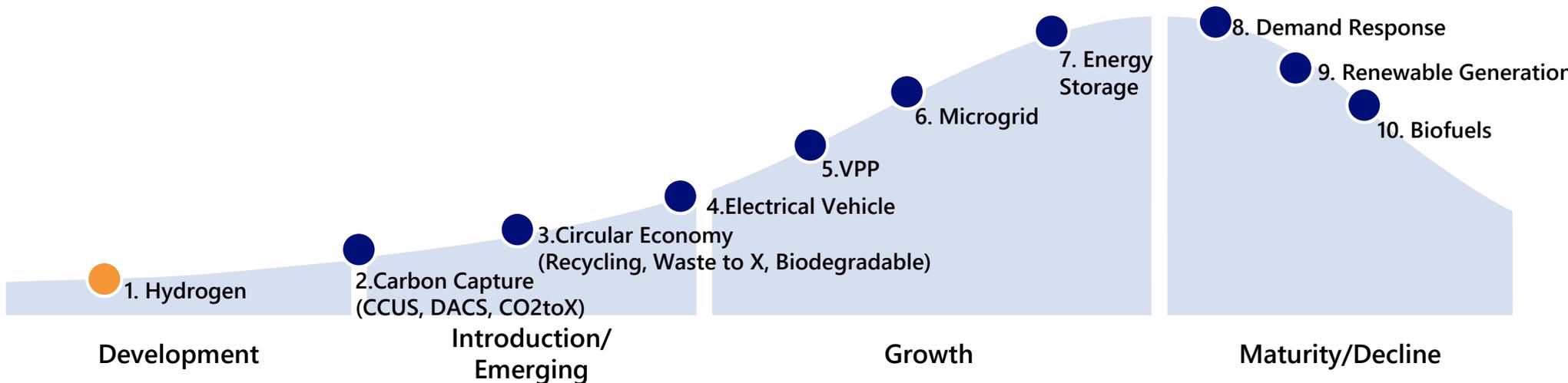
**2. Emerging Clean Technologies**

2-1 Clean Technology Landscape

**2-2 Deep Dive in Hydrogen**

About NRI America

Global interests in hydrogen as a zero emission fuel are rapidly growing, with expected development in policy, market, and technology



**NRIA has developed extensive knowledge and expertise in hydrogen technology and applications, and can support businesses in defining its future hydrogen strategy by:**

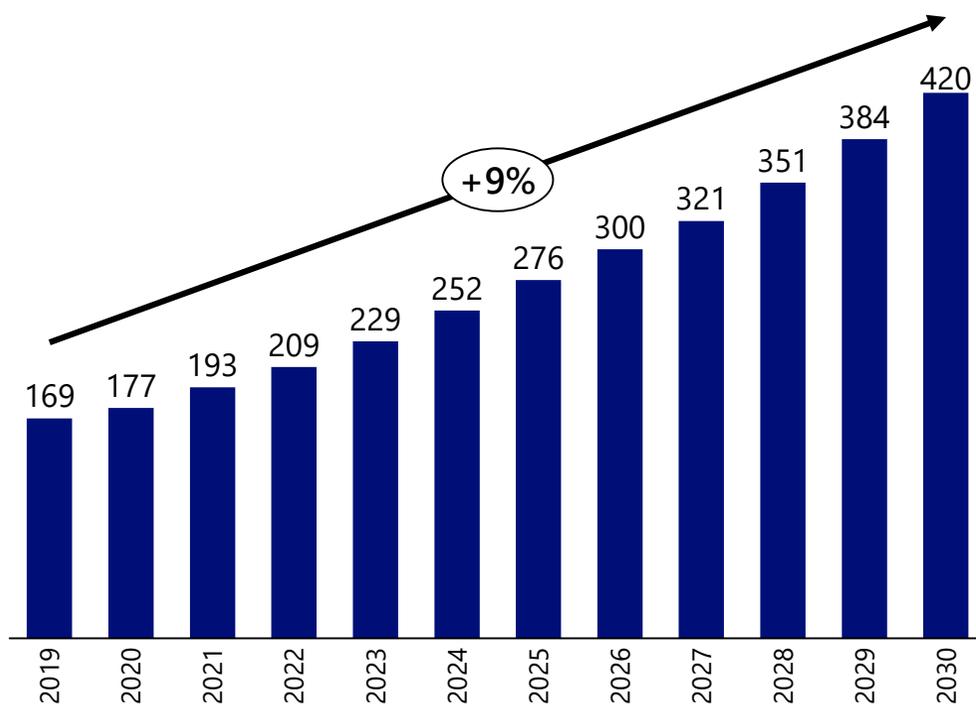
1. Providing an overview of the current market structure and emerging trends
2. Outlining political trends, including federal and state level policies for hydrogen
3. Researching private company trends, including major companies and venture companies
4. Evaluating client specific business opportunities across the hydrogen value chain

## Deep Dive in Hydrogen

The global hydrogen market is growing, yet a large percentage of the hydrogen production will be from natural gas in the next decade

### Global Hydrogen Market – Revenue Forecasts

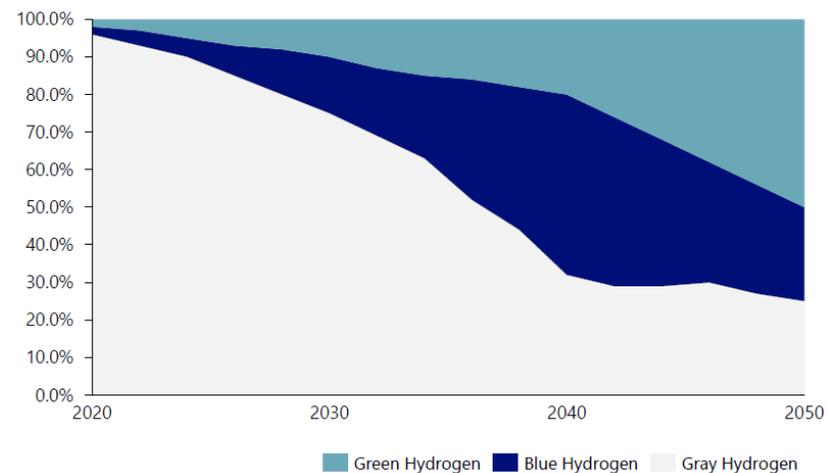
Units: \$ Billions USD



Global hydrogen production and revenue are expected to grow steadily over the next decade at a CAGR of 9%

Source) Hydrogen Market Research, NRI Analysis

### Hydrogen mix forecast (up to 2050)



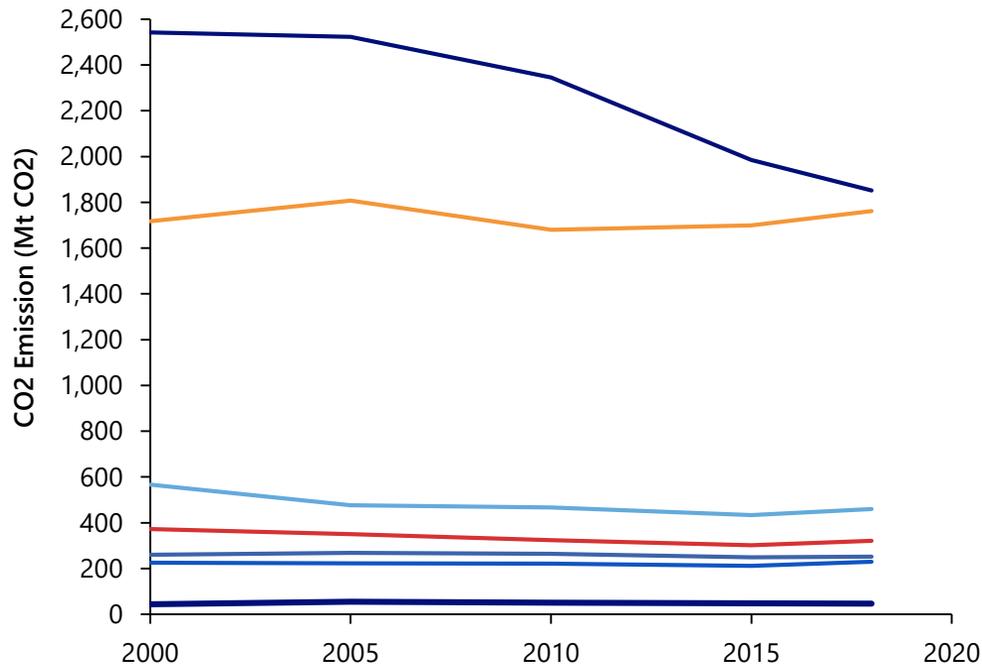
### Key factors for growth of green hydrogen

- Growth of renewable energy sources (RES) capacity to produce green hydrogen
- The cost of electrolyzers must be reduced significantly
- Additional investment and development to overcome technical and cost hurdles, including in storage, transportation, and distribution

## Deep Dive in Hydrogen

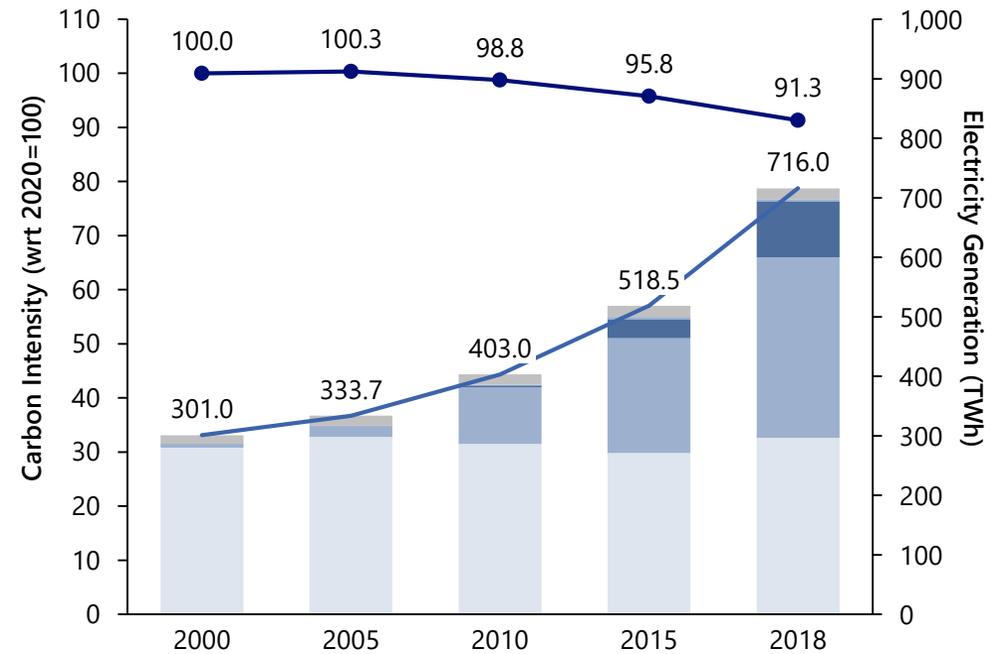
The electricity sector is seeing a rapid decrease in the CO2 Intensity from RES expansion. On the other hand other industries will likely benefit from Hydrogen

USA: CO2 Emission by Sector



- Electricity and heat producers
- Other energy industries
- Industry
- Transport
- Residential
- Commercial and public services
- Agriculture
- Final consumption not elsewhere specified

USA: Carbon Intensity and RES installation in Electricity Sector



- CO2 Intensity of Power (Left Axis)
- Renewable Energy Consumption (Right Axis)
- Geothermal
- Solar thermal
- Solar PV
- Wind
- Hydro

## Deep Dive in Hydrogen

# Global energy leaders are incorporating hydrogen into sustainable recovery plans and its strategy to reduce carbon emissions to net zero

Country / Region & Leader	Net-Zero Emissions Target	Policy / Plan	Hydrogen Activity Details
 Joe Biden	<b>2050</b> To be announced	Clean Energy Revolution	<ul style="list-style-type: none"> <li>Establish ARPA-C to focus on advanced technology research such as using renewables to produce carbon-free hydrogen at the same cost as that from shale gas</li> </ul>
 Justin Trudeau	<b>2050</b>	Hydrogen Pathways	<ul style="list-style-type: none"> <li>Alberta announced a strategy to develop large-scale hydrogen production with CCUS (blue hydrogen)</li> <li>The largest proton-exchange membrane (PEM) electrolyser (20MW) is nearing completion in Quebec</li> </ul>
 Ursula von der Leyen	<b>2050</b>	EU Recovery Plan, Hydrogen Roadmap Europe	<ul style="list-style-type: none"> <li>Highlights opportunities hydrogen provides to decarbonize gas grids and transport and industry sector</li> <li>Several countries have set targets for FCEVs, Hydrogen Refueling Stations, and installed electrolyser capacity</li> </ul>
 Xi Jinping	<b>2060</b>	14 <sup>th</sup> Five-Year Plan	<ul style="list-style-type: none"> <li>Beijing's city government has set a target of 1,000 fuel cell buses in operation for the Beijing Winter Olympics in 2022</li> <li>China hopes hydrogen will account for 10% of the energy system by 2040</li> </ul>
 Yoshihide Suga	<b>2050</b>	Basic Hydrogen Strategy	<ul style="list-style-type: none"> <li>The Basic Hydrogen Strategy outlines a roadmap for lowering production costs and expanding hydrogen use</li> <li>A demo project by Japanese government (NEDO), 10MW green hydrogen electrolyser project in Fukushima is now operational</li> </ul>

# Global governments are approaching wider adoption of green hydrogen and working to establish the supply chain for hydrogen

Region/Country		Type of Hydrogen		Type of Technology	Type of SCM		
		H <sub>2</sub> Type	H <sub>2</sub> State		Established	Early	
Asia	China	Gray, Blue, Green	Gas, Liquid (Early)	Fuel Cell, ICE	Production	Storage	
	Japan	Green	Gas, Liquid	Fuel Cell	Production	Storage	Transport.
	South Korea	Green	Gas, Liquid	Fuel Cell	Production	Storage	Transport.
Australia		Gray, Blue, Green	Gas, Liquid	Fuel Cell, ICE	Production	Storage	Transport.
European Union	France	Green	Gas, Liquid	Fuel Cell	Production	Storage	Transport.
	Germany	Green	Gas, Liquid	Fuel Cell, ICE	Production	Storage	Transport.
	Austria	Green	Gas, Liquid	Fuel Cell	Production	Storage	Transport.
	Netherlands	Blue, Green	Gas, Liquid	Fuel Cell, ICE	Production	Storage	Transport.
Latin America	Argentina	Gray, Blue, Green	Gas, Liquid	<i>N/a</i>	Production	Storage	Transport.
	Brazil	Green (Early)	<i>N/a</i>	Fuel Cell	Production	Storage	
	Chile	Green (Early)	<i>N/a</i>	Fuel Cell, ICE	Production	Storage	Transport.
	Uruguay	Green (Early)	<i>N/a</i>	Fuel Cell	Production	Storage	Transport.
	Peru	Blue	Gas	<i>N/a</i>	Production	Storage	Transport.
Middle East	Kuwait	<i>N/a</i>	<i>N/a</i>	Fuel Cell		Storage	
	Oman	Green (Early)	<i>N/a</i>	<i>N/a</i>	Production	Storage	
	Saudi Arabia	Green	Gas (Early)	<i>N/a</i>	Production	Storage	Transport.
	UAE	Blue, Green	Gas (Early), Liquid	<i>N/a</i>	Production	Storage	
South Africa		Green (Early)	<i>N/a</i>	Fuel Cell, ICE	Production	Storage	
US		Gray, Blue, Green	Gas, Liquid	Fuel Cell, ICE	Production	Storage	Transport.

# The US Hydrogen Roadmap was released, positioning the US market as an opportunity for early movers in the industry

	Immediate Step (2020-2022)	Early Scale up (2023-2025)	Diversification (2026-2030)	Broad Roll Out (2030-2050)
Policy Support	<ul style="list-style-type: none"> <li>Establish decarbonization goals (Technology Neutral)</li> <li>Increase public incentives and reduce barrier to entry</li> <li>Define Hydrogen codes and safety standards</li> <li>Consider Policy /Regulatory frameworks (e.g. for grid or long duration energy usage)</li> <li>Develop Workforce</li> </ul>	<ul style="list-style-type: none"> <li>Establish state and federal incentive for early market transition</li> <li>Enhance and widen public incentives</li> <li>Regulatory Frameworks (e.g. for H2 Storage)</li> <li>Implement cross sector decarbonization incentives</li> </ul>	<ul style="list-style-type: none"> <li>Transition of policy for direct support to scalable market-based mechanisms</li> <li>Applications to broaden beyond transportation</li> </ul>	<ul style="list-style-type: none"> <li>Reduce direct policy when cost parity is reached</li> <li>Define robust Hydrogen Code at Federal level</li> </ul>
Supply and End Use	<ul style="list-style-type: none"> <li>First dedicated hydrogen production for mobility</li> <li>SMR with RNG feedstock</li> <li>Midscale Electrolyzers (10-50MW)</li> <li>Develop Gaseous/Liquid Distribution networks in pioneer state</li> <li>Introduce H2 tolerant equipment</li> <li>Second Gen FCEV and Fuel station for Light Duty vehicles, buses and material handling</li> <li>First Gen FCEV for heavy duty vehicles</li> <li>Fuel Cell for Data Center or facility backup</li> <li>Initial pilot for energy storage</li> </ul>	<ul style="list-style-type: none"> <li>First large scale electrolyzer plants (50MW +)</li> <li>First large scale SMR or Auto Thermal Reforming +CCUS</li> <li>Hydrogen Pipeline to industry clusters</li> <li>New FCEV introduction</li> <li>Second Gen FCEV for Heavy duty vehicles (inc. fueling station)</li> <li>Introduce Pure H2 tolerant equipment</li> </ul>	<ul style="list-style-type: none"> <li>Development of electrolytic hydrogen production using renewable or nuclear (dedicated supply)</li> <li>Further Development of SMR/ATR+CCS</li> <li>First hydrogen pipeline connection from production site to demand center</li> <li>Scale up hydrogen equipment production</li> </ul>	<ul style="list-style-type: none"> <li>Expand usage across sectors</li> <li>Retrofitting of CCUS Technology</li> <li>Establish competitive market for SMR/ATR +CCS on cost</li> <li>Compatible system to scale hydrogen in existing gas infrastructure</li> <li>Expansion of vehicle modes</li> </ul>

1. US Energy Transition Trends

2. Emerging Clean Technologies

**About NRI America**

## Business Overview

Research and Consulting Division offers a wide variety of services, from industry and trend researches to strategy consulting, in order to meet the needs of every client.



### Industry and Technology Research

- Conduct analysis on all major industries such as retail, finance, electronics, IT, telecommunications, energy, automotive, and heavy industry

### Trend Watching

- Provide trend reports for major global companies
- Monitor trends related to startups and venture capital in the US

### M&A Consultation

- Provide consultation on M&A operations
- Support target company selection and deal-making
- Due diligence and financial valuation

### Market Analysis

- Support major Asian and Japanese companies' expansion to the US
- Market opportunity analysis in Latin America

### New Business Development

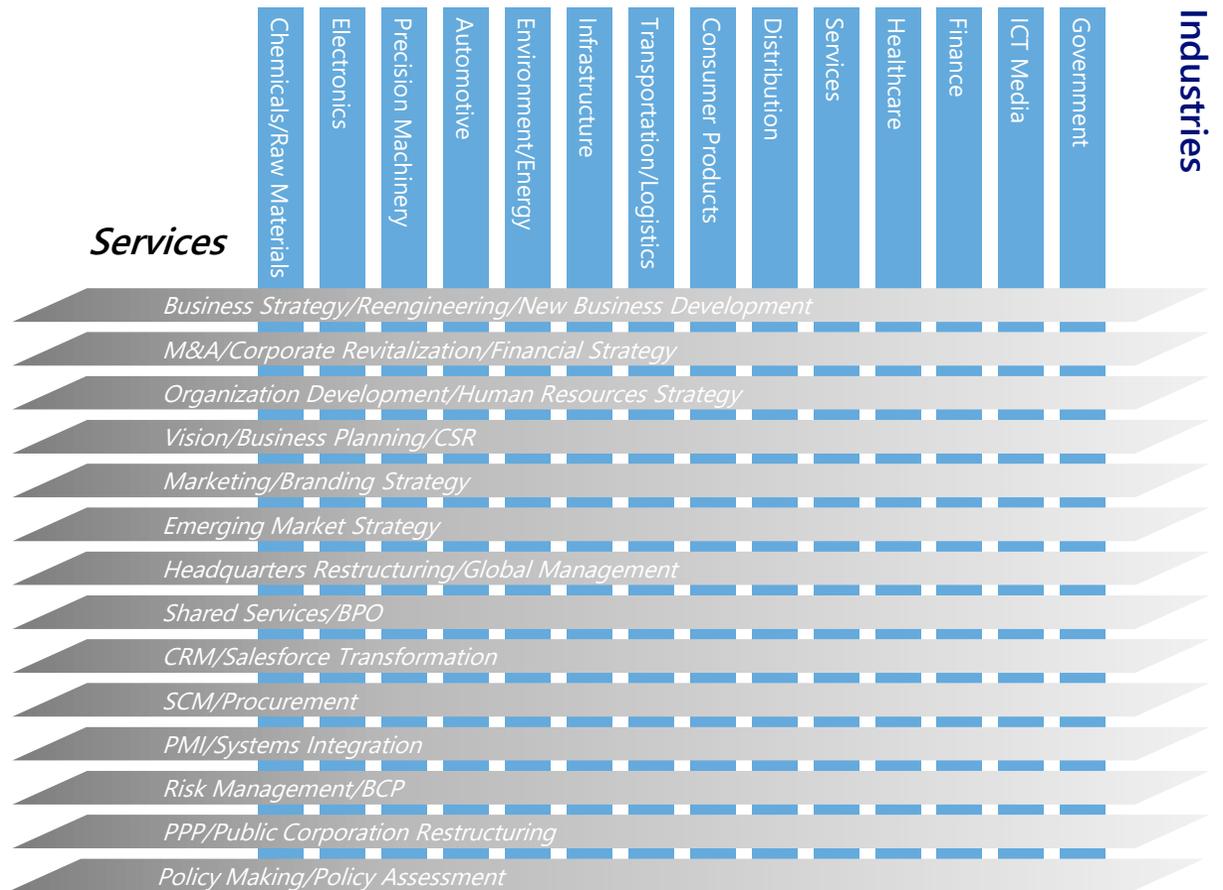
- Find new business opportunities in diverse industries
- Conduct feasibility studies for potential business items

### Business Consulting

- Strategy formulation and operation innovation
- Competitor analysis of diverse business functions

## Consulting Coverage in NRIA

NRIA leverages NRI group's global and comprehensive knowledge to develop and expand its services primarily in Americas.



- NRI's expertise covers the entire spectrum of industries (including policy support for government agencies)
- NRI provides end-to-end solutions, from strategy formulation to implementation.
- NRI has an excellent reputation in the manufacturing sector, especially in the automotive, energy, and infrastructure industries.

## Snapshot of Past Projects

### Energy & Infrastructure



- US natural gas market research
- Oil & Gas market entrance strategy
- Global construction market research and business expansion planning
- US smart grid market entry strategy
- Urban energy infrastructure development strategy

### Automotive & Manufacturing



- Evaluation of R&D competitiveness
- M&A of aerospace parts company in the US
- Automobile semiconductor trend study
- M&A of auto parts company in Mexico
- M&A of food ingredient company

### Latin America



- Business Environment assessment
- Market entry and expansion strategy
- Business environment and national policy assessment
- Infrastructure development strategy
- Investment promotion in Asia

### ICT & Advanced Technology



- Analysis of tech start-ups
- Emerging technology trend report
- US financial institution's social media strategy
- Telematics and M2M module market study
- Insight mission for US tech companies

### Finance Industry



- Insurance market trend analysis
- Benchmarking study of US banks' cost reduction strategy
- US fintech market trend analysis
- US financial solution market entrance strategy development

### Healthcare & Retail



- US pharmaceutical marketing and business expansion supports
- US medical tourism market research
- US healthcare market entry strategy
- E-commerce and retail strategic business planning in the US
- US Electronic retail store trend analysis

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