FUTURE ENERGY

Future Energy Summit 2021

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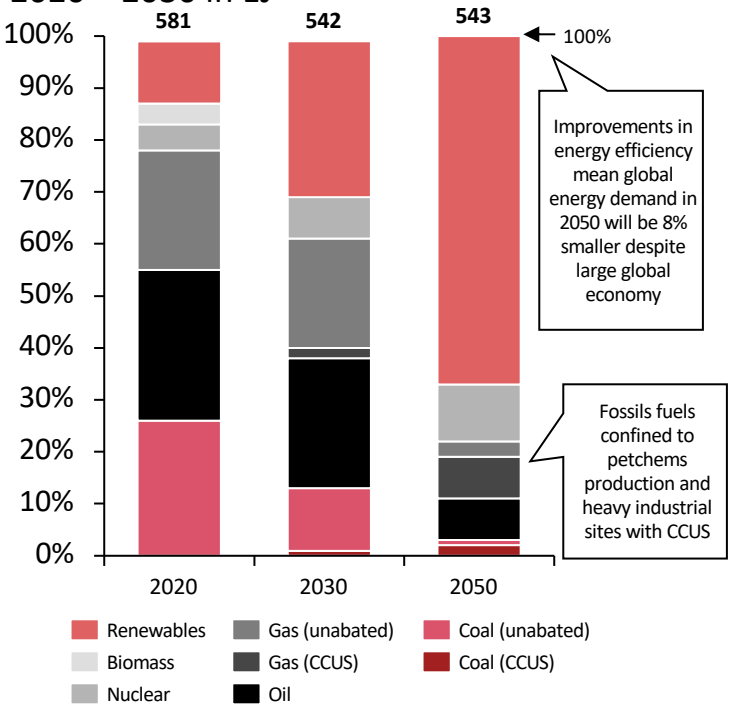
One

Energy markets
The Big Picture

Global energy system to be transformed if governments follow ‘net zero by 2050’ roadmap

Global Energy Supply by Fuel Source

2020 – 2030 in EJ



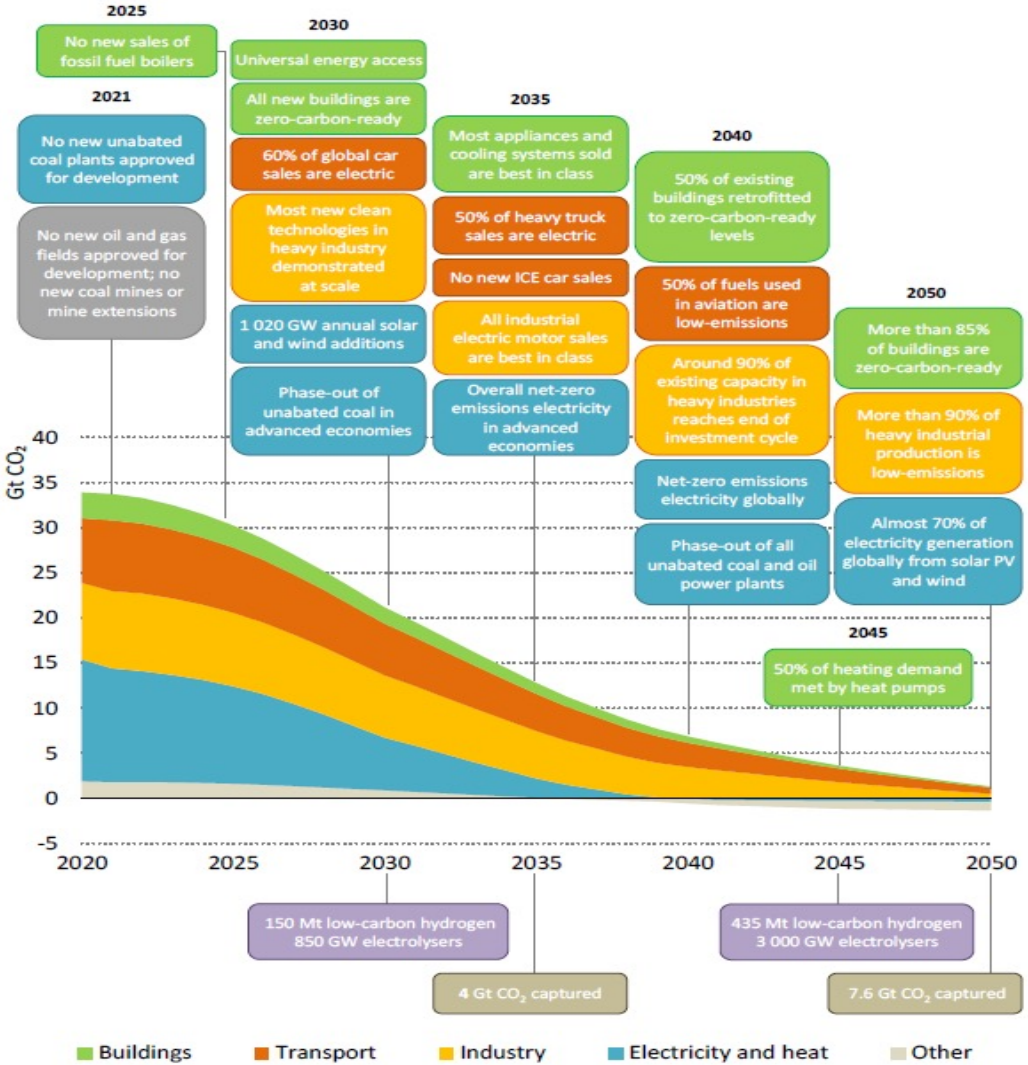
Net Zero by 2050: A Roadmap for the Global Energy Sector - IEA

Comments – IEA views

- Today energy system dominated by fossil fuels – 80%
- In 2050 dominated by clean energy (~70%)
- Solar share today is 1% and will reach 20% by 2050. Becomes single largest source of global energy mix
- More than 400 milestones for governments to follow and by when to meet 1.5C target. Milestones include:
  - Given decline in oil, gas and coal, there is no need for new fossil fuel supply investments
  - No more unabated coal fired power plants to be built around world
  - Ban on fossil fuel boilers by 2025
  - By 2035 no new sales of ICE vehicles
  - By 2040 global power systems in net terms becomes carbon free

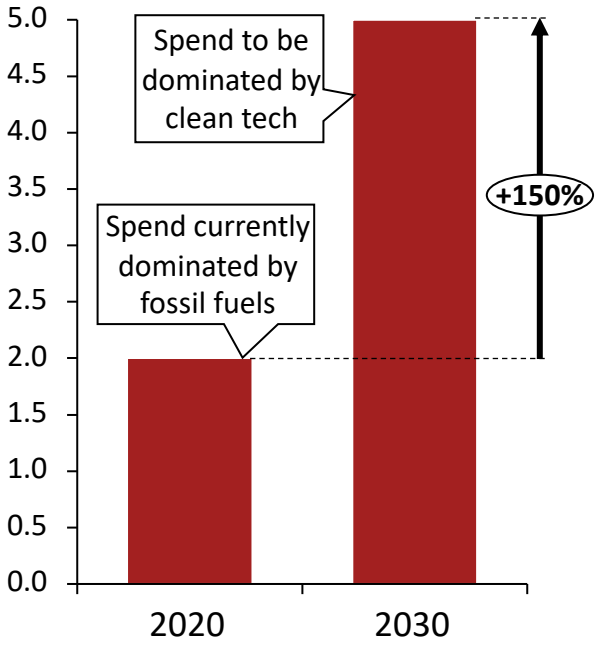
Key milestones in path to net zero

Major implications for immediate investments in long-lived assets



Historical surge in investments needed to make transition which will generate economic benefits

Global Investment in Energy 2020 - 2030
US$tr



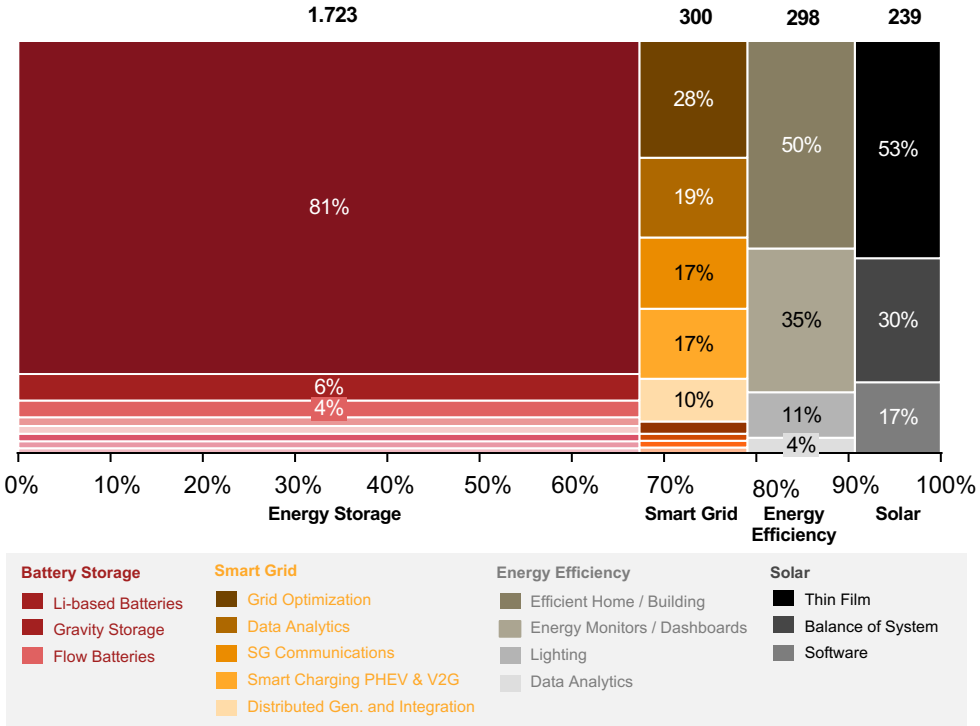
Net Zero by 2050: A Roadmap for the Global Energy Sector - IEA

Comments

- Global investment in energy to rise from US$2tr p.a. to US$5tr by 2030
- Historical surge in investment will lead to additional 0.4% annual increase in global GDP
- On employment, huge expansion in clean energy – solar panels, network electrification, energy efficiency construction etc. All together will create 30m new jobs by 2050
- 5m jobs lost especially those in fossil fuel production and related - technologies
- Biggest innovation opportunities - advanced batteries, hydrogen electrolysers, non-chemical storage. All make vital contributions re reductions in CO2 emissions between 2030 and 2050

Venture Capital Investment Distribution – Future Energy

2019 VC Funding by Category ($bn)



(1) Funding of innovative technology in solar, including the thin film and balance of system (BOS) & software segments (excludes project and development and financing)
Source: Mercom Battery Storage, Smart Grid, and Efficiency Funding and M&A 2019 Q4 and Annual Report, Mercom Solar Funding and M&A 2019 Q4 and Annual Report

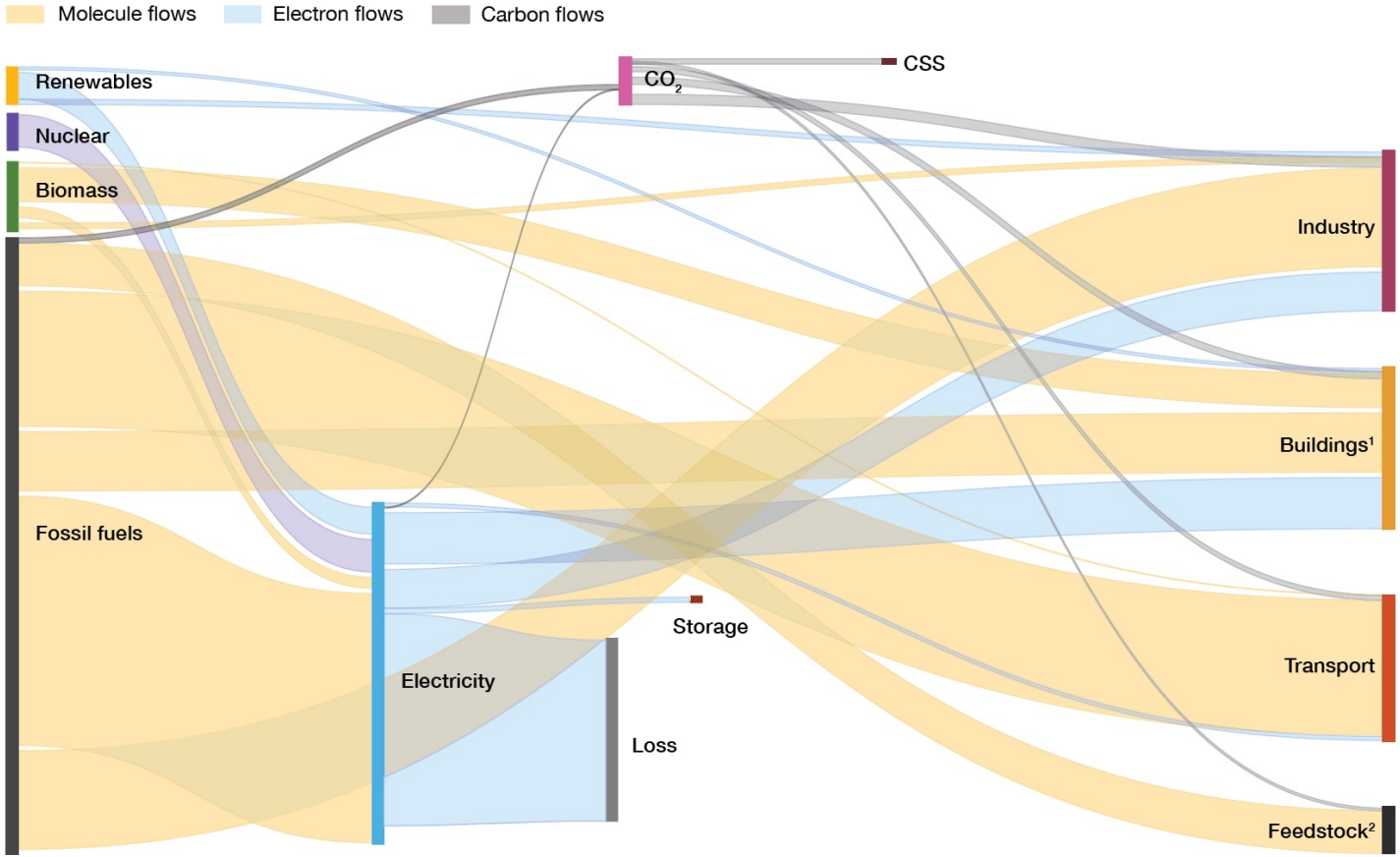
Spend Drivers

- **Venture capital funds quickly** establish investment frontiers and identify smart destinations for scalable technologies
- Venture capital invested more than **$2.6B in emerging technologies across the energy services value chain** in 2019
- Given its prominence and perceived value, **batteries** - particularly lithium ion – have been the preferred destination
- The focus on storage spend dominated in the recent past, **but now focus has shifted to broad smart grid technologies**
- These funds are extremely facile and are quick to cycle capital into new areas as technologies mature or become crowded

Two

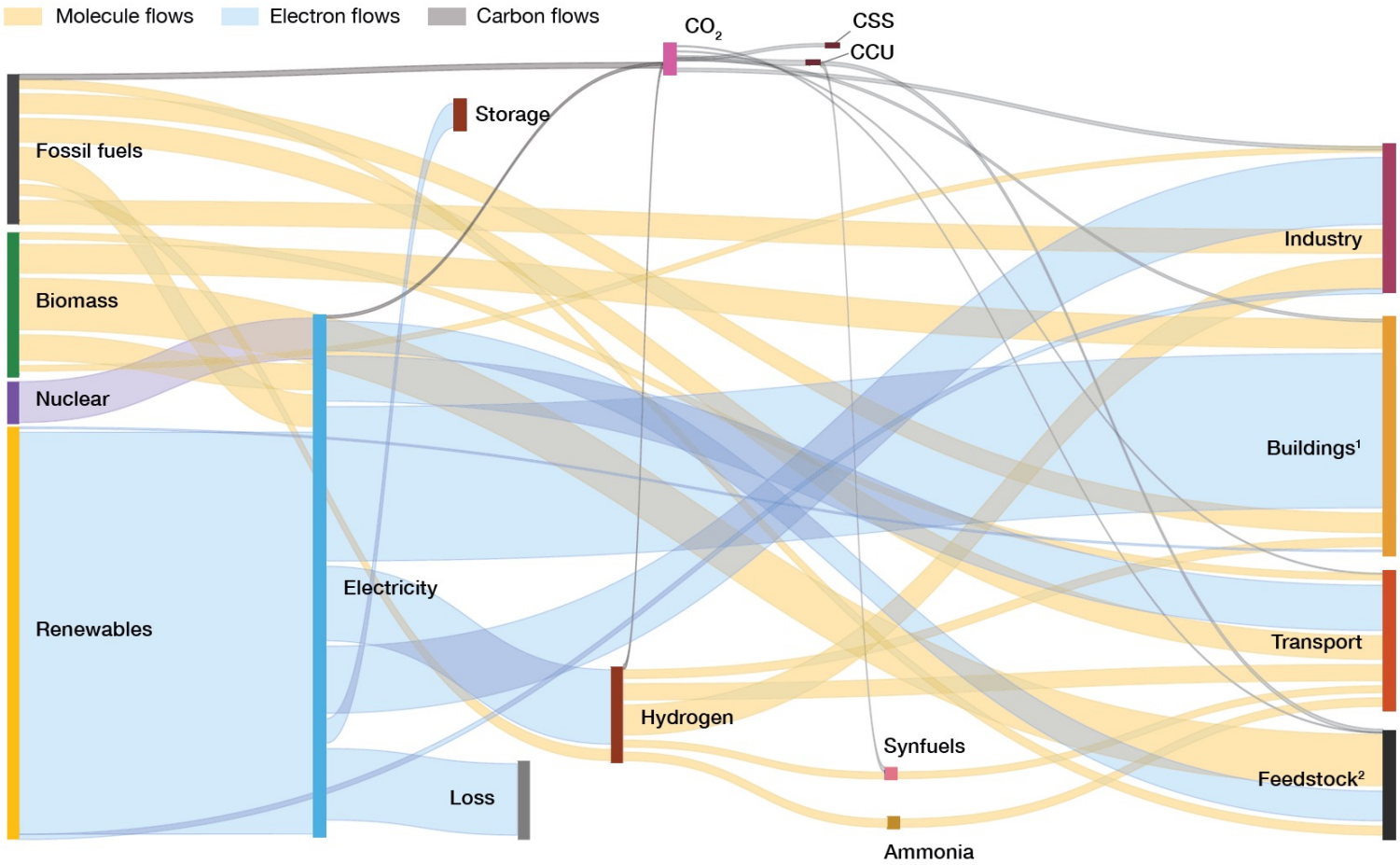
Energy Futures
The Road Ahead

Current illustrative energy flows – simple and separate flows



Extracted from 'PwC Inventing tomorrow's energy system' June 2021

Future energy flows look much different – lower carbon/more complex



Extracted from 'PwC Inventing tomorrow's energy system' June 2021

New energy vectors emerge and dominate over time

Exhibit 6: New vectors for molecules and electrons

Electricity-dependant

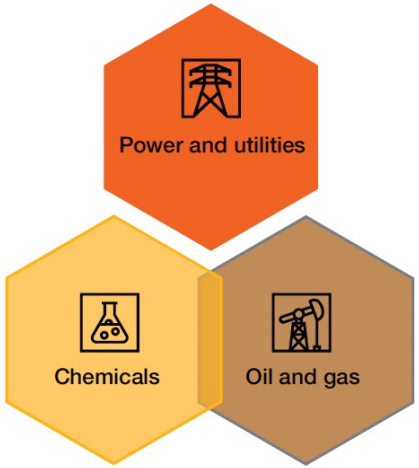
Sectors	Heat and power	Transport	Feedstock/ chemical agent
Current vectors	Oil and gas	Fossil fuels, EV batteries	Natural gas, Grey hydrogen
End-state vectors	**Cooling or heating:** Heat pumps, Green hydrogen, Biogas **Power:** Pumped hydro storage, Renewable energy sources	Syngas and synfuel, Hydrogen, EV batteries	Bio-methane, Green hydrogen, Carbon capture
	• Electric heat pumps and district systems decarbonise cooling and heating. • Hydrogen and biogas replace fossil fuels to supply industries requiring high-temperature heat. • Power generation depends on renewables and carbon-free energy storage (e.g., pumped hydro).	• Fossil fuels convert to electricity-based energy and its byproducts, such as hydrogen and batteries. • Synfuels and syngas are a vital source of carbon-free fuel for heavy-duty long-haul transport.	• Chemical feedstock primarily depends on bio-methane and green hydrogen. • Chemical agents are prioritised for carbon-capture solutions, such as the recycling of complex molecules.

Source: Strategy& analysis

Extracted from 'PwC Inventing tomorrow's energy system' June 2021

Convergence of value streams and company strategies

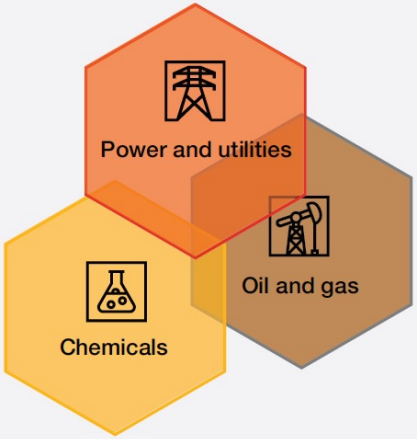
Traditional model



The **traditional model** implies a segregation of the role of the molecule and the electron, where:

- Oil and gas companies provide molecules.
- Power and utilities companies transform molecules to generate electricity.
- Chemical companies use both molecules and electrons to compose new molecules.

Converged model



The **converged model** is driving companies to intertwine the role of the molecule and the electron:

- Oil and gas companies become electricity and new molecules suppliers (e.g., H_2) and expand their business model into a utility provider (e.g., electricity generator).
- Chemical companies store electric power and utilise renewable carbon atoms to form molecules.
- Power and utilities companies dependent on storage to secure constant supply of power (e.g., batteries, H_2, ammonia) and become suppliers of green electrons.

Extracted from 'PwC Inventing tomorrow's energy system' June 2021

The traditional hard delineation between oil and gas, chemicals, utilities and technology companies is eroding

Convergence along Energy Value Chain

	FUEL SUPPLY	POWER GENERATION	POWER DISTRIBUTION	CONSUMER ENERGY SERVICES	CONSUMER ENERGY E-MOBILITY
Oil and Gas	**Traditional playing ground**	• Announcement of decarbonization/ renewables portfolio targets • Investments in renewables	• Acquisition of retail operations • Investments in microgrid and battery technologies	• Acquisition/ Development of EV charging networks	*Limited presence*
Utilities	• Investment in hydrogen production technologies	**Traditional playing ground**		• Development of EV charging networks • Partnerships with auto players for EV charging	• Entry into broadband, rooftop solar, home automation • Focus on customer engagement/ data analytics
Tech + New entrants	*Limited presence*	• Announcement of RE100 commitments • Large PPAs with renewables IPPs	• Development of smart grid and microgrid solutions • P2P wholesale power/ trading	• Partnerships with auto players for home EV charging • Development of EV fleets	**Traditional playing ground**

Moves beyond traditional core business

IMPLICATIONS

- Consumers are expecting bundled services fulfilling all their energy needs
- As consumer facing businesses, Utilities and Tech players are leading move to consumer-centric, bundled energy services
- O&G players need to build partnerships and acquire new capabilities in consumer engagement and analytics, to effectively compete

Source: Strategy& analysis

Strategic questions and role choices

New role Traditional role

	Typical considerations	Strategic options	Strategic questions
International oil companies	Oil and gas portfolio characteristics Core, differentiated capabilities Stakeholder and regulatory environment Commercial returns	Leading integrated energy company Decarbonised oil and gas specialist	Shift to integrated model or focus on oil and gas? Aggressive pivot or gradual evolution to new energy? Pursue new energy growth via organic investments or deals?
National oil companies	National policy and ambitions Mandate and role in energy ecosystem Breadth of project management and other capabilities	National new energy champion Oil and gas resource custodian	Embrace role as national new energy champion or focus on oil and gas? Pursue net-zero ambitions or smaller emissions reduction? Develop new low-carbon products (e.g., hydrogen)?
Chemicals	Current portfolio and product mix Existing feedstock options and costs Geographic location R&D and competitive differentiation	Circular chemistry leader Traditional petrochemical company	Aggressively adopt sustainable feedstocks or continue oil and gas? Invest in captive new energy and hydrogen sources? Create and expand circular chemistry products and services?

Extracted from 'PwC Inventing tomorrow's energy system' June 2021

Strategic questions and role choices

New role Traditional role

	Typical considerations	Strategic options	Strategic questions
Power and utilities	Current generation portfolio Market and regulatory structure Core, differentiated capabilities Corporate culture, agility and customer focus	Integrated energy provider Power generation and delivery	Strike a balance between traditional and low-carbon power generation? Expand into energy trading and service offerings? Develop hydrogen and other storage options?
Investors	Market outlook and expected returns Emerging growth sectors Investor sustainability expectations	Energy transition enabler Financial return seeker	Continue to focus on traditional energy or pursue low-carbon only? Invest in mature or emerging energy solutions? Balance growth and higher-margin segments?
Government and regulators	National policy and ambitions Private-sector capabilities Market and regulatory structure Economic strengths and investment capability Consumer/societal expectations	Energy transition orchestrator Free-market enabler	Balance state vs. private investment in infrastructure? Rewrite or evolve policies and regulations? Drive transition via state subsidies or free consumer choice?

Extracted from 'PwC Inventing tomorrow's energy system' June 2021

The industry value chain is at different stages of disruption with wide-ranging drivers and impacts

Evolving Energy Value Chain

	Conventional Generation	Marketing and Trading	Unconventional Supply	Transmission and Distribution	Retail	Energy Services	Behind-the-meter (BTM)
Value (growth / decline)	▼ ▲	▼ ▲	▲	▲ ▲	▼	▲	▲ ▲ ▲ ▲
Value Drivers	• Capacity market models and dynamics • Coal and nuclear plant closures • Headroom between fossil and renewables • Potential for supply – demand imbalance	• Degree of market liquidity • Depth of market participation • Price volatility during transition • Contract tenor	• Availability of continuing subsidies • Improving parity with conventional supply • Integration of supply and storage • Preservation of supply chain security	• Sustained capex for modernization • Supportive state regulatory policy • Intelligent system and devices • Growth in upstream supply sources	• Open market policies • Supply hedging strategies • Capture of margin uplift • Avoidance of supply default	• Breadth of offering portfolio • Creativity in pricing models • Ability to integrate multiple solutions • Strong origination and channel access	• Improving economics of underlying technologies and offerings • Heightened attention to building customer awareness of offerings • Demonstration of value-added contribution from customer adoption • Utilization of partners to provide capabilities to supplement internal capacity
Implications	• Declining capacity and proportion of asset base • Tightening margins with limited ability to enhance	• Illiquid markets with high risks • Capacity market design weakness	• Supply source of choice • Economics providing market advantage	• Highest growth value chain element • Stable returns with performance upsides	• Extremely thin margins • Low growth market	• Rapidly growing customer market • Solutions model offers higher margins	• Slow market growth and customer awareness of opportunities • Technologies not yet at parity and value proposition unclear

Distributed generation *Storage* *Demand response* *EV* *Energy mgmt. services* *Home services*

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