Challenges in Decarbonisation: Building a Resilient Net-Zero Future

Day 2 Keynote

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Reimagining the Future Energy System

Decarbonisation
- Accelerate economy-wide, low-carbon solutions
  - Electric sector decarbonization
  - Transmission and grid flexibility: storage, demand, EVs
  - Efficient electrification
- Achieve a net-zero clean energy system
  - Ubiquitous clean electricity: renewables, advanced nuclear, CCUS
  - Negative-emission technologies
  - Low-carbon resources: hydrogen and related, low-carbon fuels, biofuels, and biogas

Resiliency
- Mitigate climate impacts and cyber/physical risks
  - System and asset hardening
  - Improved response
  - Faster recovery
  - Cybersecurity
- Future proof energy system design basis
  - Resilient power system design
  - Advanced asset design and strategic undergrounding
  - Smart integration of energy carriers

Transformation
- Drive affordability of a clean and resilient energy system through digital transformation
  - Power system modernization: pervasive sensors, monitoring, advanced analytics using AI
  - Upgraded and expanded communications infrastructure and control systems

Making Energy More
- Clean
- Affordable
- Reliable
DECARBONISATION Across the Economy many technologies needed

Global CO₂ Emissions by Sector

- Today ~33 Gt
- 2050

- Electricity and heat
- Industry
- Transport
- Buildings
- Other

Reference: Adapted from IEA World Energy Outlook 2021
Decarbonisation Pathways Enabled by Innovation

Decarbonisation

Accelerate economy-wide, low-carbon solutions
• Electric sector decarbonization
• Transmission and grid flexibility: storage, demand, EVs
• Efficient electrification

Achieve a net-zero clean energy system
• Ubiquitous clean electricity: renewables, advanced nuclear, CCUS
• Negative-emission technologies
• Low-carbon resources: hydrogen and related, low-carbon fuels, biofuels, and biogas

2030++
2050
Today
Past
Efficient Electrification
Low-Carbon Resources
Energy Efficiency
Cleaner Electricity

~10-15 years
~15-30 years

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Decades of Effort
from concept to commercialization

- Advanced Nuclear Reactors
- Clean Hydrogen
- Carbon Capture Utilization and Storage
- Nuclear Power
- Combined Cycle Gas Turbines
- Solar Photovoltaic
- Wind Power

Notional timelines
TECHNOLOGY+++ won’t be as ‘simple’ as today

Primary Energy → Conversion → Storage and Delivery → Energy End-Use

- Renewable Energy
- Nuclear
- Natural Gas
- Petroleum & Coal
- Bioenergy & Waste

Electricity Generation → Refining → Bio-Refining

Electricity Storage → Gas Storage

Distributed Resources

BUILDINGS

INDUSTRY

TRANSPORTATION

Liquid Fuels

Conventional Fuels

Biofuel
New Resources and Players: how will they fit and transition?

Primary Energy

Conversion

Storage and Delivery

Energy End-Use

- Renewables
- Nuclear
- Natural Gas
- Petroleum & Coal
- Bioenergy & Waste

Electricity

Hydrogen

Ammonia Synthesis

Electricity Storage

Distributed Resources

Co-Gen/CHP

BUILDINGS

INDUSTRY

TRANSPORTATION

On-Road

Non-Road

Liquid Fuels

Natural Climate Solutions

Conventional Synthetic Biobased

Captured CO₂

Direct Air Capture

Fuel Synthesis

RNG

SNG

Gas Storage

Re-Fueling Infrastructure

Growing Complexity and Players in the Energy System

COMPLEXITY

New Resources and Players: how will they fit and transition?
Low-Carbon Fuels Pathway from the Electric Sector

LOW-CARBON GENERATION, TRANSMISSION & DISTRIBUTION

Direct Electrification

Indirect Electrification

Low-Carbon Fuels*
- Hydrogen
- Ammonia
- Synthetic Hydrocarbons

*Representative of one of several pathways
DECADES OF CHANGE

WHAT DOES 2050 LOOK LIKE?

What are the technologies to address economy-wide decarbonisation?

What are the strategies and approaches to drive value across the economy?

What are the barriers to overcome and who are the key stakeholders for collaboration?