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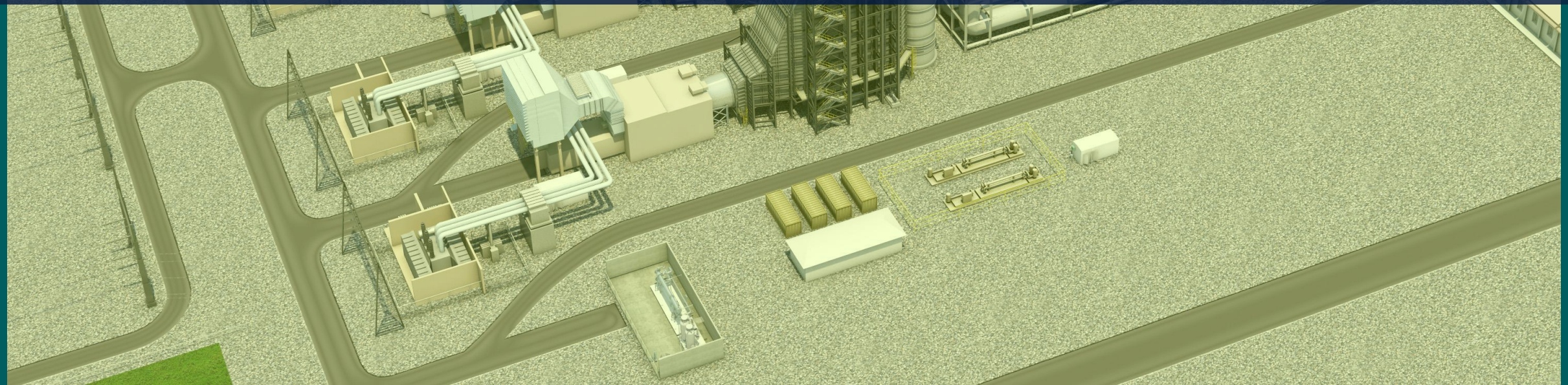
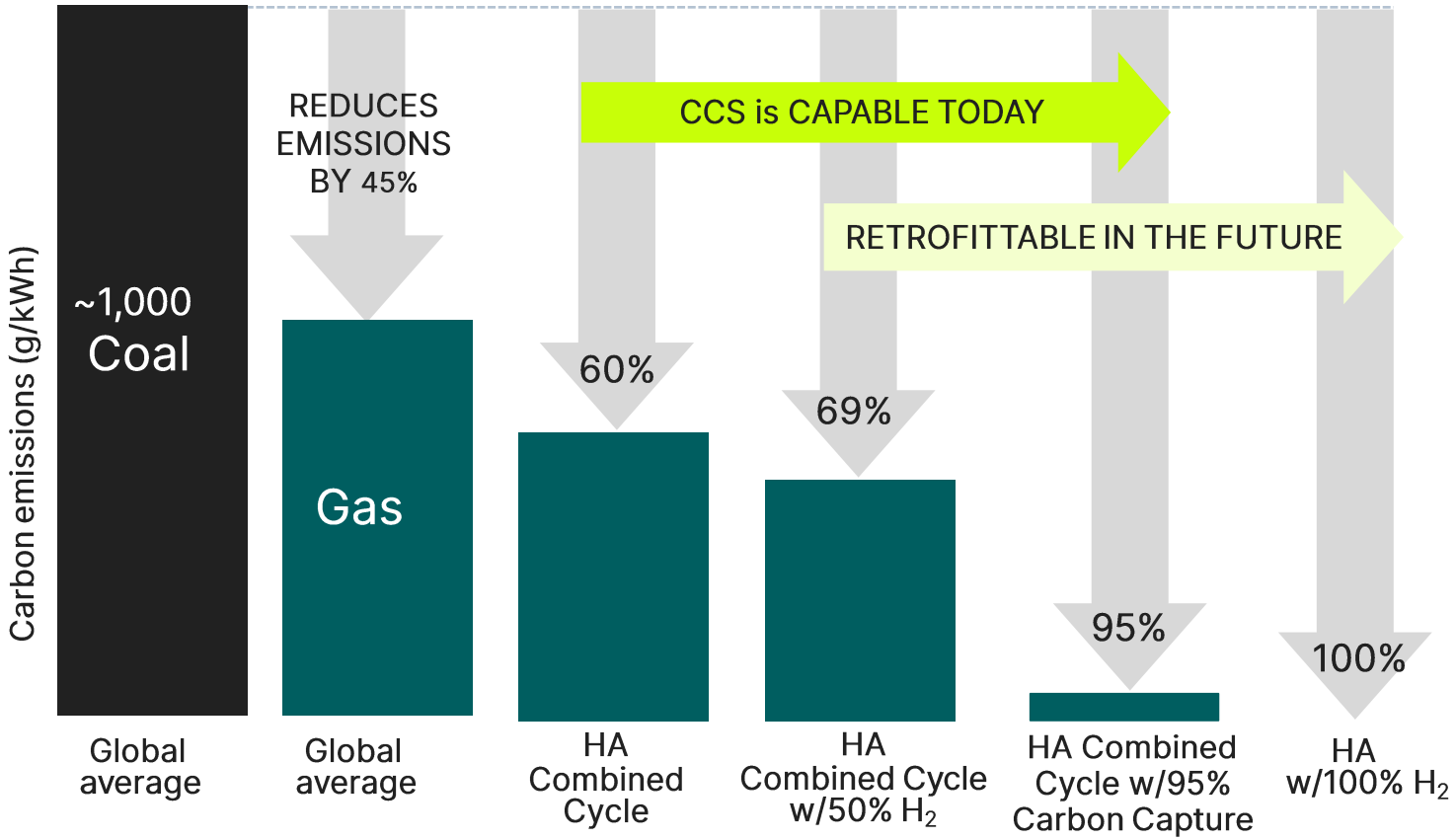
Integrated NGCC-Carbon Capture Solutions

For Japan & Asia



Why Carbon Capture For Gas Power?



Coal-to-Gas Switching, Hydrogen, Carbon Capture and Sequestration

ARE VIABLE PATHWAYS TO LOW OR ZERO CARBON POWER

Carbon Capture is a ready to implement technology…helps in accelerating the decarbonization journey

Source: VRP Global Industrials Conference, September 2021

Chart Source: GE Future of Energy White Paper, Dec 2020
(a- GE H_2 statistics as of September 2021 – inclusive of both, heavy-duty and aero-derivative gas turbines

NGCC CO_2 capture Options : bolt-on Vs integration

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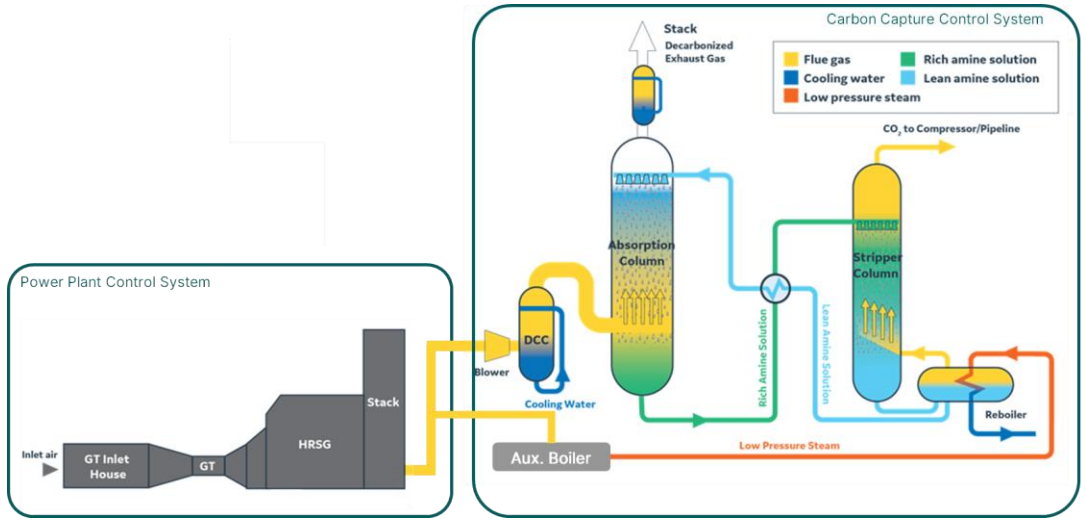
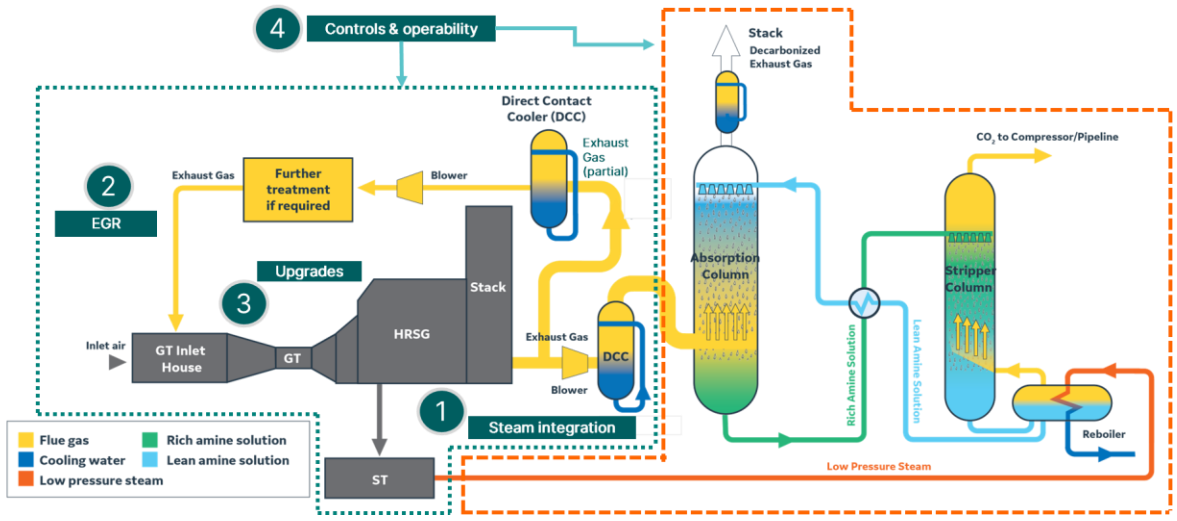
NGCC with Bolt-On Carbon Capture



- Bolt-on auxiliary boiler adds CapEx and OpEx
- Auxiliary boiler creates CO_2 emissions that must be sent to a larger, and more costly, CO2 capture system
- Both carbon capture and the auxiliary boiler reduce plant efficiency

CCGT with Integrated Carbon Capture



- Integration reduces CapEx and OpEx
- Exhaust gas recirculation reduces flow and concentrates CO_2 leading to a smaller, and less costly, CO2 capture system
- Integration recovers some of the efficiency loss

GE Vernova's Integrated NGCC+CCS Solutions

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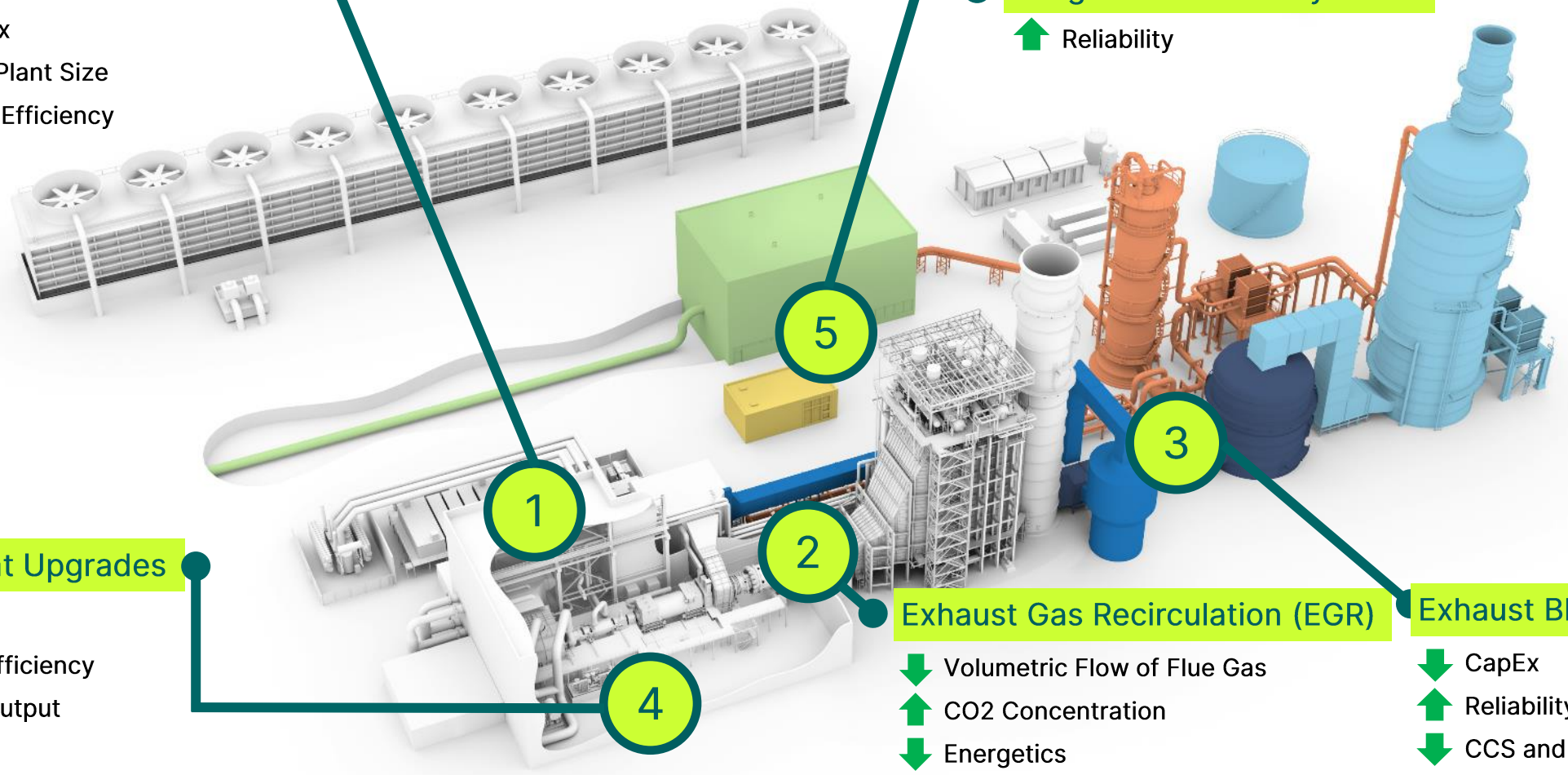
up to **~20%** CAPEX

5% Performance*

*as compared to Bolt-on



Steam Integration

- ↓ CapEx
- ↓ CCS Plant Size
- ↑ Plant Efficiency

Integrated Control System

- ↑ Reliability

Equipment Upgrades

- ↓ CapEx
- ↑ Plant Efficiency
- ↑ Plant Output

Exhaust Gas Recirculation (EGR)

- ↓ Volumetric Flow of Flue Gas
- ↑ CO2 Concentration
- ↓ Energetics
- ↓ CapEx

Exhaust Blower Elimination

- ↓ CapEx
- ↑ Reliability
- ↓ CCS and EGR Footprint

Integrated NGCC+CCS solutions can improve NGCC efficiency & reduce CCS cost (CapEx & OpEx)

EGR : Exhaust Gas Recirculation

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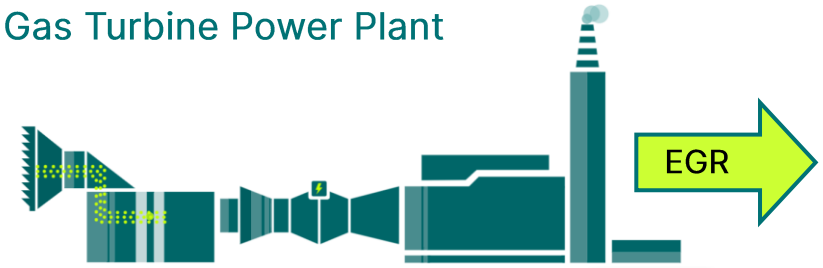
Gas Turbine Power Plant

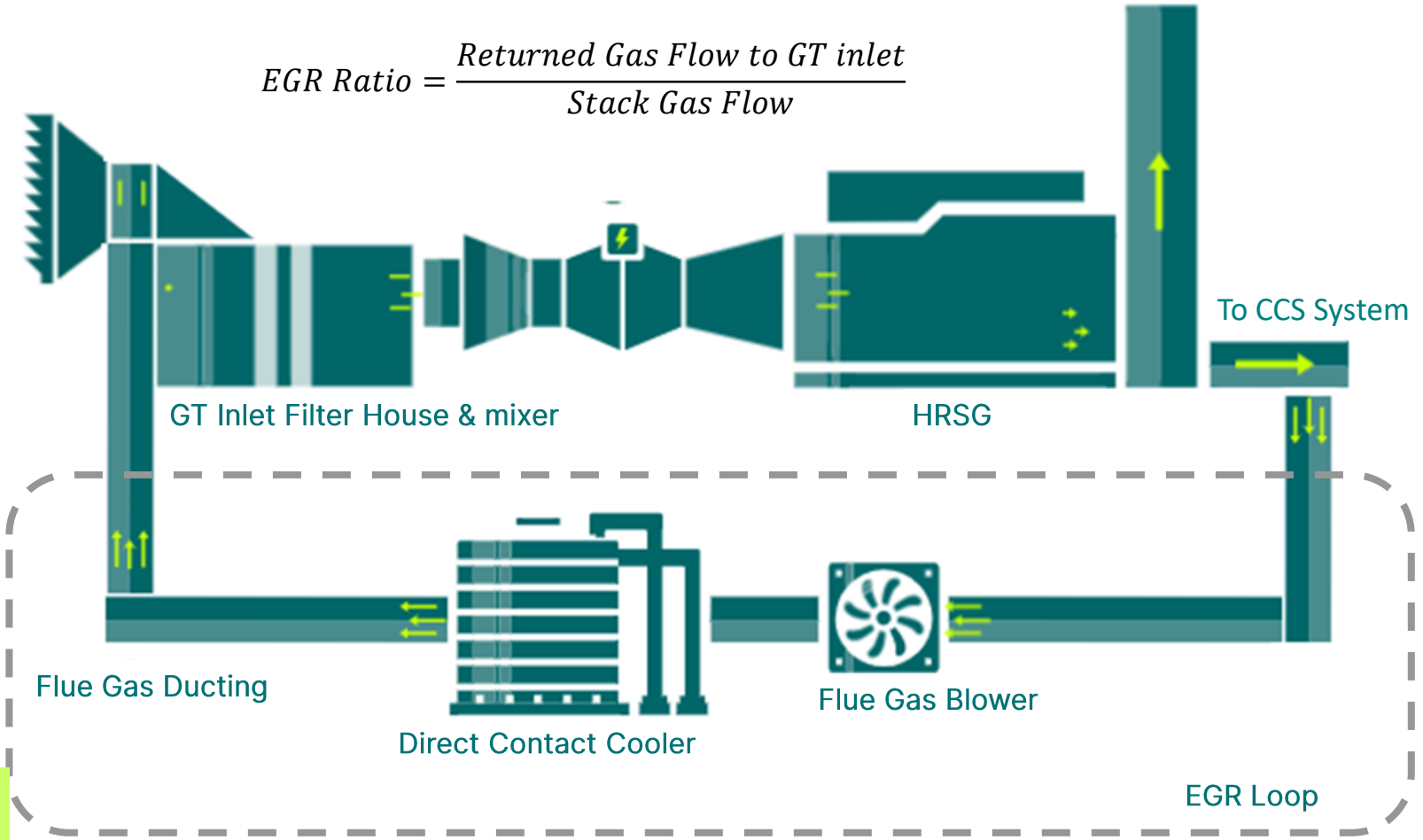


$$EGR\ Ratio = \frac{Returned\ Gas\ Flow\ to\ GT\ inlet}{Stack\ Gas\ Flow}$$

- ↓ Flue Gas flow
- ↑ CO_2 Concentration

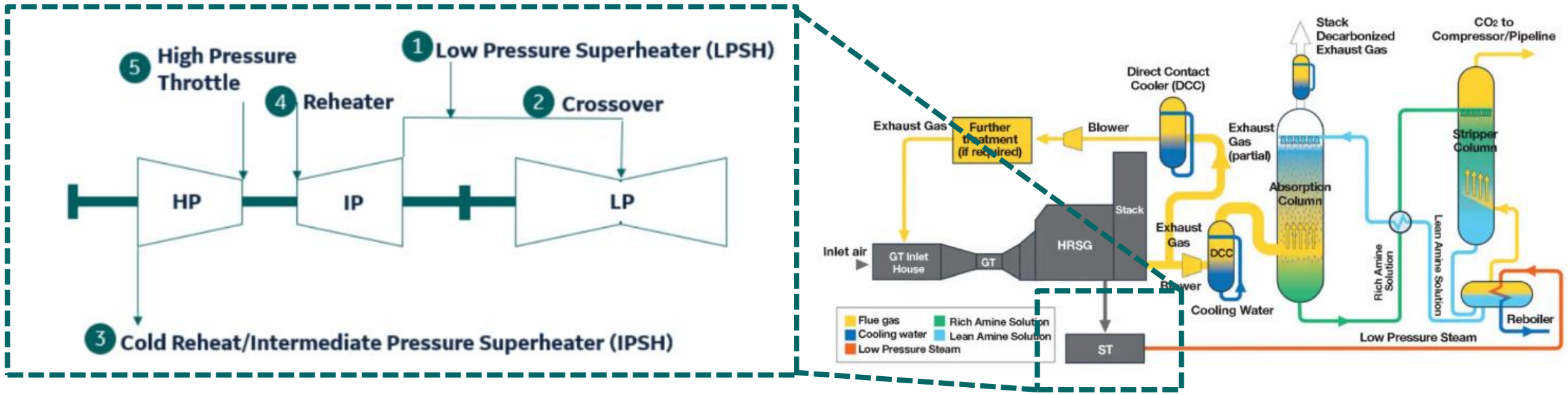
- ↓ Absorber size
- ↓ Reboiler duty

- ↓ CapEx and OpEx
- ↓ CCUS Footprint
- ↑ Power Output
- ↑ Efficiency



GE Vernova is working on developing the EGR since 2006 for NOx reduction, which is repurposed to increase the CO2 concentration

Steam Turbine Integration For NGCC-CCS



Less Flow Conditioning

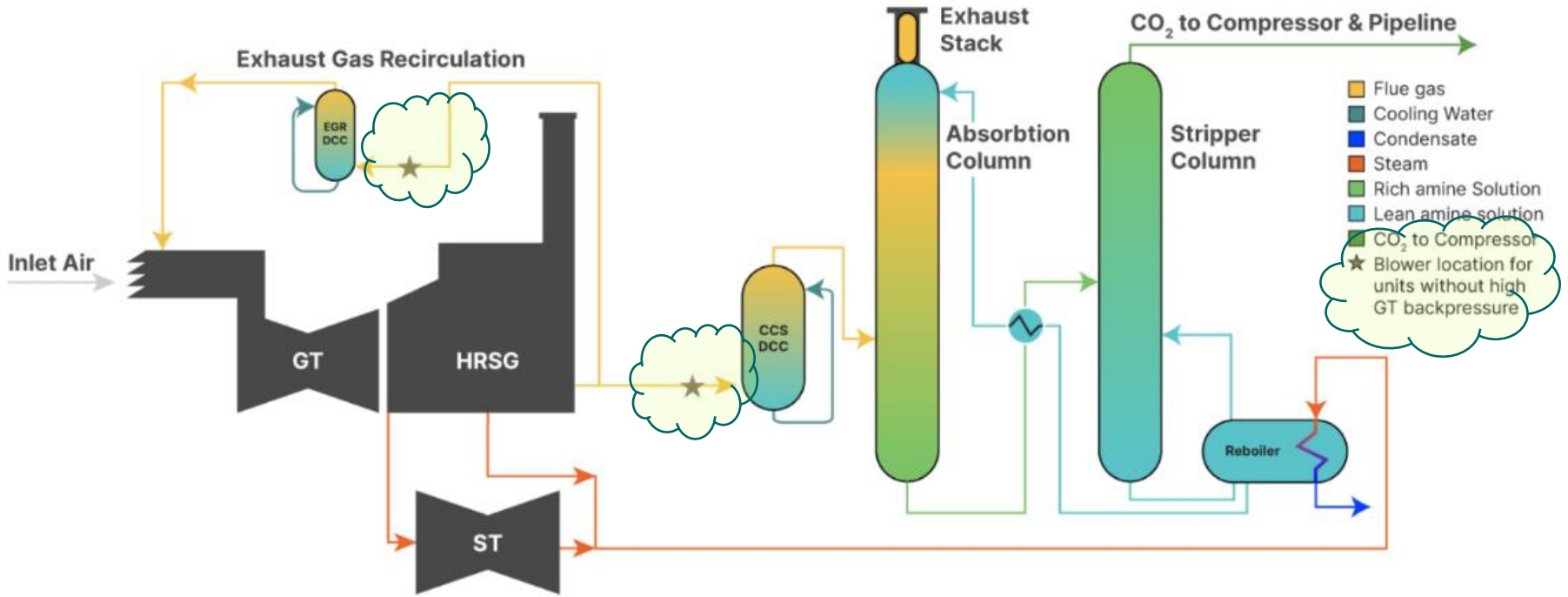
1. Low Pressure Superheater	2. Crossover	3. Cold Reheat/IPSH	4. Hot Reheat	5. HP Throttle

Higher ST MW Penalty

✓ Extractions from steam turbine instead of auxiliary boiler, reduces the additional emissions from auxiliary boiler , which can improve the overall efficiency NGCC-CCS plant.

High Backpressure Operation : No Blowers

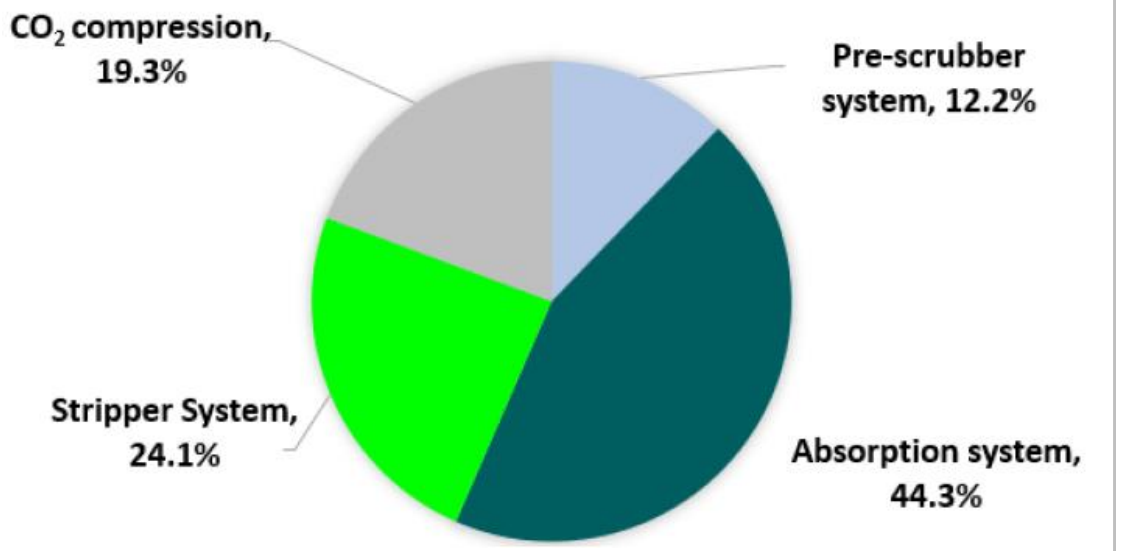
Designing the Gas Turbine and HRSG to operate at higher backpressure enables seamless integration with EGR and carbon capture systems - eliminating the need for auxiliary blowers to drive flue gas flow and improving overall system efficiency.



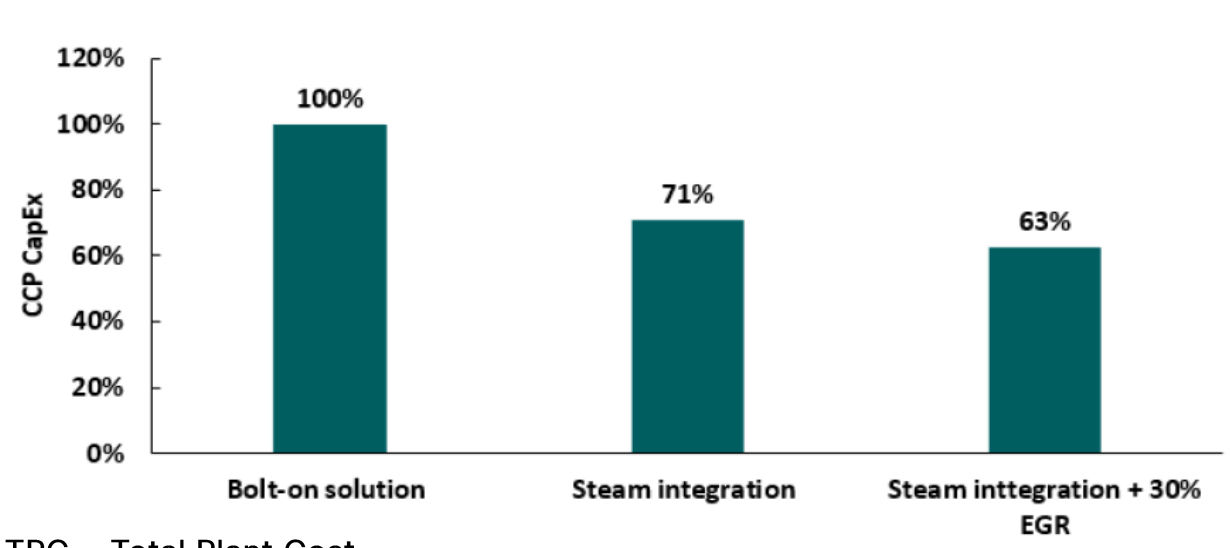
Benefits:

- ✓ Lower CapEx
- ✓ Lower Footprint
- ✓ Less maintenance
- ✓ Higher reliability

CapEx Impact with Integrated NGCC-CCS

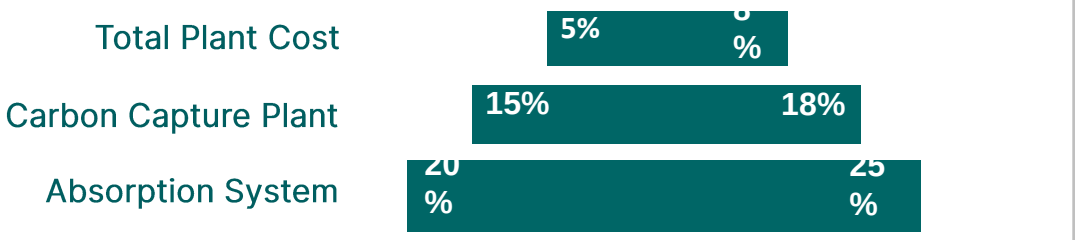


CCP Equipment's CapEx breakdown



TPC = Total Plant Cost

CCP CapEX saving with EGR & steam integration



CCP Equipment's CapEx Reduction with 30% EGR alone

- EGR alone can reduce the Carbon Capture Plant CapEx by up to 8%
- Steam Integration has a potential reduce the CapEx by up to 29% - By smaller CCP size & elimination of Auxiliary Boiler
- High Back Pressure adds further Cost Reduction

NZT Power : World's First Integrated NGCC-CCS Plant

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GE Vernova ⊕ Technip Energies WILL LEAD THE INTEGRATION OF THE

world's first CARBON CAPTURE and COMBINED-CYCLE power plant

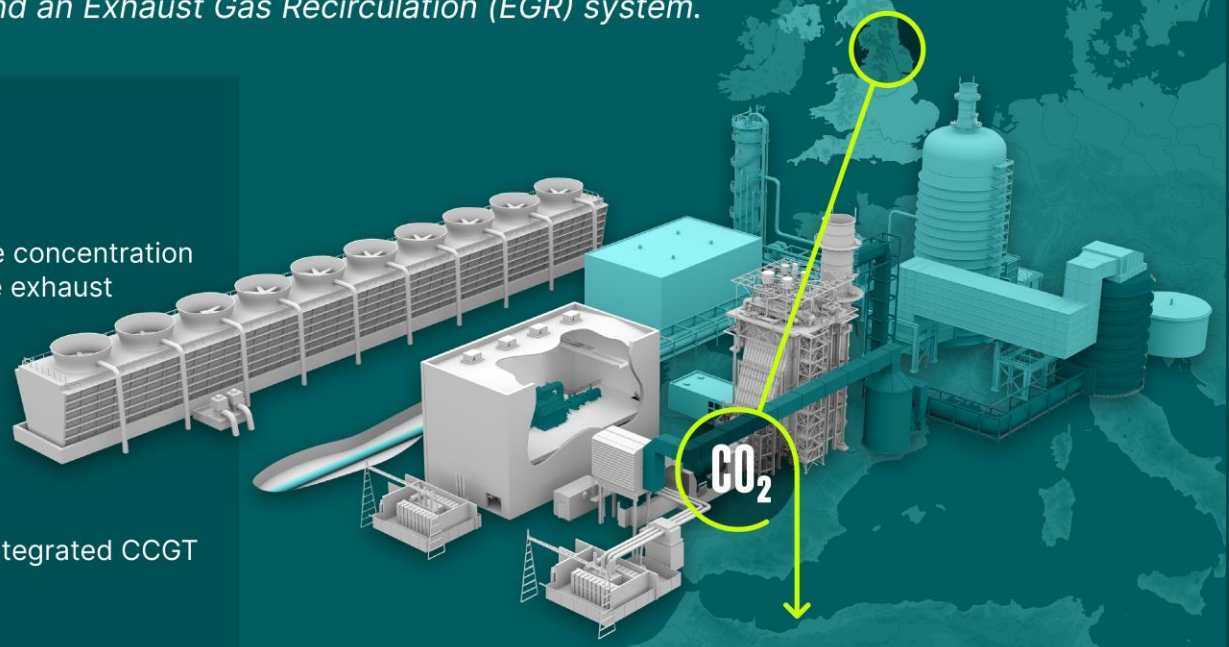
The plant will be powered by GE Vernova's advanced 9HA.02 gas turbine, a steam turbine, a generator, a Heat Recovery Steam Generator, and an Exhaust Gas Recirculation (EGR) system.

The plant will feature the 1st commercial use of **GE Vernova's EGR technology**, which:

1. Recycles CO2-rich flue gas back to the turbine inlet
2. Increases the concentration of CO2 in the exhaust

Potential benefits of the EGR system:

- Reduced overall carbon capture plant cost
- Improvements in performance/emissions for the integrated CCGT
- Reduced solvent usage



Expected to capture UP TO **2 MILLION** TONS OF CO2 ANNUALLY

⊕

Power the equivalent OF **1 MILLION** HOMES WITH

FLEXIBLE

DISPATCHABLE

LOWER CARBON

POWER

vernova.is/ccs-nzt

NGCC-CCS Solutions for Japan & Asia

Toshiba and GE Vernova Sign MoU to advance carbon reduction and efficiency for gas turbine fired power plants in Japan and other parts of Asia

- MoU to cut CO_2 emissions by integrating GE Vernova's Exhaust Gas Recirculation (EGR) system with Toshiba's proprietary CO_2 capture technology for NGCC power plants across Japan and Asia.
- Strengthens a 40-year strategic partnership, aligned with the METI–GE Vernova focus group supporting Japan's decarbonization goals.
- Feasibility studies show strong potential, with integrated GTCC–CCS solutions improving CO_2 capture efficiency, reducing costs, and minimizing power output loss.

Summary

1. ***NGCC+CCS ensures the stability, flexibility and reliability*** *needed for a renewables-heavy, electrifying grid, while cutting CO_2 intensity by up to 95% versus conventional gas and coal plants [(1)].*

2. ***Efficient NGCC-CCS solutions are essential*** *to scaling the deployment of carbon capture in power generation.*

3. ***Integrated NGCC-CCS*** *enhances the plant performances and reduces the Cost (CapEx & OpEx) and improves the reliability as compared to Bolt-On solution*

4. ***Deploying integrated CCS-capable designs today*** *helps avoid significant retrofit expenses later and ensures quicker rollout, with only modest incremental cost at present.*

1. IEA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