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ENVIRONMENTAL
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Exploring Project Structures - Making CO_2 Capture Make Sense

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The World Wants Action

- More than 100 countries are committed to a carbon net-zero goal by mid-century
- Carbon emitting industries are investing in advanced carbon-reduction solutions to embrace the Energy Transition
- Innovative solutions are required to bring us successfully into the low-carbon future

Most companies have adopted ESG commitments that require them to address CO_2 emission reductions over the next 20 years

Emerging Solutions

A lot of companies (B&W included) have introduced new processes and technologies to address the coming Energy Transition

- Transitioning to **Non-Carbonaceous fuels** Like Hydrogen
- Deploying **process changes** to reduce, concentrate, or eliminate CO_2 emissions
- **Post-Combustion CO_2 capture** solutions (Amine Scrubbing, Cryogenic Capture)

Unfortunately, many industrial plants will find these solutions costly and challenging to implement

Challenges with Non-Carbonaceous Fuel switching

- H_2 availability
- cost of H_2
- cost and complexity of on-site H_2 generation
- Process' current fuel base may be a low-cost or opportunity basis or integral to plant financial performance
  - Elimination of process byproducts
  - Synergistic relationships with neighboring facilities
  - Facility income

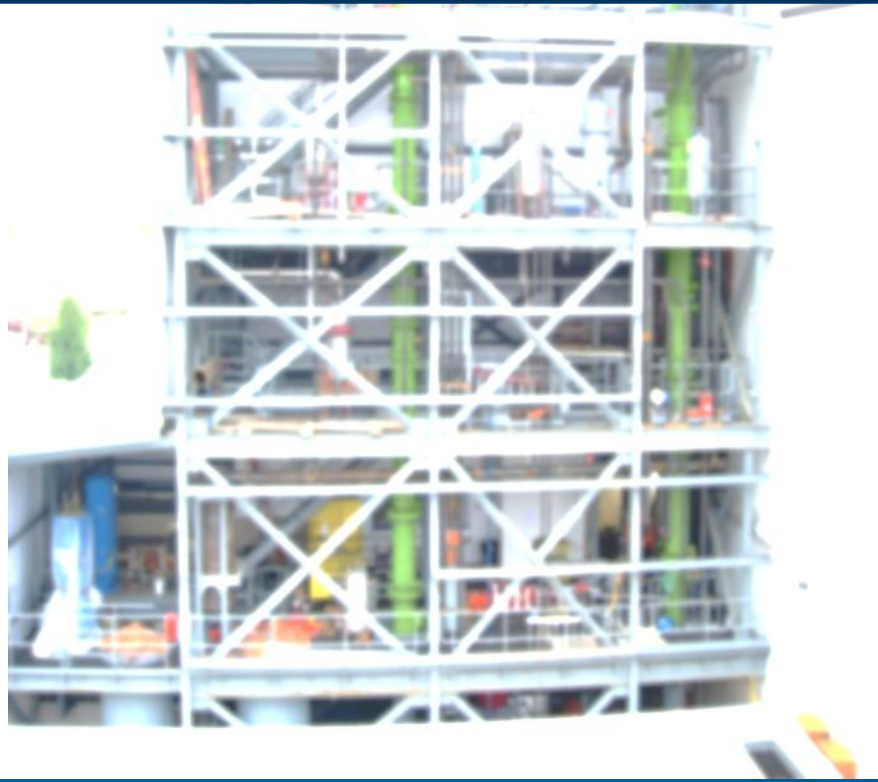
Challenges to Process Change Deployment

- Technology Readiness
- R&D Investment
- Cost to reconfigure an entire facility
- Often facilities employ several processes that will need to be revisited

Challenges of Post-Combustion Carbon Capture

Post Combustion capture technologies are by far the most developed solutions – however

- Large Scale applications are expensive to install and operate
- Multiple point sources of sometimes very different emissions at a single facility
- **CO_2 offtake solutions** not readily available, regionally limited
  - Sequestration
  - Pipeline to EOR
  - Beneficial Uses are limited

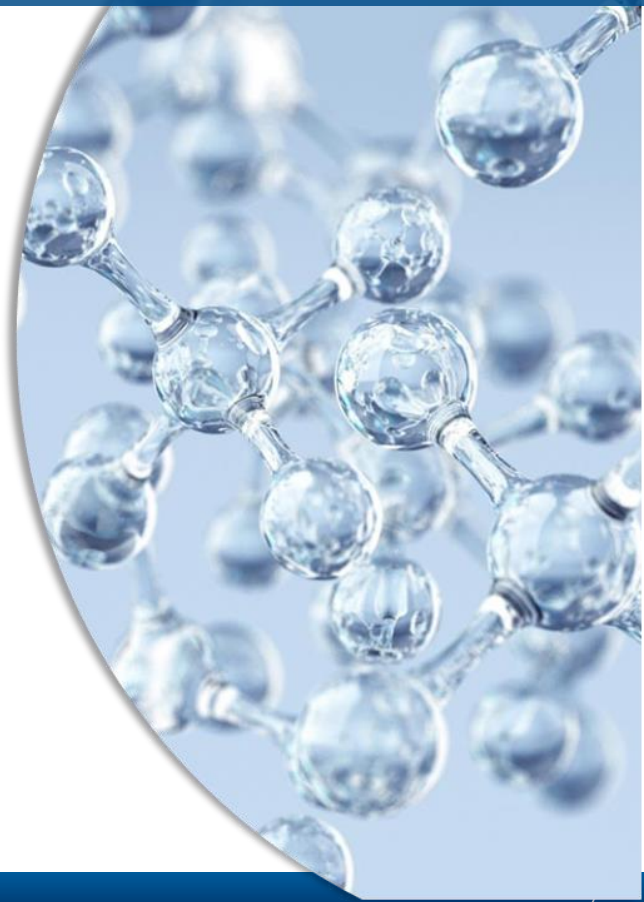


Learning to think of CO_2 as a product

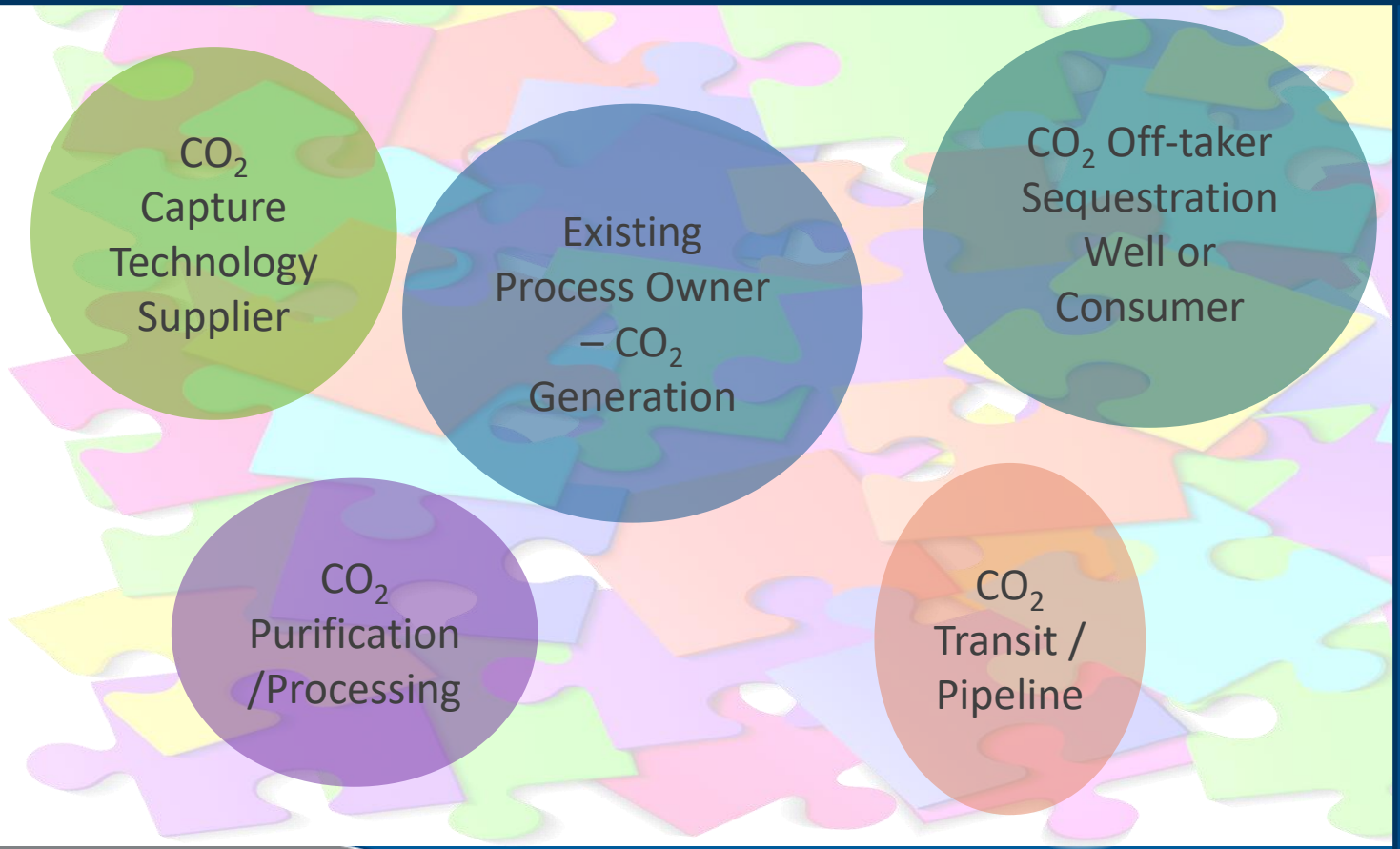
Sequestration is costly – and slow to develop

Success will lie in the development of new processes that utilize CO_2

i. Direct hydrogenation of CO_2 for green methanol production (biogenic CO_2)
ii. Incorporation into cement and other developing building materials
iii. Green Urea using biogenic CO_2

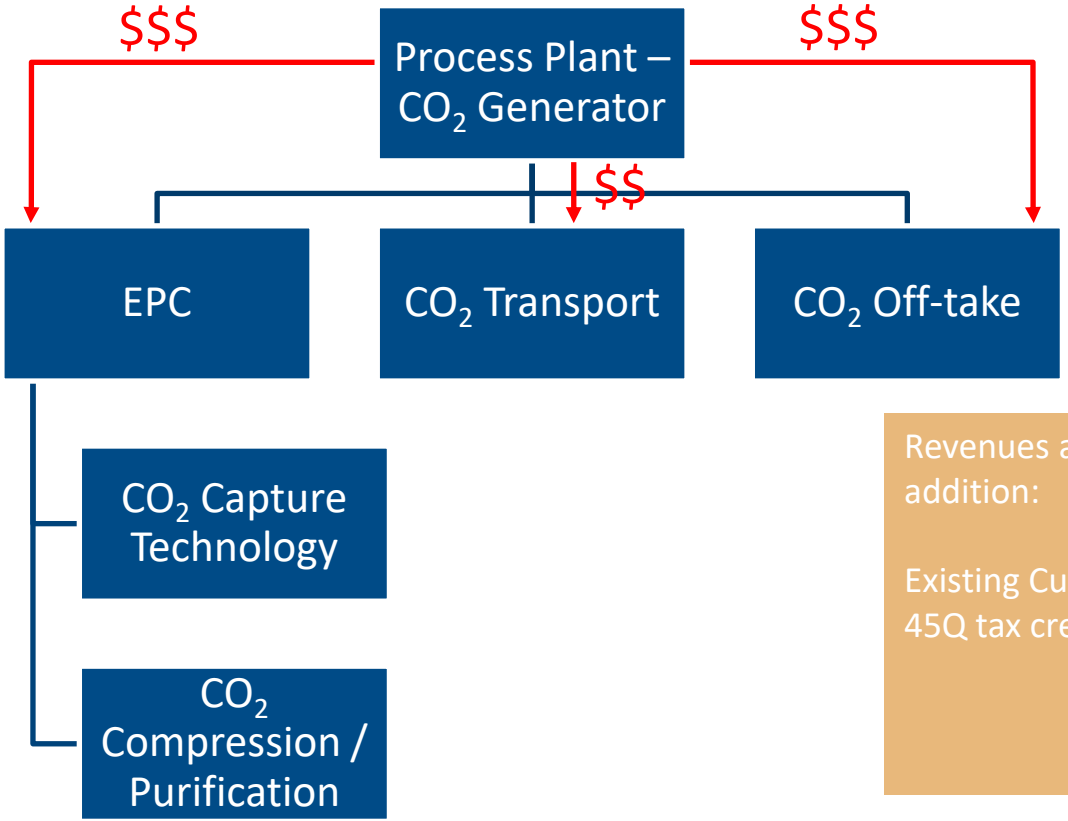


Cooperation between disparate industries will be required to make the financial model work



How do these players work together to create a sustainable project?

Traditional View - *Process Plant Captures CO_2*

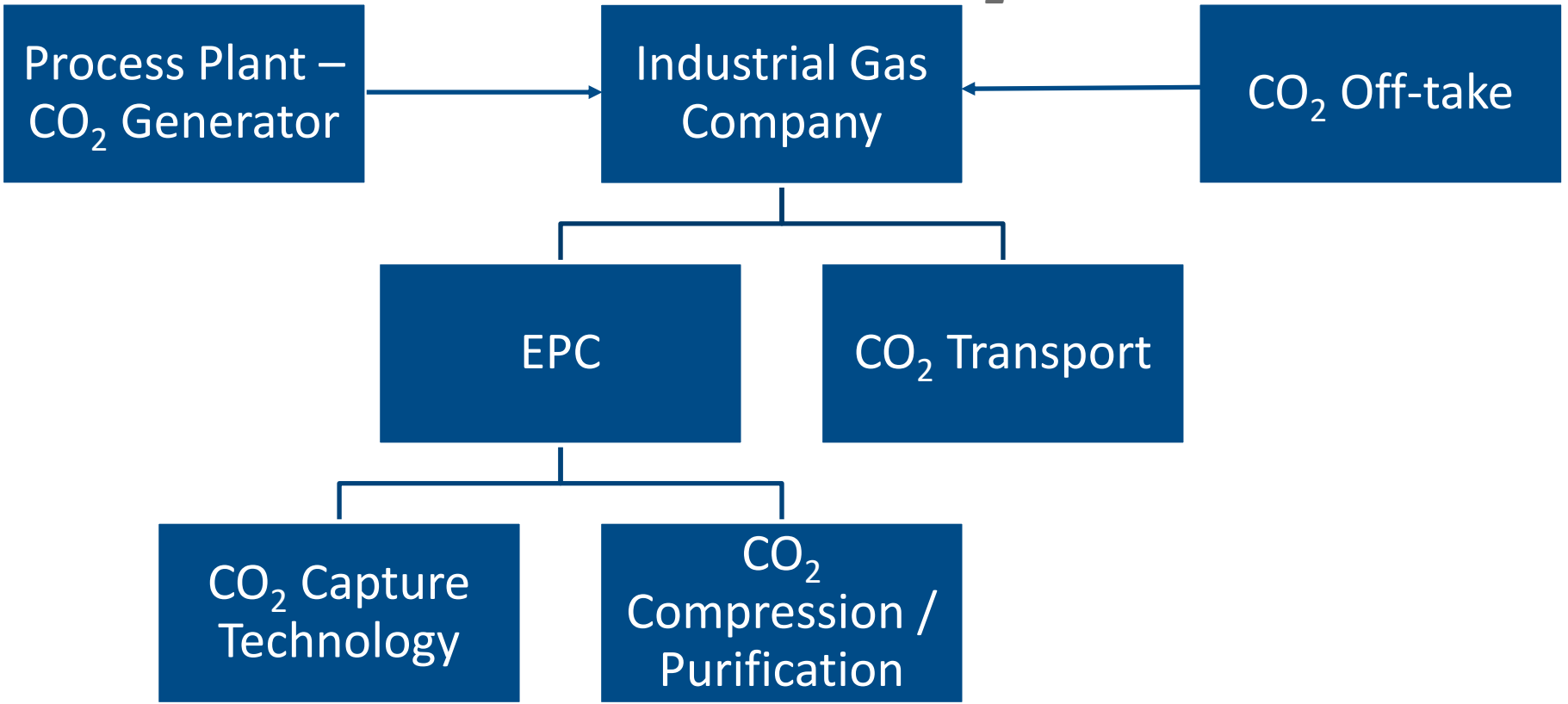


Revenues after addition:

Existing Customer Sales
45Q tax credits

Model 1 –

Industrial Gas Company Builds CO_2 Generation Facility



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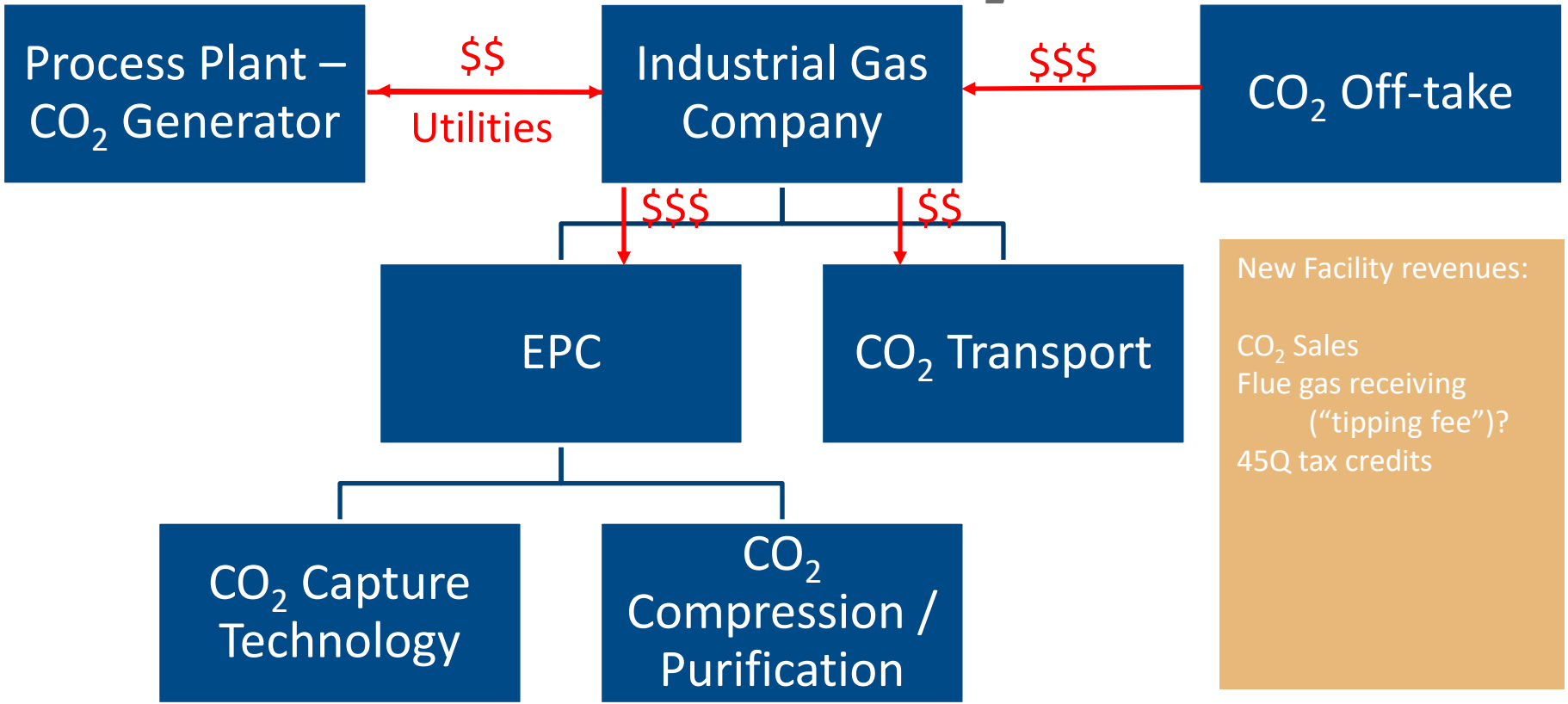
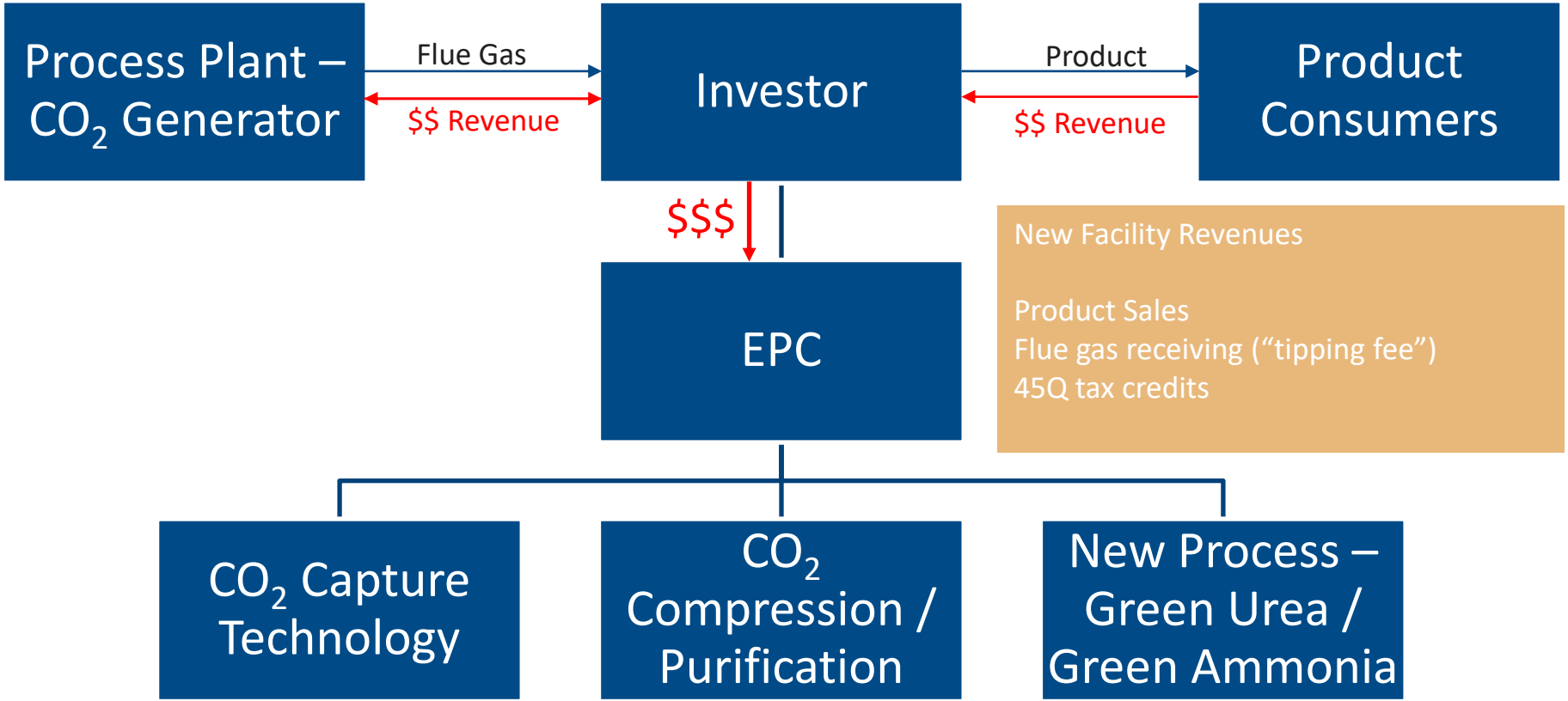


New Facility revenues:

CO_2 Sales
Flue gas receiving ("tipping fee")?
45Q tax credits

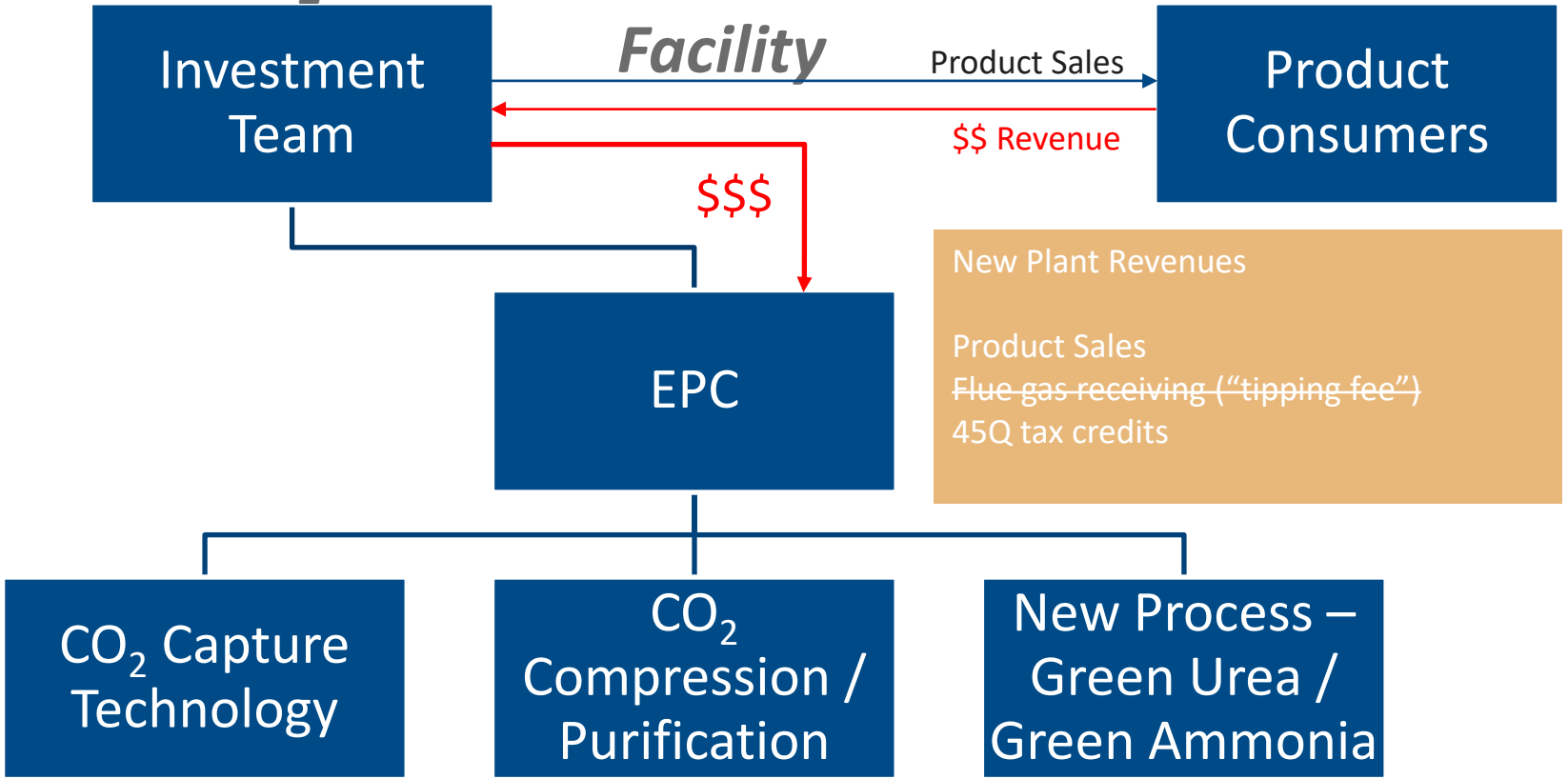
Model 2 –

Investor Builds a Beneficial Use Facility



Model 3 –

Investor/CO_2 Generator Team Builds a Beneficial Use Facility



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