



Kivi Offshore Technology

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Circular Energy is...



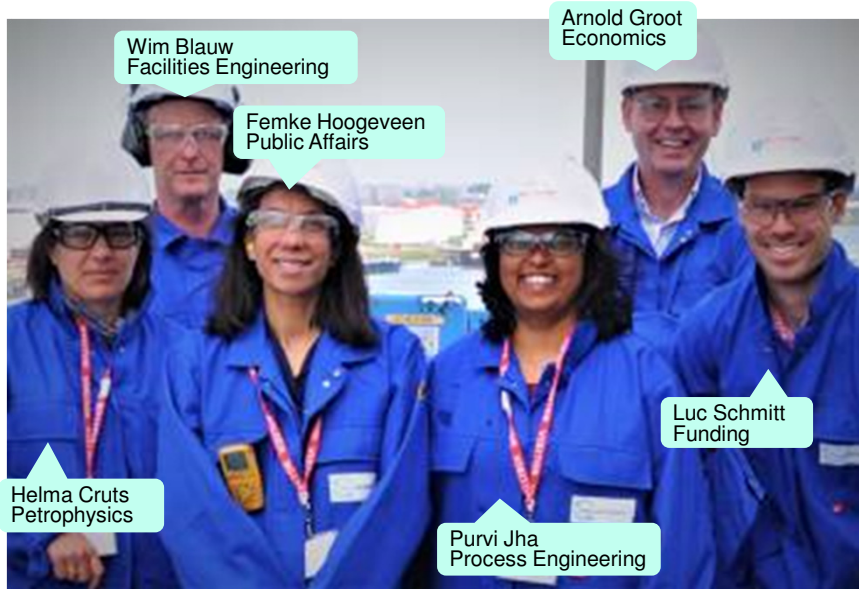
Circular Energy is

- A start-up company based in The Netherlands
- Targeting small offshore gas discoveries
- Producing power offshore
- Capturing and injecting CO₂
- Selling 100% CO₂-free power

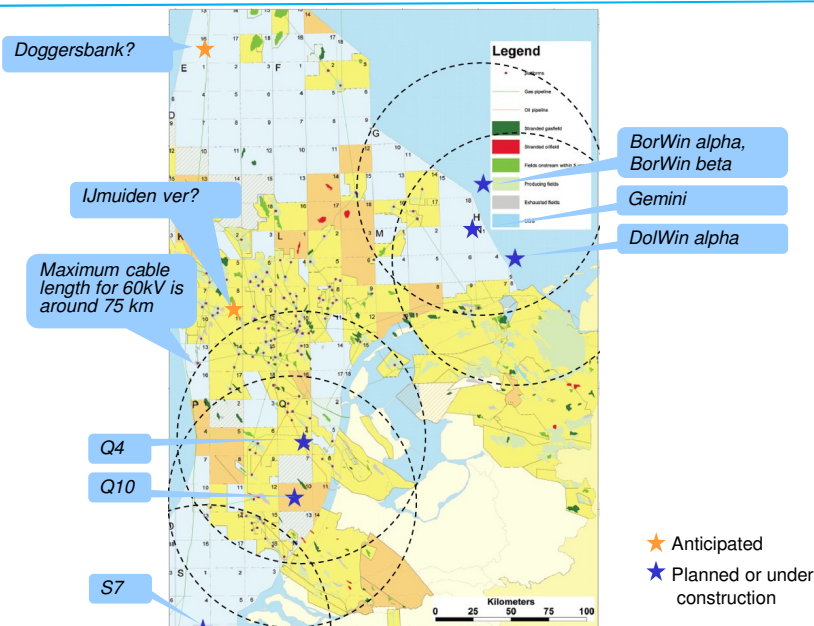
Circular Energy does not

- Apply new technology
- Take Exploration risk

Who is on board?



Opportunities for offshore Powergen



The export route determines the sizing



Power **produced** is given by number of wells, well productivity and powergen efficiency

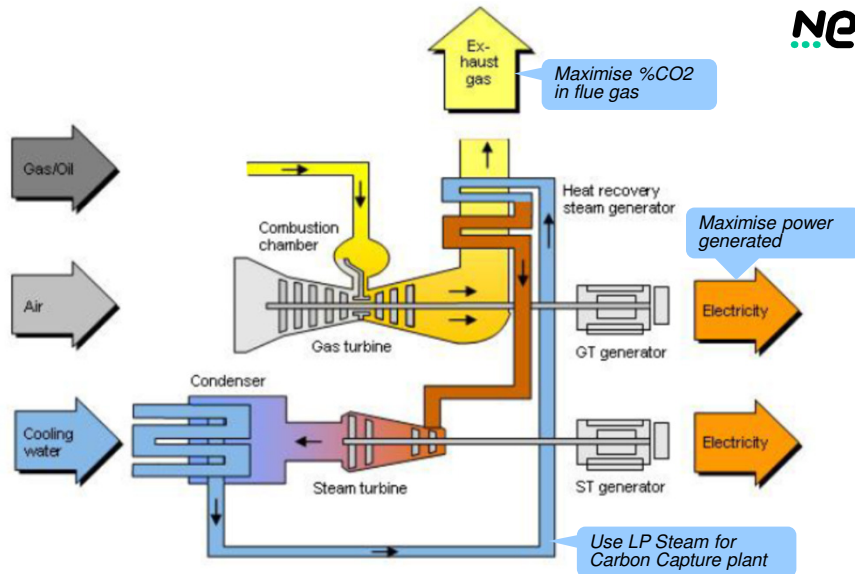


Power **transported** is given by available export cable capacity from windfarm to shore

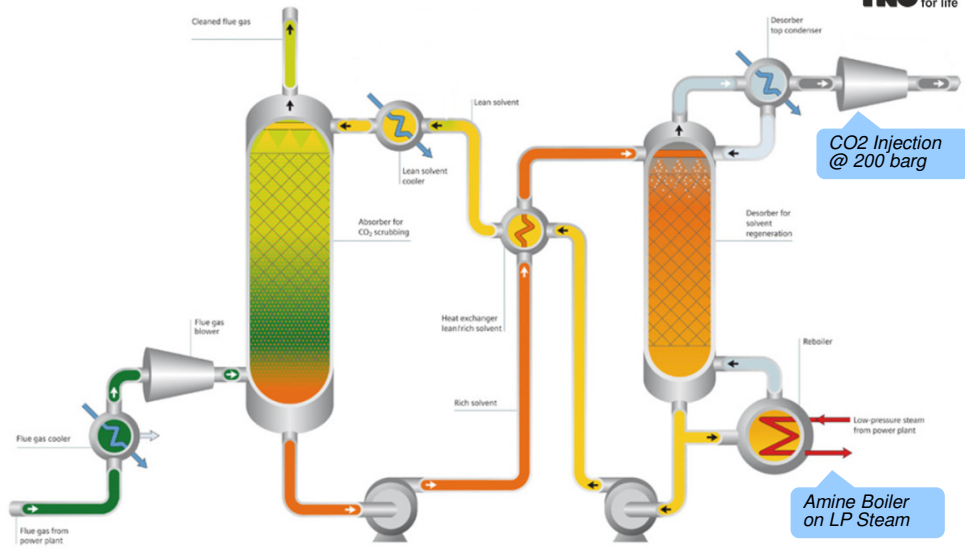


- Average "Time Online" is given by:
- Nameplate capacity of the windfarm
 - Capacity of export cable
 - Power fed into cable by Circular Energy
 - Probability distribution of wind speeds

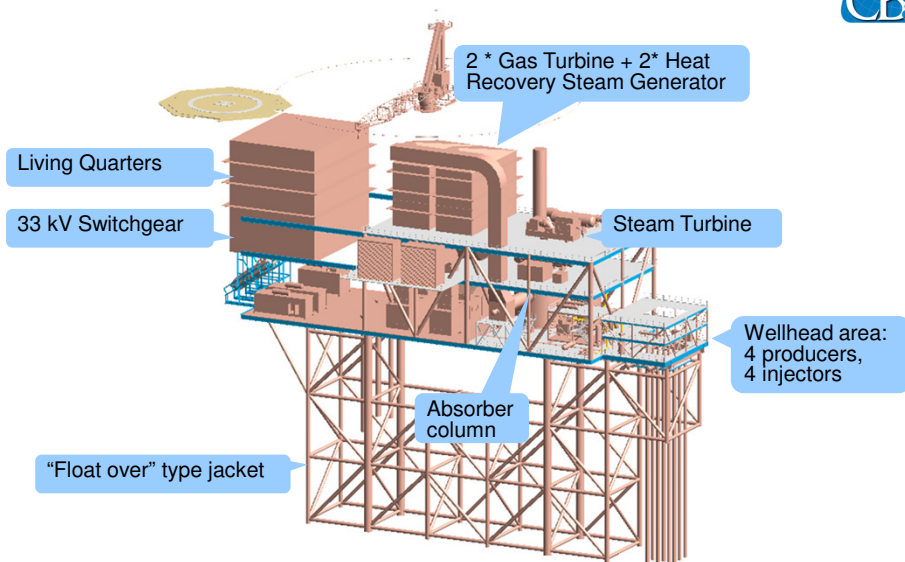
Power Generation plant



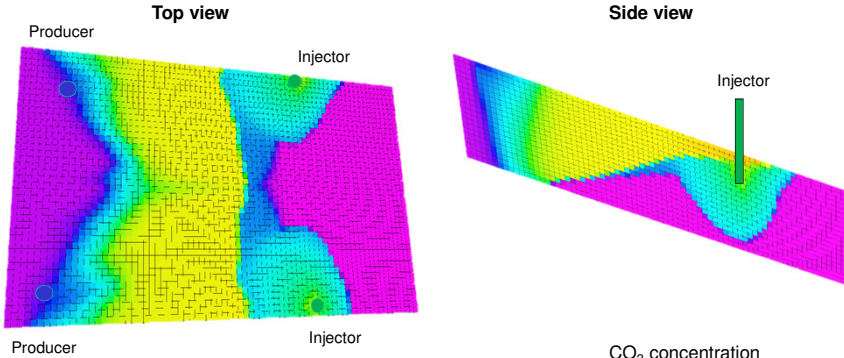
Carbon Capture Plant



Topsides to be optimised

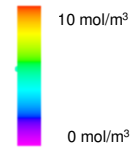


Propagation of CO₂ through the reservoir can be managed

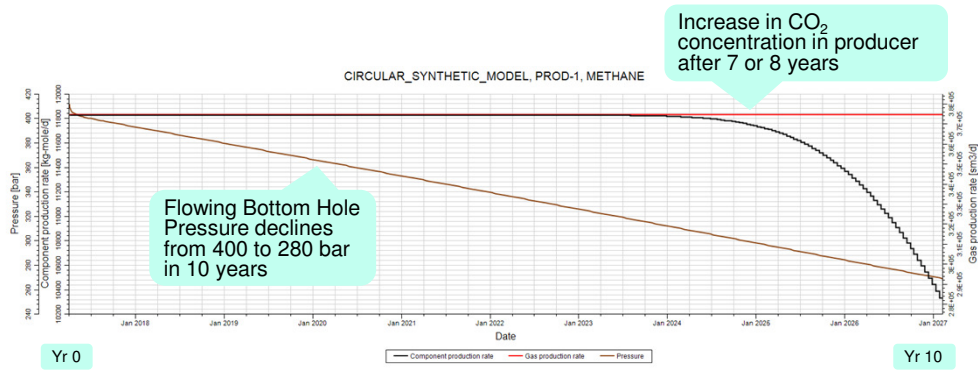


- Propagation depends on
- Rock properties
 - Well spacing
 - Well design
 - Pressure & temperature

CO₂ concentration after 10 years:



CO₂ breakthrough can be deferred



Flowing Bottom Hole Pressure declines from 400 to 280 bar in 10 years

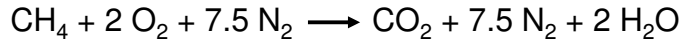
Increase in CO₂ concentration in producer after 7 or 8 years

Well design, well spacing and isolation of individual zones may defer CO₂ breakthrough further

Reservoir pressure decline is counteracted

Ambient air comprises typically of 21% oxygen and 79% nitrogen

The processing of Nitrogen is a major source of inefficiencies for power plants



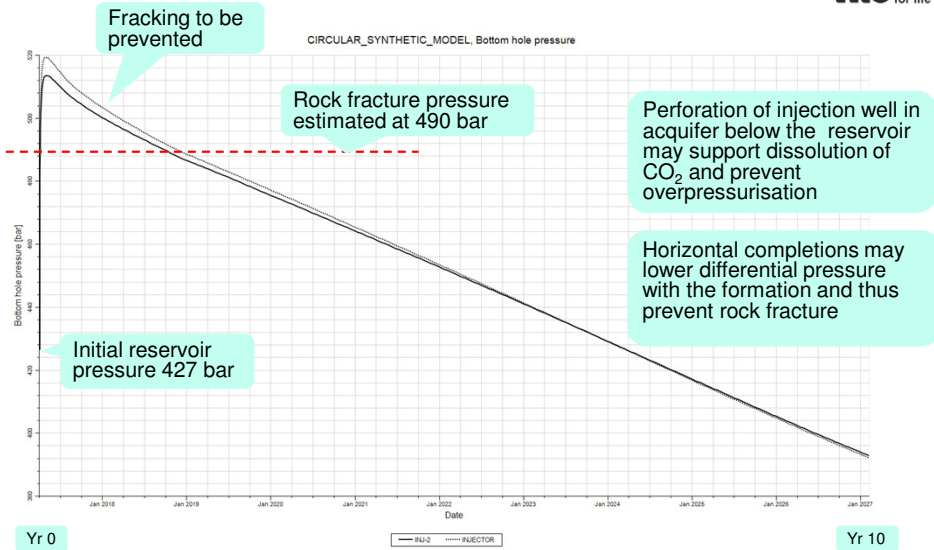
Natural gas comprises typically of:

- 93.00% C1
- 2.85% C2
- 0.35% C3
- 1.70% CO₂
- 1.90% N₂

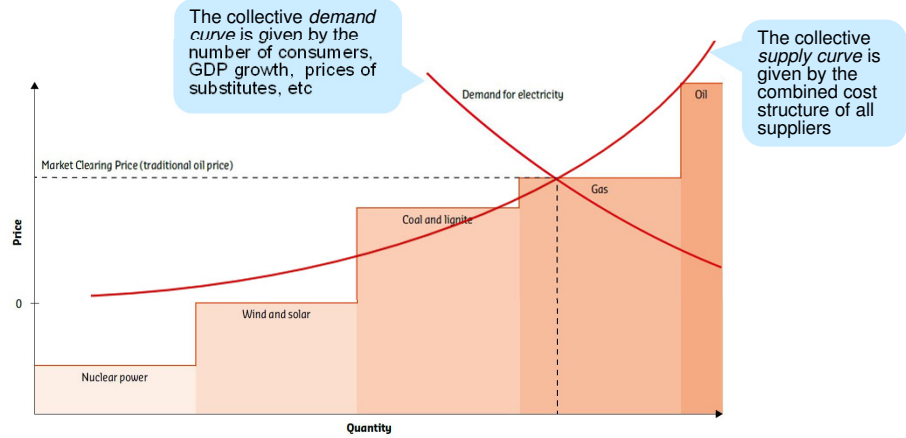
For every mole of CH₄ produced one mole of CO₂ is injected, assuming perfect capture effectiveness.

The reservoir receives a similar volume of CO₂ as the volume of natural gas produced from it.

Injection pressure to be managed



The Merit Order



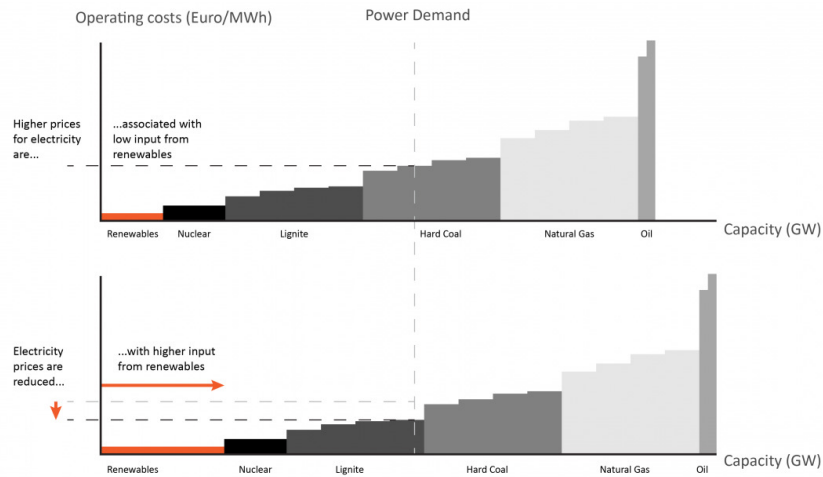
The collective *demand curve* is given by the number of consumers, GDP growth, prices of substitutes, etc

The collective *supply curve* is given by the combined cost structure of all suppliers

When the market clears, the price is set by the *highest marginal cost* producer. All producers with a lower MC make a profit. Producers with a higher MC are not producing.

The *Merit Order* describes the sequence in which additional capacity is brought online when the demand curve moves to the right.

Price volatility resulting from growth in Renewables



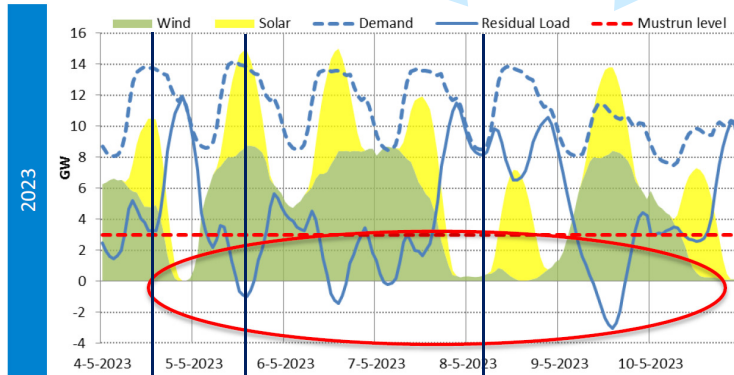
Renewables typically have high *Fixed Costs* but low *Variable Costs* and therefore produce at low Marginal Cost

Thermal Power Plants typically have high *Variable Costs* (fuel) and therefore high Marginal Cost

A day in The Netherlands in 2023

Residual Demand = Demand - Wind - Solar

MustRun = lowest available capacity, i.e. nuclear or CHP with a heat demand



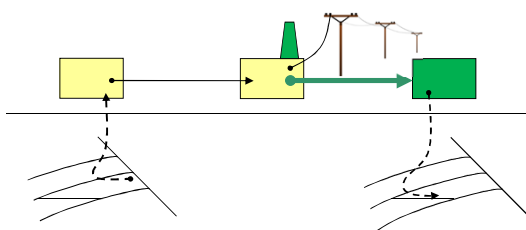
Residual -/ MustRun = 0, prices are likely to be low

Residual -/ MustRun < 0, negative prices

Residual -/ MustRun > 0, prices are likely to be high

How come Circular Energy can do something others can't?

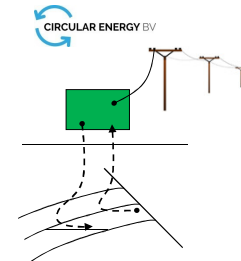
End-of-pipe solution



Additional Capex: Capture Plant + Flowline to existing offshore installation + Wells

Additional Revenues: none

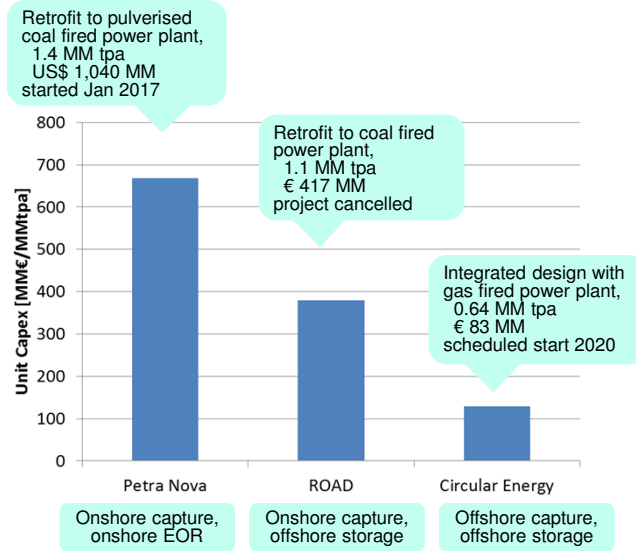
Integrated solution



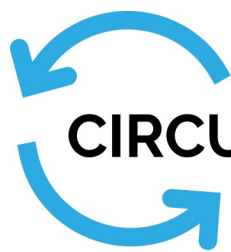
Capex: Power Plant + Capture Plant + Wells

Revenues: Sales from gas field that would otherwise not be developed

How does this compare to other CCS projects?



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CIRCULAR ENERGY BV