Forecasting the net zero transition:

How to reach a thousand company Financial Digital Twins!

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Zerolytics

THE 2ND INTERNATIONAL CONFERENCE OF THE SYSTEM DYNAMICS SOCIETY
1984 – Oslo, Norway

The following papers were presented at the conference. The original printed proceedings were printed in hardcopy and distributed at the conference. Below please find the Paper Index for these proceedings. Papers are listed alphabetically by the last name of the first author. Available papers are Acrobat (.pdf) files and can be read using Acrobat Reader available from adobe.com.

PAPER INDEX – *listed alphabetically by first author:*

THE ART OF CAUSAL LOOP DIAGRAMMING

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INTRODUCTION

In this paper I present two simple rules, which are helpful in increasing the clarity of causal-loop diagrams. I do not embark on a discussion of logical content, what variables to present, or possible problems with causal-loop diagrams. My only purpose is to show how structure can be better explained through careful drawing. The rules I present might also be applied to flow-diagrams.

FIRST RULE: FEEDBACK-LOOPS LOOK LIKE LOOPS

The Big Read Climate change Added

How companies are starting to back away from green targets

In the past year, many have dropped or missed goals to cut emissions or to loosen ties with polluting sectors

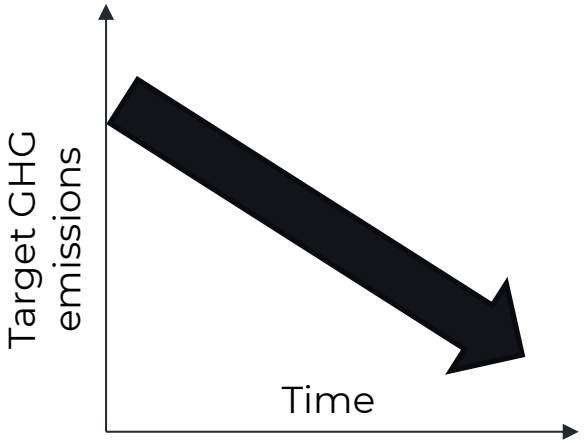
Bent Erik Bakken

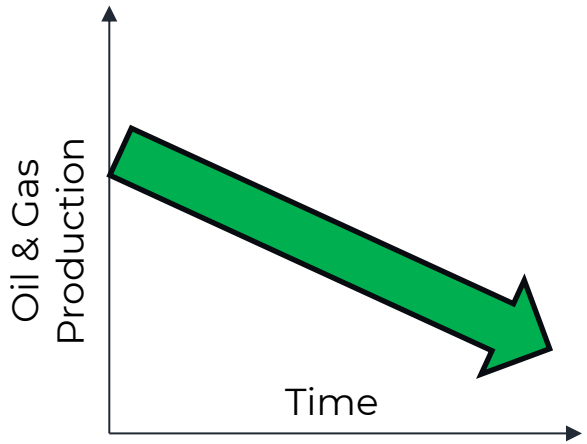
Professor emeritus, Oslo Met

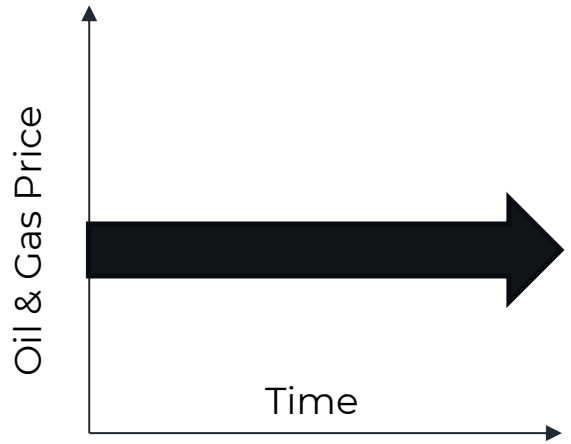
Co-founder - Chief Modelling Officer, Zerolytics

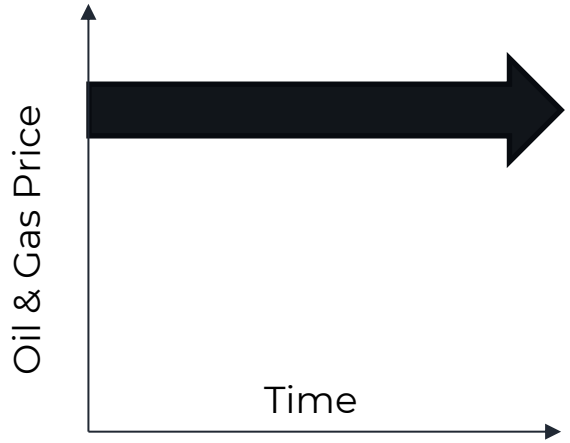
Problematique: ‘Reference Mode’

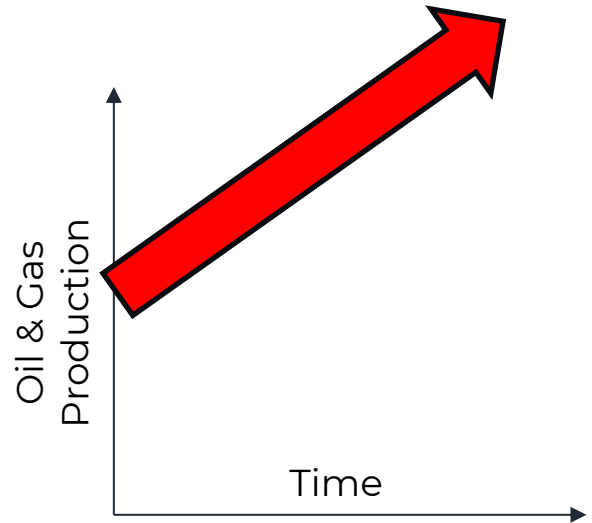
- *Can investors trust that companies will meet their Net Zero targets*: targets that compete with short-term profitability. Profitability usually wins!

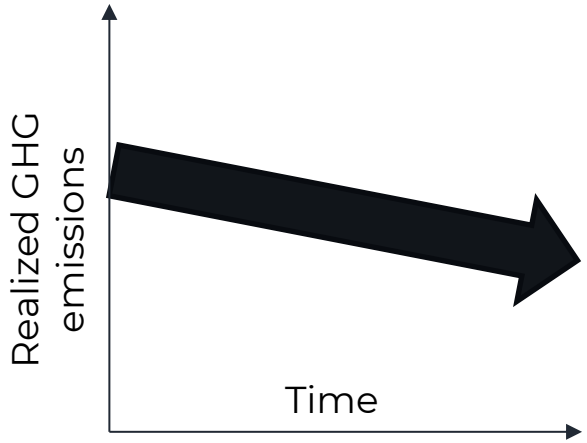












- Our *'Stella' Financial Digital Twins* reflect this '**fight for investment**' (CAPEX) where most profitable options win

- Decision making in twins: Choose among portfolio of 'brown and green' business opportunities based on 'Excess Profitability' over 'Hurdle Rate': *primary tasks of C-suites and Boards*

- *Main tool: Forecast of company profitability and climate emissions*

The green transition to net zero presents significant risks, necessitating a shift in how asset managers allocate capital

9 trn

USD/ year*

**Spending on energy and land-use systems in a Net Zero Scenario, McKinsey (“The net-zero transition: What it would cost, what it could bring”)*

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> 4100

companies claimed in 2022 to have developed a 1,5°C-aligned climate transition plan

- Carbon Disclosure Project, February 2023

> 1 Gt*

saved/ year

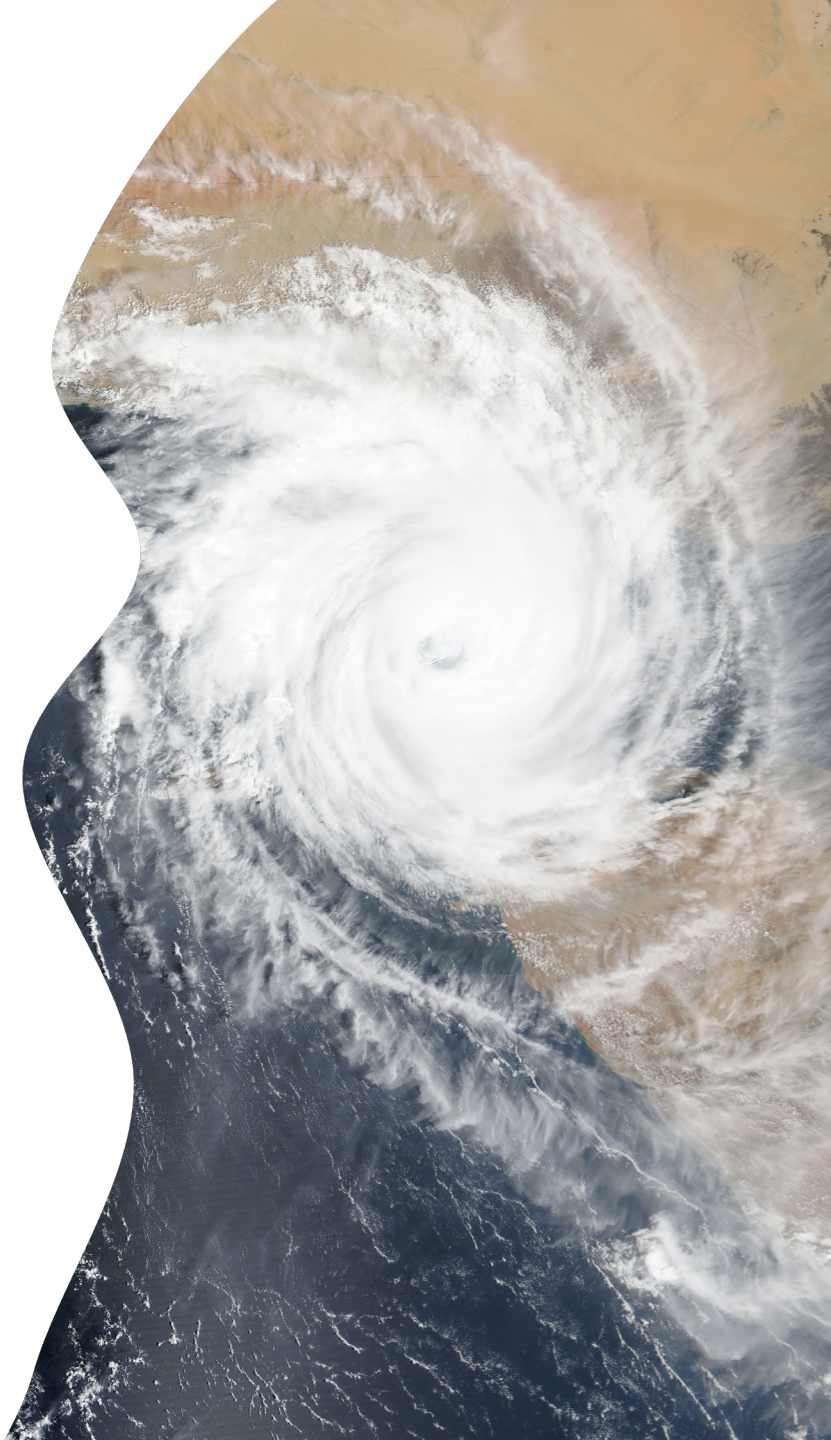
“The sustainability revolution has the magnitude of the industrial revolution but the speed of the digital revolution.

The task is to allocate capital to speed it even more.

- Al Gore

** A 1% better allocation of capital represents an efficiency improvement of approx. 90 billion USD per year. Using today's Co2 price in the EU (90 Euro/ton Co2), this means about 1 billion tonnes/year saved. By way of comparison, UK's total emissions for 2020 are approximately 350 million tonnes per year.*

Zerolytics develops hundreds **financial digital twins** to help **asset managers** assess the **feasibility** of investees' climate transition plans.

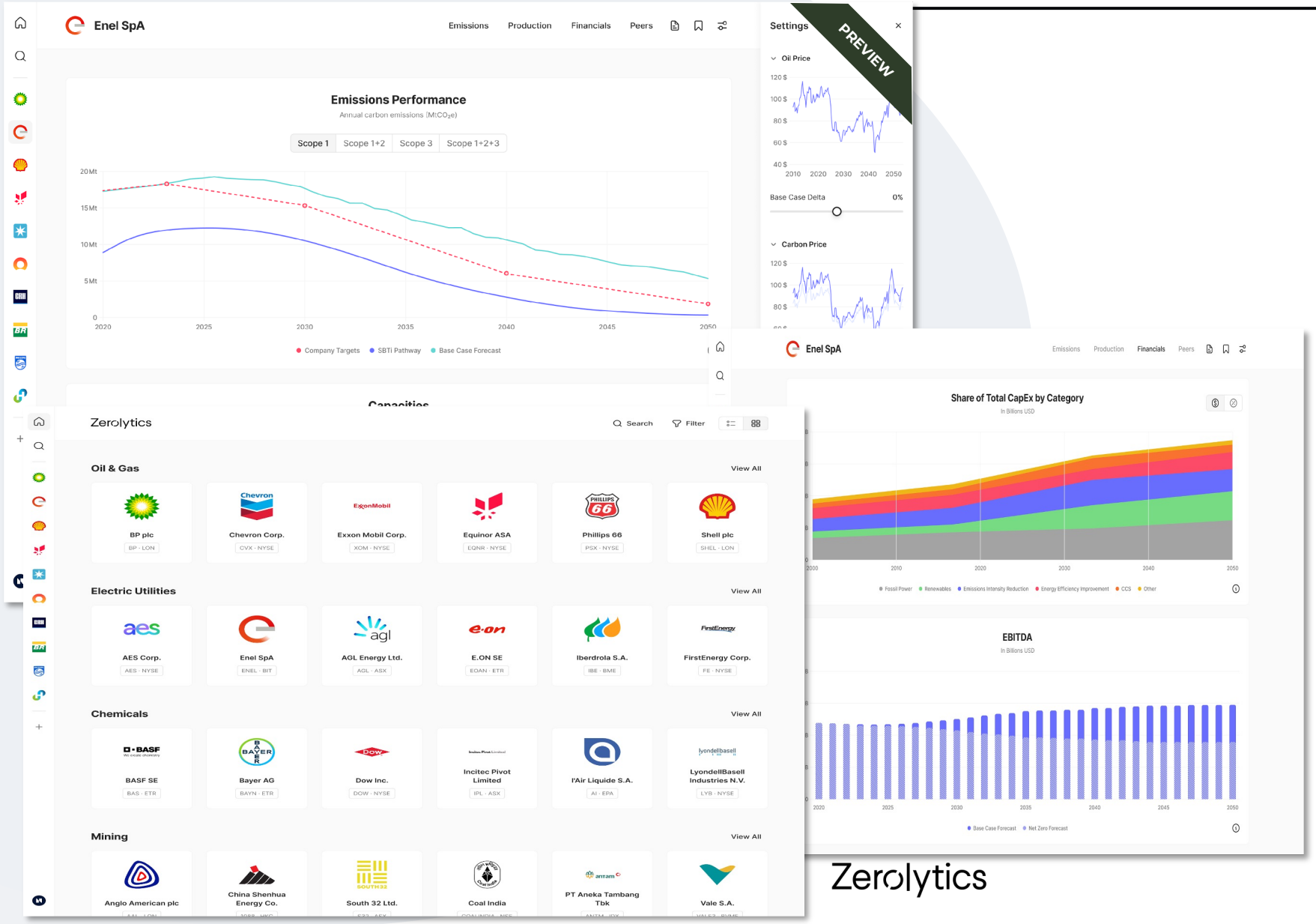


What is different

- *Any model of a company is a digital 'twin' of the company*
- Commonly, the focus is on the single company, or an **array** of companies where only parameter values differ between them
- But if the heterogeneity between companies is large, need to cluster in 'industries', allowing at the extreme to allow not only for parameter, but also for modelling differences also within industries
- Model calibration (including model as well as parameter-value tweaking) to recreate historical behavior (over time) is time- and competence-consuming
- No knowledge of an effort that aims one thousand models

Product

Platform released February 2024



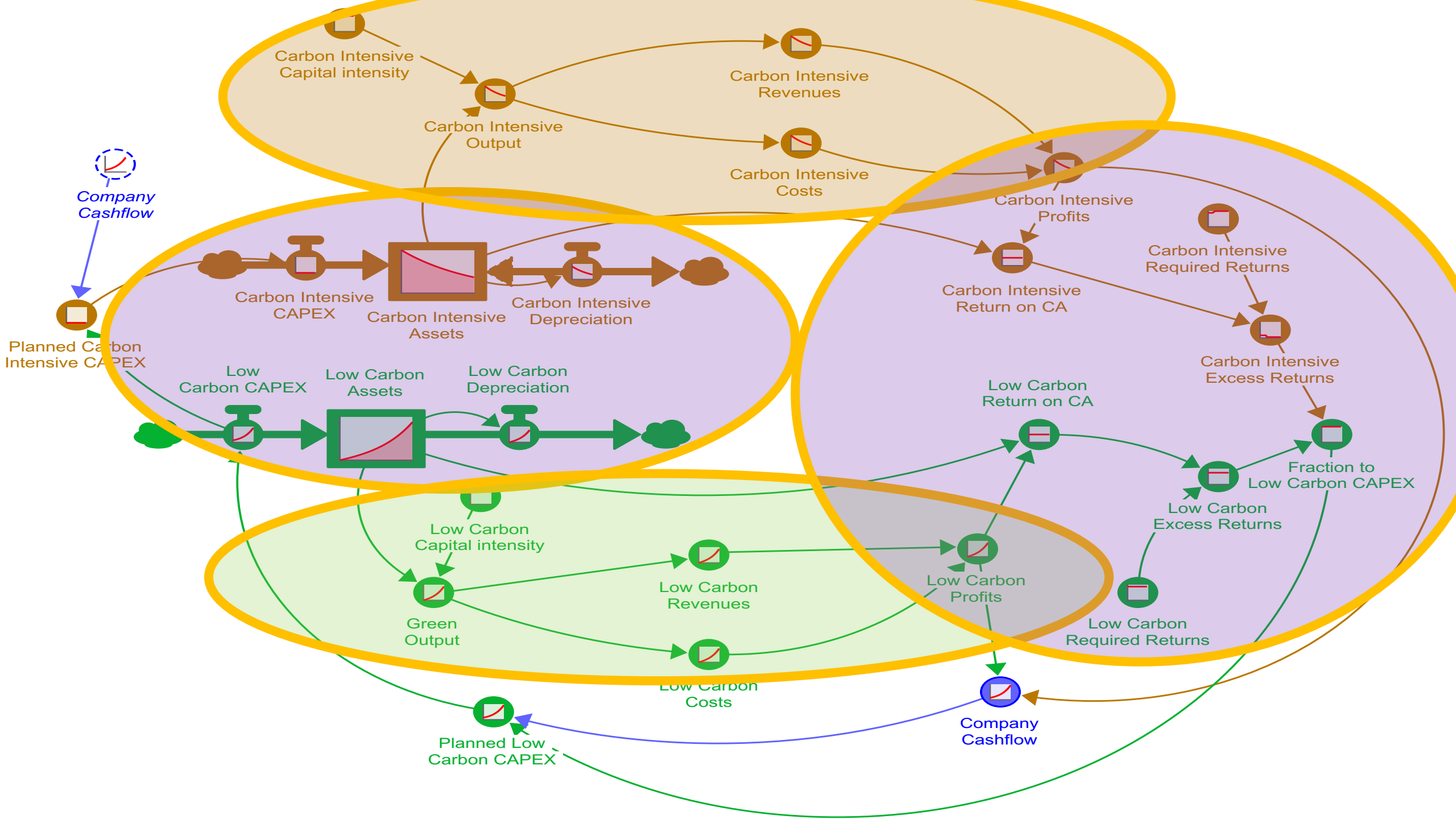
Proprietary data

Digital twin models

Interactive tools

… answering asset managers' key questions

1. Will investees achieve their Net Zero targets?
2. If not, what will it take to reach Net Zero targets?
3. What is the impact of switching to a Net Zero future?
4. What distinguishes transition leaders from laggards?
5. What are the key factors influencing companies' financial and emissions performance?


Carbon Intensive Capital intensity
Carbon Intensive Output
Carbon Intensive Revenues
Carbon Intensive Costs
Company Cashflow
Carbon Intensive CAPEX
Carbon Intensive Assets
Carbon Intensive Depreciation
Planned Carbon Intensive CAPEX
Low Carbon CAPEX
Low Carbon Assets
Low Carbon Depreciation
Carbon Intensive Profits
Carbon Intensive Return on CA
Carbon Intensive Required Returns
Carbon Intensive Excess Returns
Low Carbon Return on CA
Fraction to Low Carbon CAPEX
Low Carbon Excess Returns
Low Carbon Capital intensity
Green Output
Low Carbon Revenues
Low Carbon Profits
Low Carbon Required Returns
Low Carbon Costs
Planned Low Carbon CAPEX
Company Cashflow

CAPEX and assets by class for an integrated oil and gas company

Traditional Assets

- **Oil**
  - Upstream
- **Gas**
  - Upstream
- **Oil**
  - Refineries
- **Gas**
  - LNG

Low Carbon Assets

- **EV charging**
- **Solar PV**
- **Windfarms**
  - Onshore
  - Offshore

Carbon Removal

- **CCS**

Energy efficiency

Cleaner Energy Provisions

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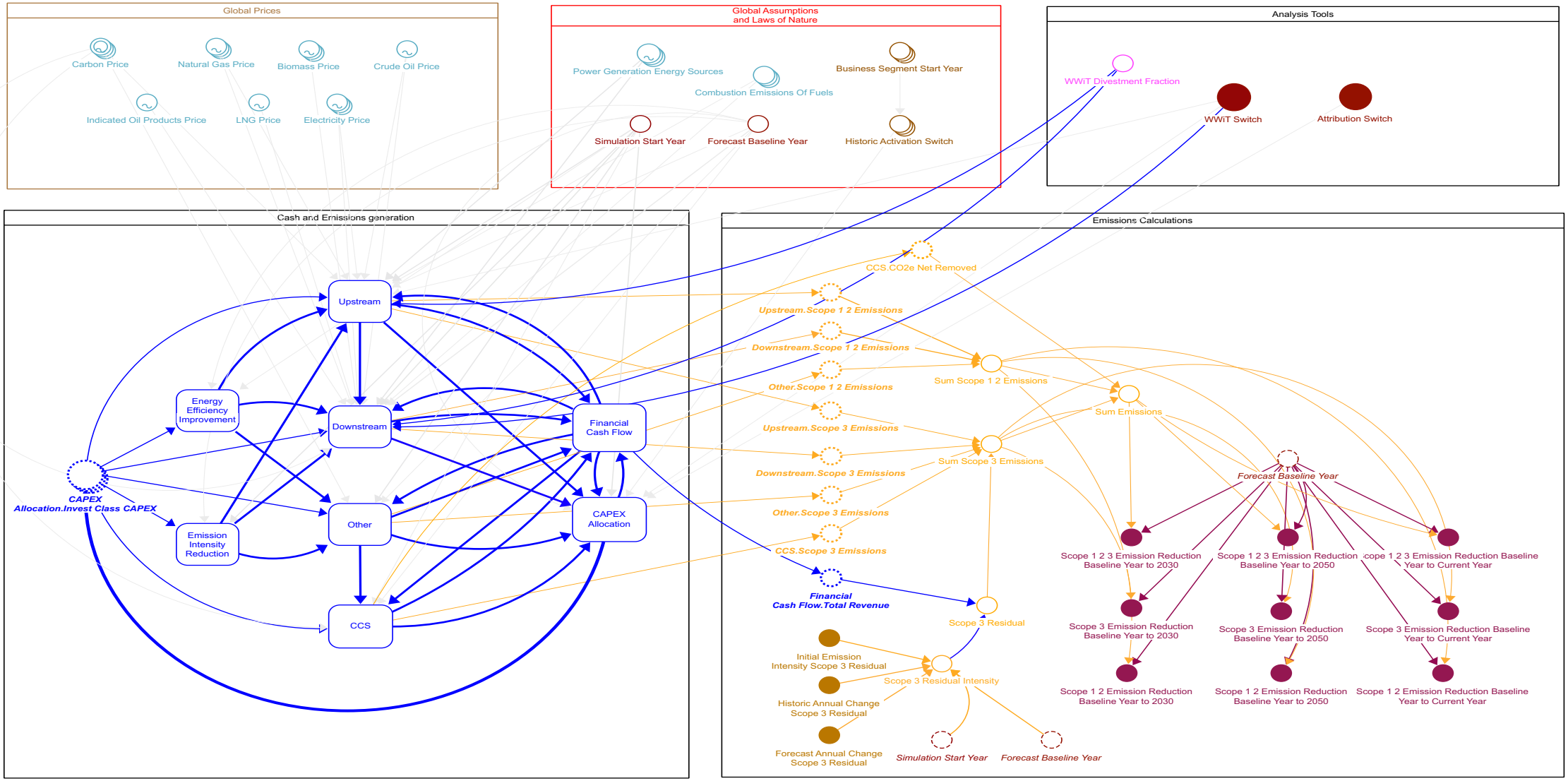
Example of Financial Digital Twin for an integrated oil & gas company



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Model coverage will increase as we scale

	Stage 1 Dec 2023	Stage 2 Sep 2024	Stage 3 Dec 2025
Companies		 **150 companies**	**‘000s companies**
Sector	**Oil and gas**	**10+ sectors**	**All relevant sectors**
End user	**Engagement managers**	**+ portfolio managers, financial analysts, risk managers**	**+ other financial institutions, risk consultants, auditors++**

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Development process

- Issue: Decarbonization goals are typically not met (for companies, [&states, regions])
  - Owners require financial returns, but profitability [Welfare] would hurt in the short run-> Investors cannot trust such Net Zero plans and need a ‘right’ forecast – a second opinion
- Pilot Financial Digital Twin (fall 2022) used BP
  - Sees 26% O&G production decline to 2030 [vs BP NZ plan 40%]
  - Feb 2023: BP announced update of O&G production decline –> 25% to 2030 [‘must provide O&G to a needy world..’]
- Model (template) simplified and detailed into 4 High Emitting industries [O&G, Utilities, Cement, I&S], and simplified version for all other industries
- Digital twin of each company calibrated within industry template framework
  - Using historical data and commodity price forecasts from Bloomberg, consultancy reports, industry associations
- Front-end developed in parallell

Findings from first 50 twins in five industries

		Industry				
		O&G	**Utilities**	**Cement**	**Chemicals**	**Autos**
% on a NZ* path ->		**0 %**	**22 %**	**10 %**	**17 %**	**0 %**
% change in profits compared to MLF**, If twin forced onto a NZ* path						
2030	**Improved**	**0 %**	**33 %**	**0 %**	**0 %**	**9 %**
	Hurt	**100 %**	**44 %**	**100 %**	**100 %**	**91 %**
2050	**Improved**	**53 %**	**67 %**	**10 %**	**0 %**	**37 %**
	Hurt	**47 %**	**11 %**	**90 %**	**100 %**	**63 %**

* NZ = Net Zero
** MLF = Most Likely Future

Petrobras

Oil & Gas

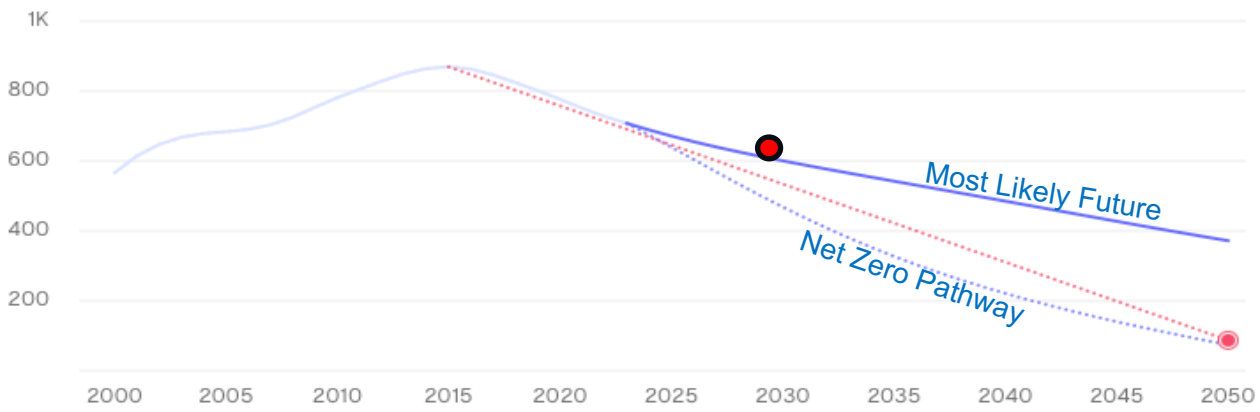
Transition KPIs

Company	2030 Emissions Gap	2050 Emissions Gap	Net Zero EBITDA Impact: 2030	Net Zero EBITDA Impact: 2050
Petrobras PETR4	+6%	-328%	-1.4%	+26%
Exxon XOM	+25.6%	-542%	-3.3%	-9%
Shell SHEL	+15.5%	-139%	-0.2%	+4.7%
Repsol REP	+9.3%	-264%	-1.3%	+4%
BP BP.	+3.7%	-168%	-0.3%	+13.6%
TotalEnergies TTE	+27.3%	-161%	-2.4%	+5.1%
ConocoPhillips COP	No company target	-134%	-2.8%	-6.9%
Marathon Petroleum MPC	No company target	-471%	-6.6%	-17.1%
Chevron CVX	No company target	-482%	-1.2%	-0.8%
Valero VLO	No company target	-826%	-6.1%	+2.6%
Phillips 66 PSX	No company target	-486%	-3.4%	+6.3%
Eni ENI	No company target	-173%	-5.9%	-4.9%
OMV OMV	No company target	-161%	-3.5%	+4.1%
Equinor EQNR	No company target	-546%	-10.3%	-18.7%
Saudi Aramco 2222	No company target	-1K%	-15.4%	-40.9%

Emissions Pathways

$MtCO_2e/year$

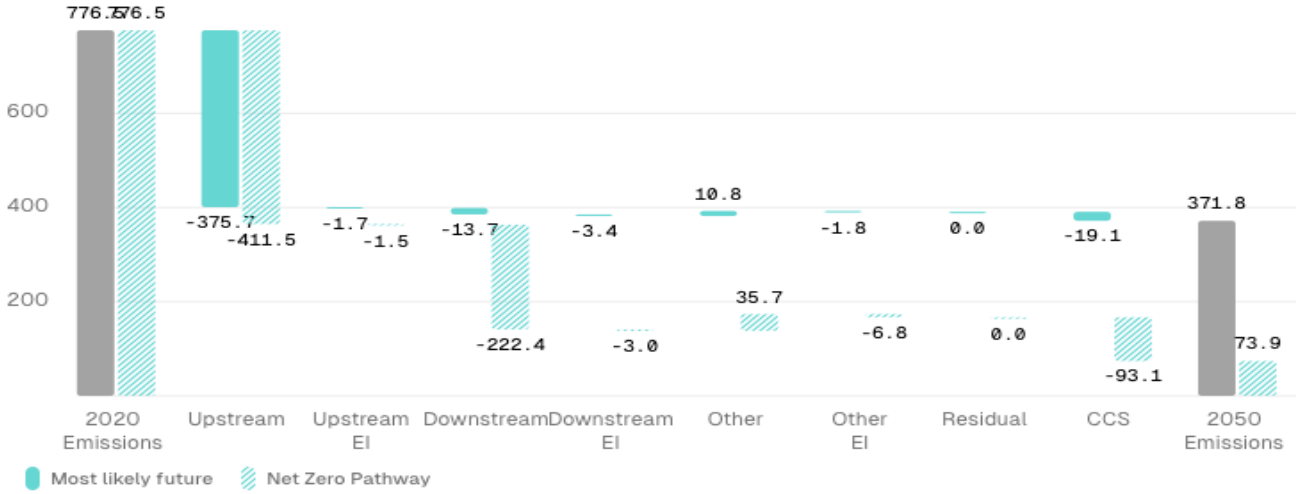
Scope 1+2 | Scope 1+2+3 | Scope 3



Contributions to Emissions Reductions

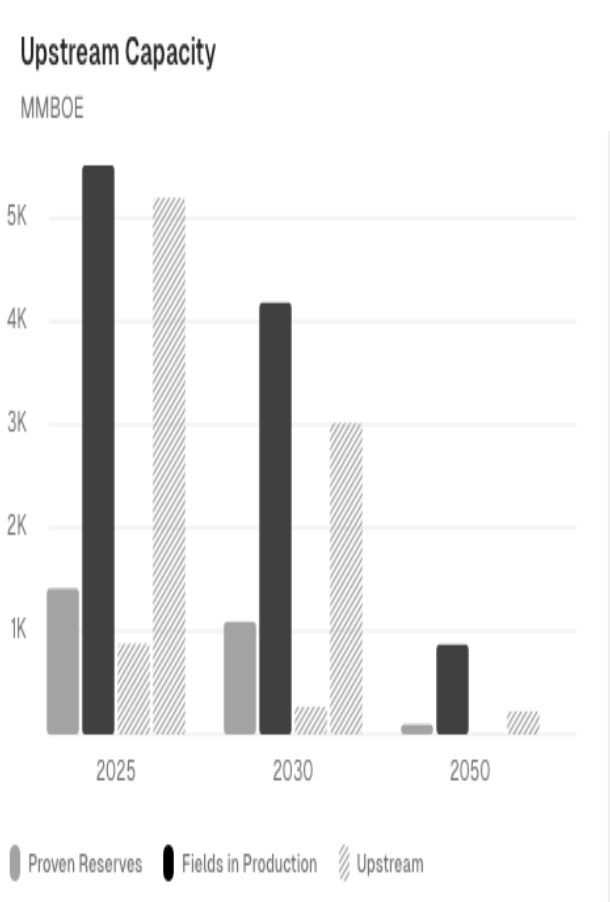
$MtCO_2e$

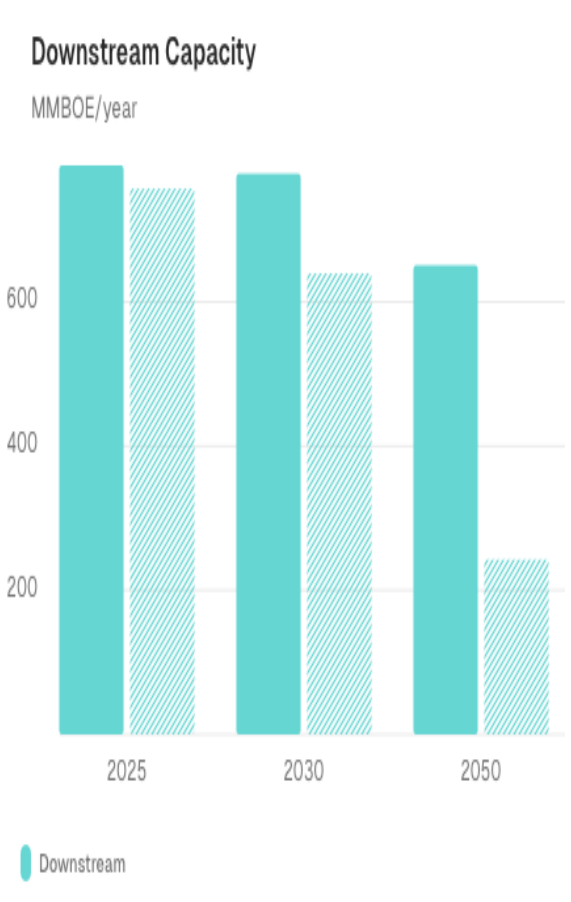
2020-2030 (Scope 1+2) | 2020-2050 (Scope 1+2) | 2020-2030 (Scope 1+2+3) | 2020-2050 (Scope 1+2+3)

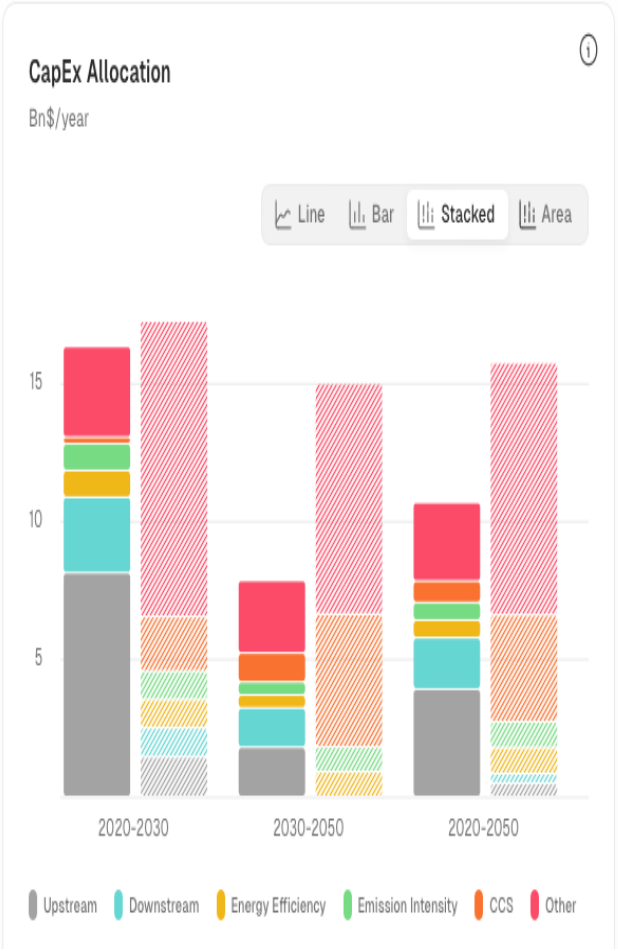


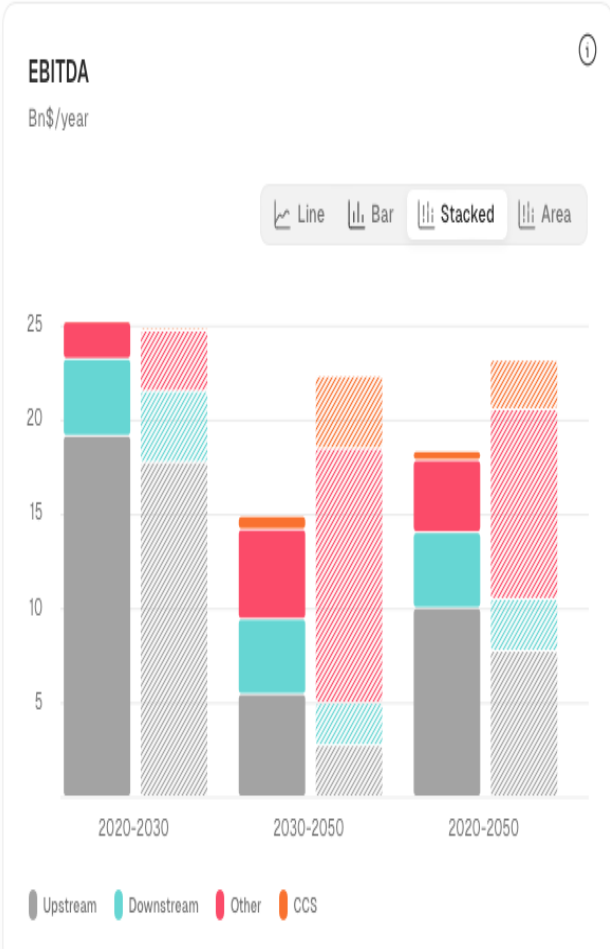
Front-end II

Petrobras









Team size, qualifications

- Two teams (of 4-5) (+ management & marketing)
  - Modelling & analysis
  - Engineering (Front-end, back-end, AI,…)
- Modelling & analysis
  - MSc (Cybernetics/Control Engineering): 2
    - 2 years' non-SD exprience on average
  - MSc (Industrial economics/Physics): 2
    - 5 years' non-SD experience on average (incl 2-5 years NBIM)
  - PhD (MIT System Dynamics): 1
    - Team leader: 40 years' SD experience

Development challenges

- Calibration of each twin to estimate parameter values
  - History is ‘noisy’
    - Companies may have doubled in size one year, to divest and cut in half again after another two, with debt, shares etc following suit
    - Energy prices in various parts of the world, similarly may triple form one year to the next to stay at that level, or drop down again -> smoothing out may well veil important dynamics
  - Each twin is ‘an island onto itself’, yet companies’ environments are partly impacted by companies themselves at the aggregate
    - Oil prices are exogenous to an oil company, but not to the oil industry
- Size of task
  - Team members need to understand the company in < 2 days, and model its digital twin
    - Eventually model calibration of thousands of twins will need to be done automatically, and Chief AI officer is already preparing this

Start-up financing

- Co-founders are serial entrepreneurs
- Run-way of 3-4 (another 2..) years assured
- Market value NOK 120 million (12 M USD)

- First sale expected (summer 2024)
- Burning cash = USD 100 000/employee/year

Kjendisinvestorer flokker seg rundt ny tech-startup

Per-Otto Wold har hentet 40 millioner kroner til ny tech-startup. – En fordel av å ha bygd tre virksomheter tidligere, sier seriegründeren som fikk napp hos Geir Førre og Kjell Inge Røkke.

Publisert 30. jan. 2024 kl. 21.00 Lesetid: 5 minutter

HENTET 40 MILLIONER: Seriegründer Per-Otto Wold har hentet inn 40 millioner kroner til sin nyeste start-up. – Vi driver med noe som ingen andre har gjort før, sier han. FOTO: ZEROLYTICS

Teknologi

Market size

- *Climate transition the defining issue of our time*
- Asset owners and –managers typically voice that they have an obligation to contribute to a planet that is also liveable in the future (but also to secure competitive returns of their holdings)
- Digital twin is System Dynamics, includes non-linearities, allows user to do ‘what-if’ analysis of 12 key exogenous inputs
- No similar offering in the market
- -> Thousands of AO/M might be interested, each with dozens of users

Further work

- Automated calibration and forecasting to reach one thousand twins
- Allowing Energy Efficiency and Emissions Intensity Reduction Investments to be treated as ‘Business Areas’
- Linking twins to make market prices endogenous (currently exogenous, such as commodity prices)