Energy transition through innovation

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Our key figures

- **105,000 employees worldwide**
- **$4.1 bn** in adjusted net income in 2020, demonstrating our resilience
- **$1 bn** invested in R&D in 2020, of which 40% on carbon reduction
- **$2 bn** invested in renewables in 2020
- **$100 m** annual amount devoted to CCS R&D and industrial pilot projects by TotalEnergies
- Active in more than 130 countries
- More than 4,000 researchers in our 18 R&D centers
What’s new in our 2021 scenarios?

**Momentum: market trends acceleration & NZ 2050 countries’ commitments**

- **Ban on new ICE* sales** in NZ 2050 countries in 2035 spurring a revolution in transport:
  - Electrification of light vehicles
  - Increased adoption of H2, H2-based fuels** and bioenergies in other transport segments
- **Broad end-use electrification** with increasing demand for renewable power (solar & wind)
- **Large scale use of natural gas as a transition fuel** especially in power & industry
- **Single-use plastic ban** in NZ 2050 countries & China from 2040 and increased plastics recycling
- **China’s emissions to peak in the mid 2020’s, with ~60% decarbonization by 2050**

**Rupture: how to reach well-below 2°C**

- **Extension to all emerging economies** of NZ 2050 countries decarbonization trends
- **Amplification of energy transition levers** allowed by innovation diffusion:
  - Increased energy efficiency
  - Further development of electricity & renewables
  - Higher penetration of new energy carriers (clean H2 in industry & transport, e-fuels, biofuels and biogas...)

* Internal Combustion Engine
** Includes H2, e-fuels (H2 + CO2), methanol, ammonia…
Meeting the energy needs of a growing population
Necessity of a just transition

World total energy demand in Momentum
PJ/d

- World population will grow from 8bn today to 10bn people by 2050, driven by non-OECD countries: +2bn
- Growing population and improving living standards will increase energy demand, again driven entirely by emerging countries

World energy demand per capita in 2019
MJ/d/capita

- The evolution of energy demand per capita over the next 30 years is critical for non-OECD countries
- Without these countries the global Net-Zero goal cannot be achieved

The challenge: reconciling growing energy demand with decarbonization and broader sustainable development goals

* Compounded Annual Growth Rate
Key modeling drivers of our scenarios  
Sector-based assumptions

<table>
<thead>
<tr>
<th>Category</th>
<th>2019</th>
<th>Momentum 2050</th>
<th>Rupture 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong electrification of end-use</td>
<td>~20% of final demand</td>
<td>~30%</td>
<td>~40%</td>
</tr>
<tr>
<td>Deep decarbonization of power supply</td>
<td>solar+wind: ~110 GW/yr</td>
<td>Pace x3.5 (380 GW/yr)</td>
<td>Pace x6 (620 GW/yr)</td>
</tr>
<tr>
<td>Gas going greener</td>
<td>&lt;1% green gases in gas supply</td>
<td>~20%</td>
<td>~30%</td>
</tr>
<tr>
<td>Sustainable mobility</td>
<td>&lt; 1% BEV &amp; FCEV* in light vehicles fleet</td>
<td>~65%</td>
<td>~80%</td>
</tr>
<tr>
<td>Optimizing plastics demand</td>
<td>~100% kerosene fueling aircrafts</td>
<td>Sust. aviation fuels @ ~30% of demand</td>
<td>SAF @ ~60%</td>
</tr>
<tr>
<td>Optimizing plastics demand</td>
<td>7% recycled</td>
<td>40% recycled</td>
<td>~50% recycled</td>
</tr>
<tr>
<td>CCS to abate remaining emissions</td>
<td>~35 Mt (0.1% CO2 emissions)</td>
<td>3 Gt (~10%)</td>
<td>7 Gt (~45%)</td>
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<tr>
<td>Energy efficiency acceleration</td>
<td>1.5%/yr energy intensity improvement since 2000</td>
<td>+2.4%/yr</td>
<td>+2.6%/yr</td>
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* Battery-Electric Vehicles and Fuel-cell Electric Vehicles  
** SUP: single-use plastic
Transforming to a multi-energy company
Our global ambitions
Net Zero by 2050: 3 major steps to reach carbon neutrality

1. Net Zero on Operations by 2050 (scope 1+2)
2. Net Zero in Europe by 2050 or sooner (Scope 1+2+3)
3. 60% or more Net Carbon Intensity reduction by 2050 (scope 1+2+3)

Reduce our direct emissions to Net Zero by 2050 (in MtCO2e)

-40% reduction

2015: 46
2030: 25-30
2050: 0

BIOFUEL
A major player in the energy transition
Building a multi-energy company by changing the energy mix

Oil
- Focusing on low-cost and low GHG emissions developments
- Developing carbon capture and storage

Natural Gas
- Consolidating our leading positions as a top 3 low-carbon LNG company
- Minimizing methane emissions from all our operations

Renewables & Electricity
- Investing profitably to become one of the top 5 producers of renewables
- Driving value in deregulated markets from integration along the value chain
- Being as recognized in tomorrow’s e-mobility market as in today’s fuel market

Biomass: Scaling up biofuels and biogas production and sales

Hydrogen: Pioneering in mass production of clean H2 and in synthetic fuels

[Graph showing energy mix]
By 2030 we aim to be top 5 in renewable energies

$60 billion
in renewable projects to be financed over 10 years

*100 GW is almost twice the installed capacity of the French nuclear fleet (60 GW)
Capital investment strategy to fund the energy transition

~50% Maintenance

~50% Growth

13-15 B$/y 2022-2025

LNG and Gas

Renewables and Electricity

Biomass

Oil
Our approach to innovation

Building a world class player in the energy transition through our skilled workforce
OneTech: engine of the transformation

OneTech

A new central organization in place since 1st September

Integrating all the technical expertise of the Company to support transformation

3,300 Engineers, researchers and technicians

1. Adapt to the new Company industrial activities

2. Better develop, retain and attract talents

3. Foster and accelerate innovation

4. Mobilize our technical resources on the most strategic and value-added topics

5. Deliver carbon footprint reduction solutions
Leveraging skills to build a multi-energy Company

- Experts in floating structures
- Metocean data specialists
- Offshore wind
- Chemical and process engineers
- E fuels
- Cryogenics experts (LNG) for H2 liquefaction
- Hydrogen
- Geologists
- Drillers
- Carbon capture and storage
Research and development

Building the energy supply chain of the future
Carbon Capture & Storage
Investing 10% of our R&D budget on CCUS

Modeling
Understand phenomena to optimize capture

New capture media
Better properties: uptake, selectivity, stability (H₂O..)

Intensification
Electrification, Footprint/weight gain

Demo Units
Svante@PERL \(\rightarrow 0,1 \text{ t / day}\)

Pilot Units
CLC @ CHEERS: 3MW \(\rightarrow 16 \text{ t / day}\)

Technical centres
Technology Centre Mongstad \(\rightarrow 75 \text{ kt / year}\)

Reservoir characterization
Depleted reservoirs: Aramis
Deep saline aquifers: Northern Lights

Injectivity
Hydrate formation, salt precipitation \(\rightarrow\) Optimized operations (Aramis)

Simulating CO₂ behaviour
Multi-physics, huge scales, open source \(\rightarrow\) State of the art for regulators

Monitoring
Large scale / Low price monitoring \(\rightarrow\) Accountability

Scope 1 & 2 emissions: Capture of anthropogenic CO₂ & Direct Air Capture

CO₂ Storage \(\rightarrow\) key to the energy transition
GEOSX
Next-Generation & Open-Source Geological CO2 Storage Simulator

5-year world class R&D partnership

20 peer reviewed publications
100+ downloads/month
4 universities freely contributing partnership demands: Chevron, ADNOC
Used by US consultants office

Fast and accurate
Open source and auditable
Can be used as standard to influence regulations

CO2 injection on Gulf of Mexico data
Faults stress to avoid induced seismicity

CO2 injection at basin scale
Seismic monitoring (not in initial plan)

TRL 5 industrial prototype delivered ahead of plan (3.5 years instead of 5)
TotalEnergies has redefined state of the art of large-scale CO2 storage modelling technology, showing a clear leadership and pioneering spirit
Solar Mapper Project
Solar potential assessment at world scale based on aerial/satellite images

Solar potential
A solution for accelerating the deployment of photovoltaic installations for private individuals
• Providing a quick and accurate estimate of the solar energy potential of their homes in Europe.
  Improvement of data quality by the development of generative algorithms
  > Thousand of potential sites are prioritized in seconds instead of days
Deployment planed in all countries covered by TotalEnergies (Spain, South Africa...).
Integrated Digital Platform for Floating Offshore Wind

Objective Optimizing energy cost

• Maximize the Annual Energy Production (AEP) of the FOWF
• Minimize the cost of the FOWF
• Improve the wind forecast for mid & long-term

R&D challenges

• Multi-source local and remote sensing data
• Integrating climate change
• Reduce computing time or increase simulation fidelity
• Analyze millions of time series
• Handling uncertainties
• Integration of different components in a single platform.

R&D Study Thor tender - Starting from a user case

• OWF capacity around 1 GW
• OWF area: 440 km²
• Around 60-70 turbines

First results

Classical design: AEP: 5.37 TWh
New design: AEP: 5.40 TWh (+0.58%)
Potential gain: +0.58% AEP = + 2.5 TWh/year
• Theoretical result
• Simplified model
Developing a sustainable business in Denmark
Key innovation projects supporting Denmark’s energy transition

Three main pillars

**OIL AND GAS**
- Reduce emissions
  - Energy Efficiency
- Field and infrastructure optimization
  - Tyra Redevelopment
- New development projects
- New Technology and Digitalization

**OFFSHORE WIND**
- Bidding for Thor wind farm (award dec 21)
- A Renewable Explorer appointed to look for new Danish renewable opportunities

**CARBON NEUTRALITY SOLUTIONS**
- CCS; Project Bifrost CO2 storage at Harald field
  - Startup storage capacity of 3 million tons of CO2 per year
  - Reuse field infrastructure and pipelines
  - Qualifying potential of using additional DUC reservoirs
Thank you