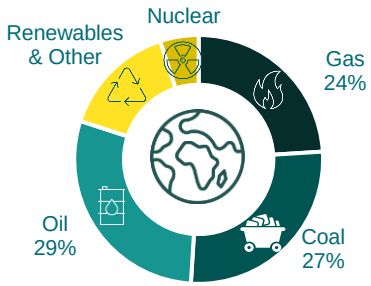
e-NG’s role for net-zero future

5th September 2024

e-NG will play significant role in decarbonising the global energy system

Green molecules are needed to fully decarbonise

Today's world energy mix[1]



Electrons: ~20%

Fossil fuels / molecules: ~80%

Hard-to-decarbonise sectors


Power & Intermittency


Chemicals


Aviation


Steel


Heavy Road / Mobility


Buildings Heating


Refineries


Maritime / Shipping

Regions needing to Import Renewables

What is e-NG?

What is e-NG? Electric natural gas (or e-NG) is a molecule entirely produced by green hydrogen and sustainably captured CO_2

How is it used? As a "drop-in" green fuel for hard-to-electrify sectors looking to decarbonise and where the energy transition has challenges

How is it green? Is an e-fuel created from green hydrogen (using 100% renewable power); Within Europe, will be certified as RFNBO

$$4\,H_2 + CO_2 \rightarrow CH_4 + 2\,H_2O$$

(Green) Hydrogen — Carbon Dioxide — e-NG — Water

e-NG overcomes the challenges of energy transition

Intermittent renewable supply (not always windy and sunny)

Supply locations ≠ demand locations; Grid constraints

Cost of changing industrial footprint & new infrastructure

e-NG is storable energy; no intermittency

e-NG is easily transportable with existing infrastructure

e-NG is "drop-in" solution for today's industrial footprint

Source: Eurostat; IEA World Energy Balances 2022
Note: 1. Energy mix expressed as share of fuels in gross available energy; TES vision based on interpretation of BP – Net Zero Scenario, IEA – Net Zero Emissions Scenario, Shell – Sky 2050 Scenario, BNEF, SP Global commodities insights

Advantages of e-NG are gaining global momentum

Large companies advocating for e-NG worldwide …

e-NG COALITION

Founding members of e-NG Coalition

TES

TOHO GAS

ENGIE

Mitsubishi Corporation

SEMPRA INFRASTRUCTURE

OSAKA GAS

TOKYO GAS

TotalEnergies

Dozens of other companies have expressed interest to join e-NG Coalition

… further cementing e-NG as a e-fuel of choice

e-NG COALITION

Unified voice from **leading energy companies advocating** for **e-NG policies globally**

G7

Solving **cross-border regulatory** burdens with alignment for **e-NG certification** and **global GHG accounting**

Including e-NG in mandated quota policies such as EU's **RFNBO 2030 quotas,** Japan's **METI blending targets** & other emerging **gas blending mandates** around the globe

e-NG gas grid targets **90% by 2050,** starting in 2030 (1%); **¥ 3 trillion Japanese gov't CfD program** launching in 2024 for green H_2 and e-fuels **(including e-NG)**

Sempra Energy, Santos, REN GAS, Mitsubishi Corporation, MASDAR, OSAKA GAS

Several **e-NG projects now under development** around the globe

Who is TES? Global leader in e-NG and green H_2 development

What is TES

Creating global leading e-NG production platform

Three strategic pillars to deliver:

1. **Market developer**
   Secure long-term customer contracts
2. **Project developer**
   Portfolio of world-scale green e-NG/H_2 projects
3. **Cost leader**
   Drive down green H_2 costs; Source lowest cost feedstocks

Strategy: produce in low-cost regions, provide to high-demand markets

Leveraging existing infrastructure

A **Upstream:** Developing production projects

Inputs

Where renewables and sustainable CO_2 are abundant and low-cost

B

C **Downstream:** Developing markets & import hubs

Outputs

CH_4 H_2

Key end-markets

TES 2030 Vision:

1 Mt e-NG by 2030 *(= 0.5Mt of green H_2 = ~3 GW capacity)*

Company details

Investors

AtlasInvest, Fortescue, HSBC, E.ON, azimut investments, UniCredit, Zodiac Maritime, zhero

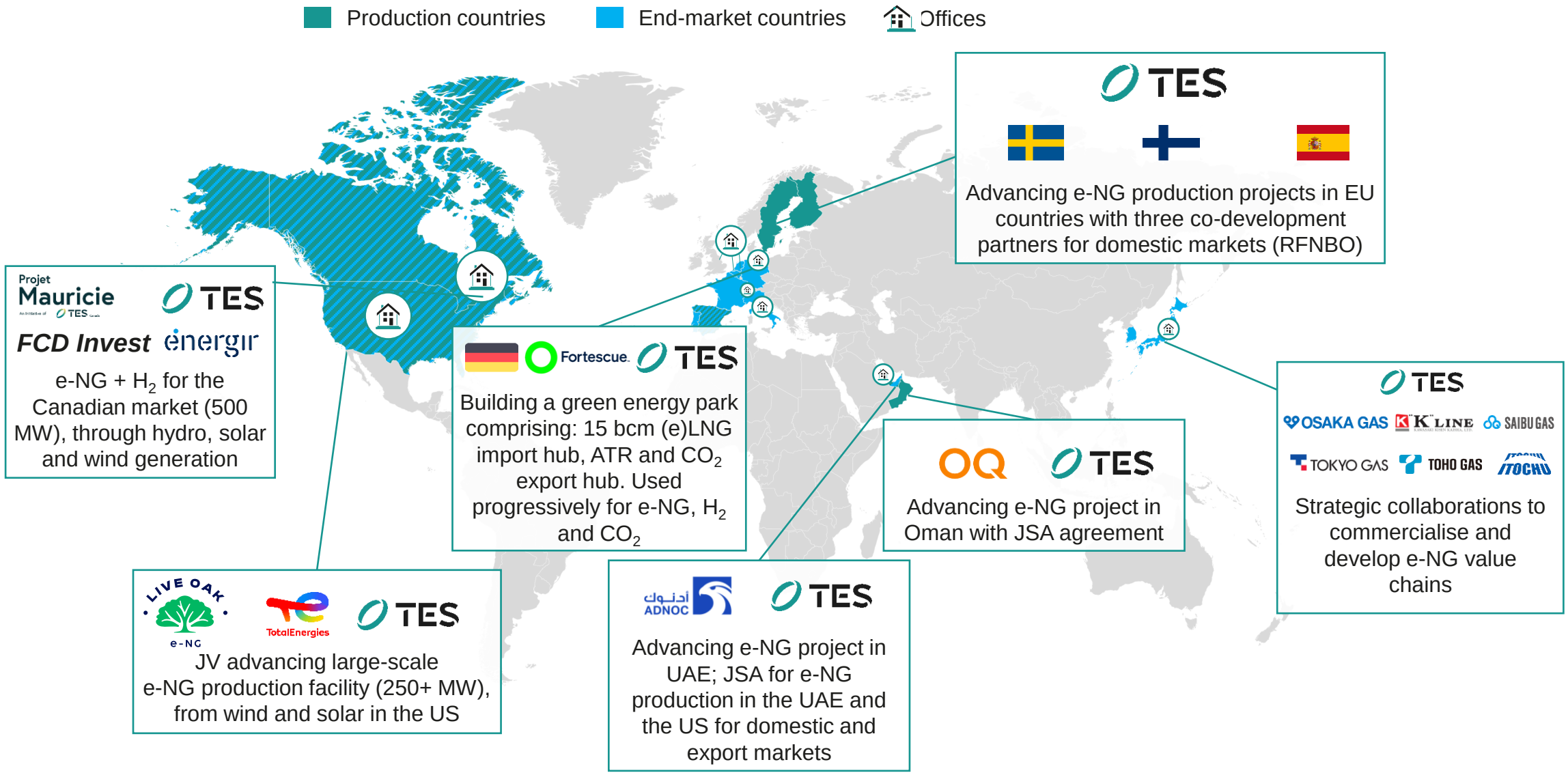
Partners

Bundesministerium für Wirtschaft und Energie, TotalEnergies, OSAKA GAS, ITOCHU, TOKYO GAS, OQ, ENGIE, Fortescue, TOHO GAS, ADNOC

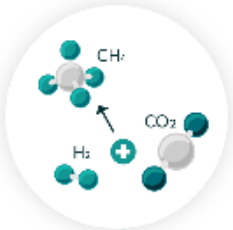
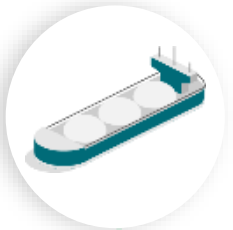
100+
TES dedicated employees

Offices in
Europe, US, Canada, Middle East and Japan

TES is actively developing portfolio of projects across the globe with partners



e-NG costs across value chain: H_2 production represents ~75% of costs

Renewable power	H2 production (electrolysis)	e-NG synthesis (Sabatier)	Liquefaction	LNG shipping	Re-gasification	End-user
						
e-NG cost breakdown *based on $/MWh LHV*	***41%***	***32%***	***19%*** *including CO_2 procurement*	***5%***	***2%***	***1%***	***No additional cost when for end-user as "drop-in" fuel***	*Total = 100%*

73%

Liquefaction, shipping and re-gasification cost can be avoided when **existing natural gas pipelines** are used

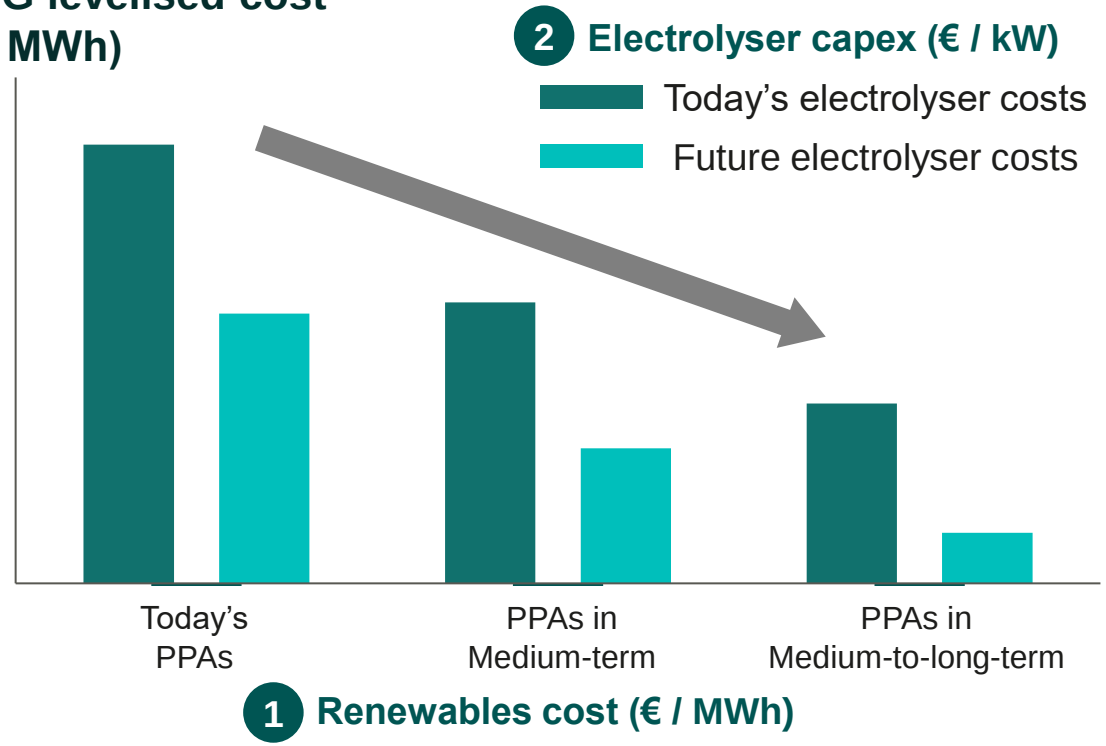
e-NG costs expected to significantly fall over time

Cost will fall significantly over the coming years

Main cost drivers are expected to significantly decline the future:

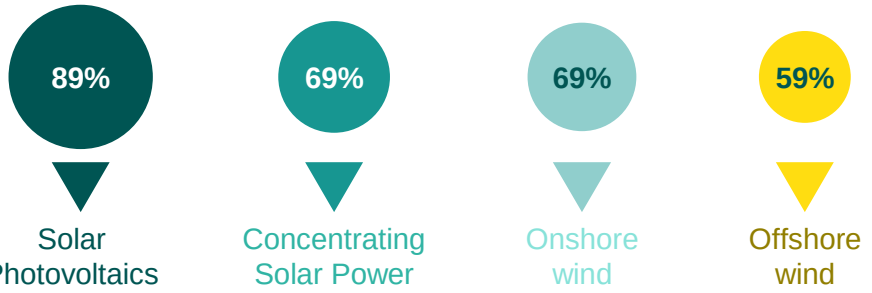
1. **Renewable prices** – continuing downward cost trajectory
2. **Electrolyser capex** – as industry moves into industrial scale

e-NG levelised cost (€ / MWh)



e-NG cost reduction

Historical cost reduction in other green technologies[2] (2010-22)



Green H_2 cost reduction drivers

- ✓ **Renewable power PPA** down as production costs decline
- ✓ **Electrolyser capex** costs down due to large scale deployment
- ✓ **Electrolyser efficiency** up with better stack and lower density
- ✓ **Battery capex** down with large-scale of new technologies
- ✓ **Battery efficiency** up with new storage technologies

Green H_2 production costs expected to fall by ~50% by 2030 (McKinsey, 2022)

Up to ~65% green H_2 production cost reduction in the US by 2030 (Deloitte, 2023)

e-NG specific drivers

- ✓ **Sabatier capex** costs decrease as the technology rolls out
- ✓ **Sabatier efficiency**: heat recovery & integration electrolyser[1]
- ✓ **CO_2 cost decline** as market for alternative sources develops (e.g. biogenic, DAC, closed CO_2 loop)

Source: TES technology and strategy team on publicly available data
Notes: 1. Under Solid oxide electrolyser cell (SOEC) scenarios in the future. 2. International Renewable Energy Agency, 2010-2022

How to globally leverage the potential of e-methane (e-NG)

1 Transparent CO_2 accounting rules

- **Clear and simple CO_2 accounting rules** are need
- **Fully reflect the CO_2 abatement/CO_2 recycling benefits** which e-methane provides, as is foreseen by EU RFNBO or IPCC accounting rules
- Ensure that the **benefit from captured CO_2 is not double counted** by moving towards multilateral agreements following the COP 28 commitments

2 Global certification to create markets

- Certification, global recognition and trading **should be facilitated based on simple rules and mutual recognition of national schemes**
  - This includes e-methane (e-NG) and also all other H_2 derivatives
- **Facilitated** inter-alia **by bodies such as** the **EU Union Database** or the **UNFCCC**

3 e-methane system benefits can enable broader H_2 development

- System costs benefits of e-methane (e-NG), **should be recognised as an enabler for long-term H_2 infrastructure and H_2 based capital investments**
  - **e-methane**, as a “drop-in” solution, can be a **useful mechanism to accelerate broader H_2 industry development**
- System cost benefits of e-methane **include the avoided costs and synergies with industrial decarbonisation related to the direct compatibility of e-methane (e-NG)** with natural gas processes, infrastructure and technologies, thus **accelerating industrial adoption of green H_2 based energy options**

TES Green energy, naturally.

Thank You