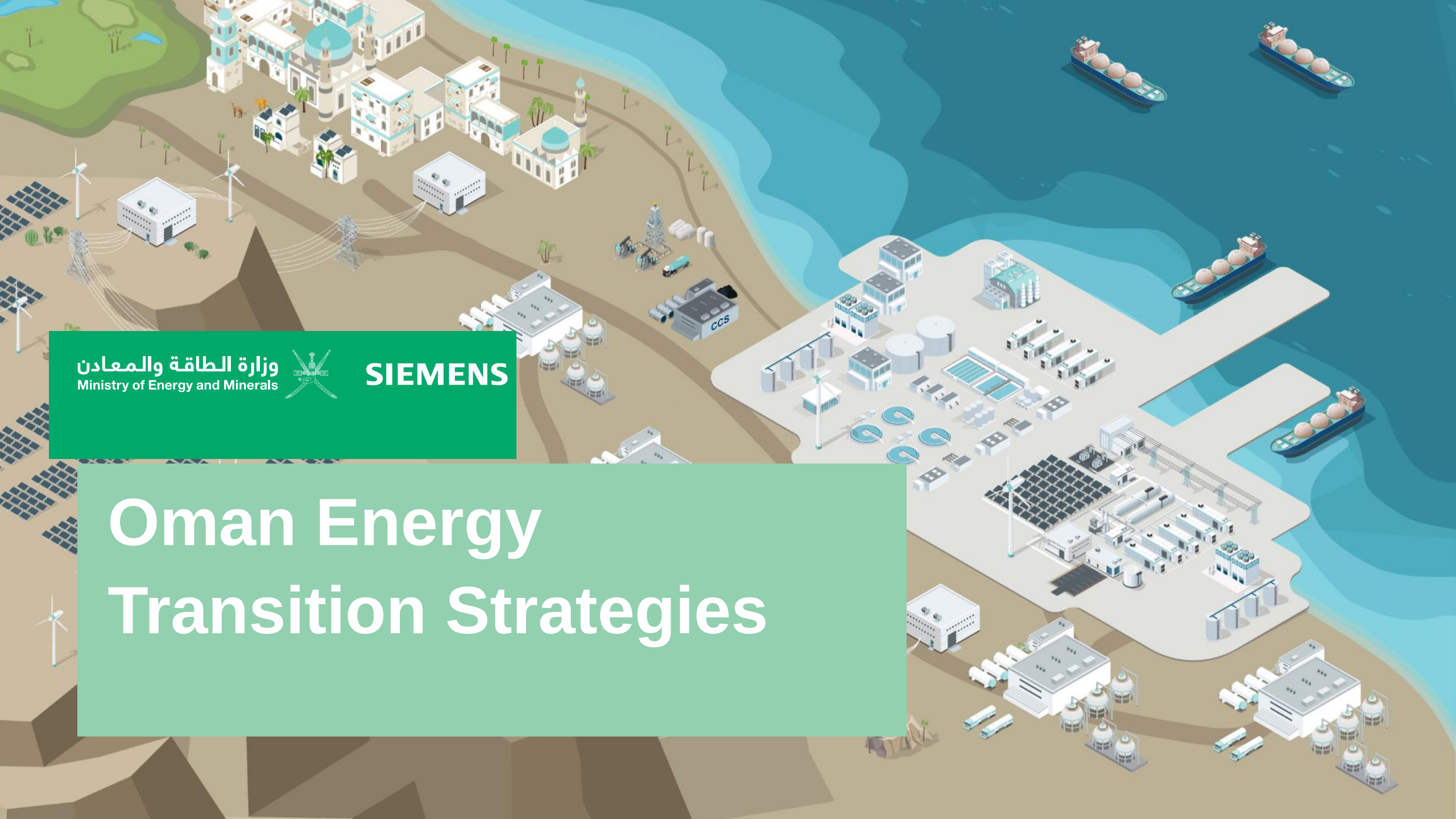

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Ministry of Energy and Minerals

SIEMENS

Oman Energy Transition Strategies

Agenda for the Presentation
Oman Energy Transition Policy

1 **Transition is A Journey**

2 **Burning Platform**

3 **Vision & Guiding Principles**

4 **Oman in 2050: Targets & Impact**

5 **Bold Strides**

6 **Steady Strides**

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Source: Oman Energy Transition Policy project

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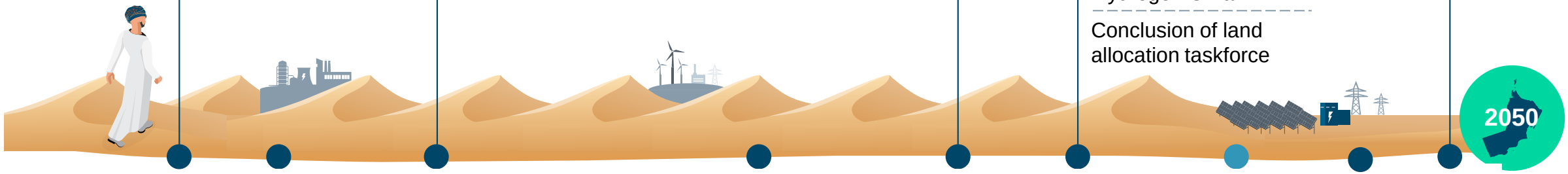
Source: Oman Energy Transition Policy project

Growing momentum for Energy Transition Journey



2021

Hydrogen Economy feasibility study

Aug 2021

Establishment of National Hydrogen Alliance (Hy-Fly)

Mar 2022

Royal Directives for Hydrogen

- Set the required strategy, policies and legal framework
- Allocate lands for green Hydrogen
- Establish a Directorate General for Clean Energy & Hydrogen
- Establish a company to develop Hydrogen sector

Creation of Directorate General for Renewable Energy & Hydrogen in MEM

Jun 2022

Incorporation of Hydrom

Tender for Energy Transition Policy & Legal Framework projects

Sep 2022

BoD Approval of Hydrom's strategy

Kick-off of Energy Transition Policy & Legal Framework projects

Oct 2022

Announcement of Net Zero Target 2050

Official launch of Hydrogen Oman

Conclusion of land allocation taskforce

Q1 / 2023

Conclusion of Energy Transition Policy & Legal Framework projects

Q2 2023

Announcement of the winning bidders of round one hydrogen block auctions

Q2 2024

Announcement of the winning bidders of round two hydrogen block auctions

Source: Ministry of Energy and Minerals

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Source: Oman Energy Transition Policy project

Vision 2040 sets high aspirations for Oman's development (5% p.a. GDP growth) – Oman Energy Transition Policy developed for economic growth & diversification scenario

Traditional economic sectors

- Economy centered around **oil and gas** export
- High exposure to hydrocarbon market fluctuations
- **Narrow** economic and people **development**

Economic growth & diversification
(Current pathway)

- **Diversified** and **growing** industrial activities
- **Sustainable** economy based on technology, knowledge and innovation
- High **value** jobs and **growth** in household incomes

Assumed in Energy Transition Policy

New Horizons

- **Booming** industrial sectors growing above market
- Global leader and **pioneer** in technology and innovation
- Exponential **benefits** to country and society

Acts as enabler

Assumed GDP growth rate:

~ 1 - 3% p.a.	~ 3 - 4 % p.a.	~ 4 - 5% p.a.

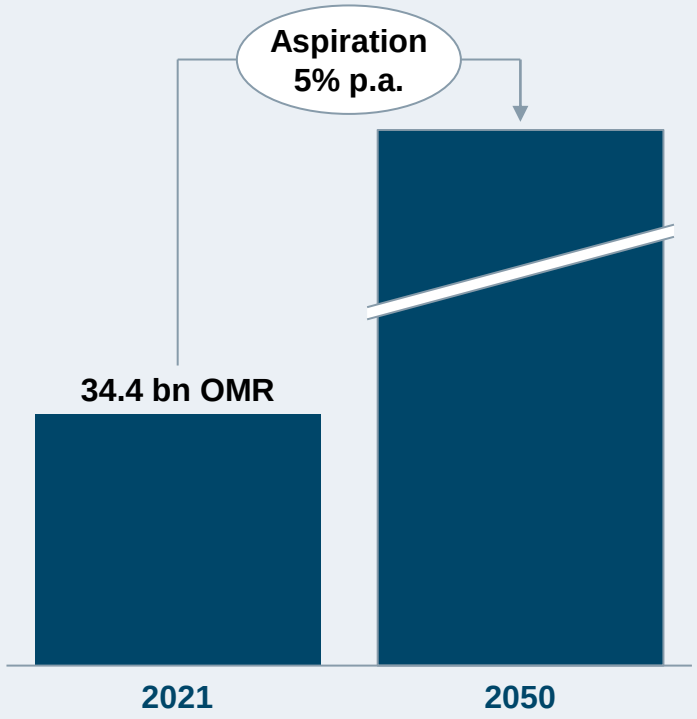
Note: No in-depth macroeconomic study has been conducted. "Traditional economic sectors" assumes growth in range of short-term IMF forecast for period 2024-2027of 1.9% to 2.7% p.a.. Vision 2040 however sets target of GDP growth of 5% – "Economic growth & diversification" assumes that this target can only be achieved in the long-term, therefore an intermediary range (3-4% p.a.) is assumed. "New Horizons" assumed target range is achieved by 2030 and can be sustained until 2050.

Source: Oman Energy Transition Policy project

Vision 2040 sets high aspirations for Oman's development (5% p.a. GDP growth) and new sources of energy are needed to meet aspirations

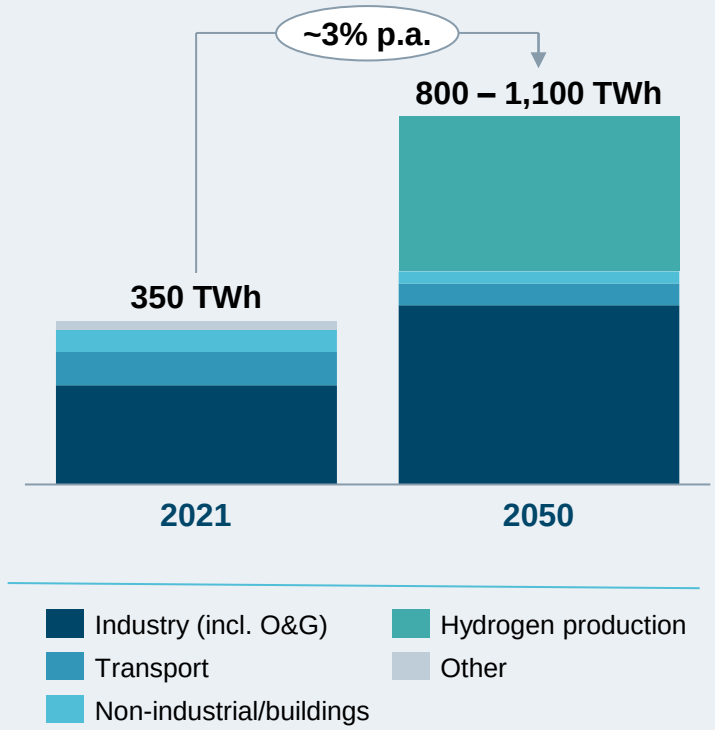
GDP growth in Oman

Vision 2040 targets 5% p.a. GDP growth



Demand for energy[1)] in Oman

GDP growth leads to an increase in energy demand



Energy Transition is needed to support economic growth & diversification

- **Diversified** and **growing** economy
- **Sustainable** industry based on energy-intensive activities, as well as on knowledge and innovation
- High **value** jobs and **growth** in household incomes

1) Including feedstock; 2050 figure assumes energy efficiency improvement, electrification of transport and industry; w/o export of natural gas and crude oil
Source: Oman Energy Transition Policy project, NCSI GDP Data, Vision 2040

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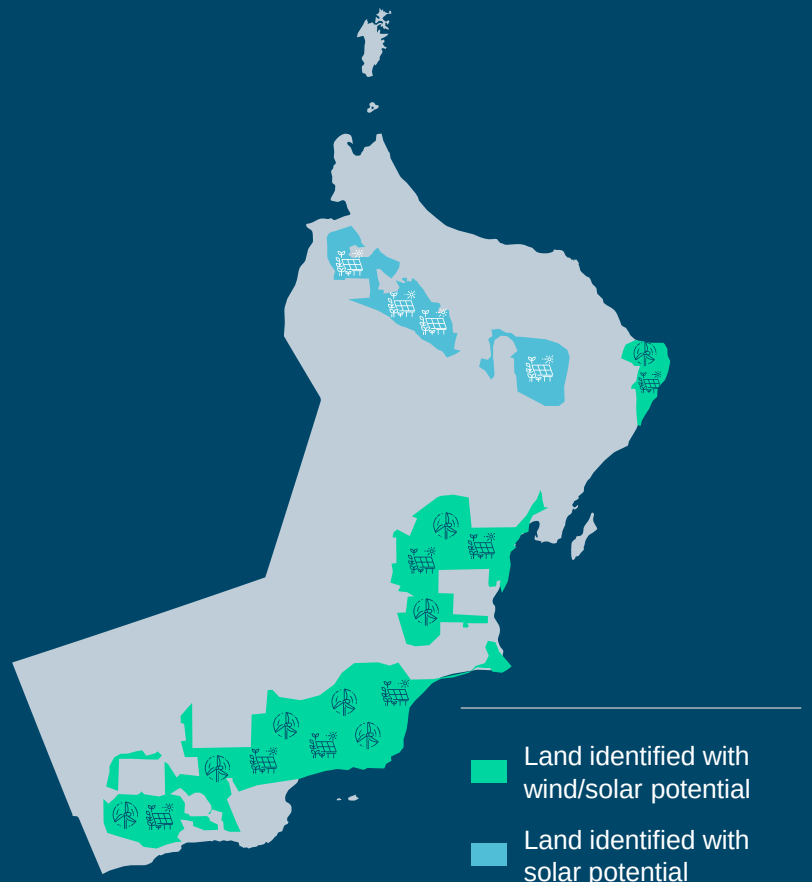
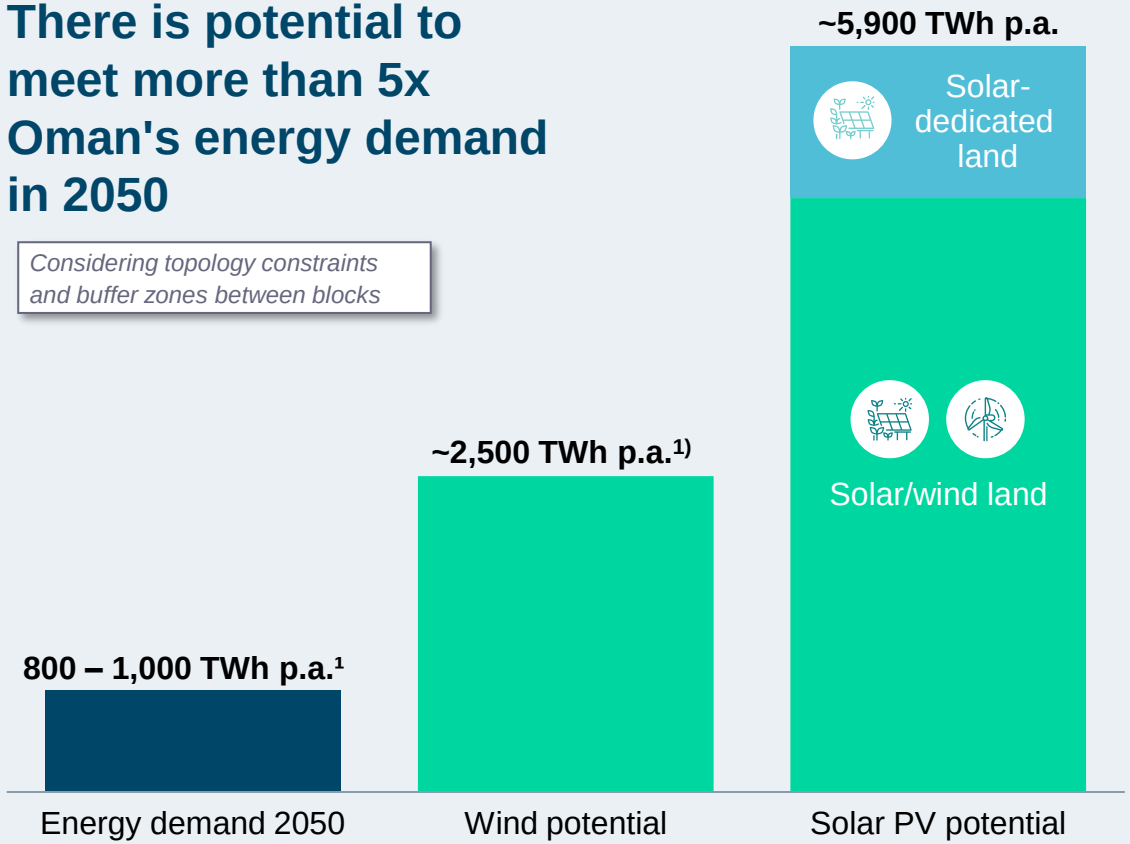
Solar and wind energy are abundant and low emission sources to meet Oman's energy demand in 2050

Oman has extensive potential to develop solar/wind energy



There is potential to meet more than 5x Oman's energy demand in 2050

Considering topology constraints and buffer zones between blocks



1) No topographical analysis conducted, top-down assessment based on satellite images assuming 100% for open, non-mountainous areas and 30% for mountainous areas. Another 20% reduction of area due to consideration of buffer zone

 Source: Oman Energy Transition Policy project

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Source: Oman Energy Transition Policy project

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Oman's Energy Transition Vision and sub-statements per building block

North Star Vision

Oman shall fulfil Net Zero by 2050 while ensuring energy security & competitiveness, growth in low carbon economy, and value to society

- **Energy Efficiency**
- **Renewable Energy**
- **Hydrogen Economy**
- **Electrification**
- **Fossil fuel Including CCUS**
- **Smart Grids**

 Source: Oman Energy Transition Policy project

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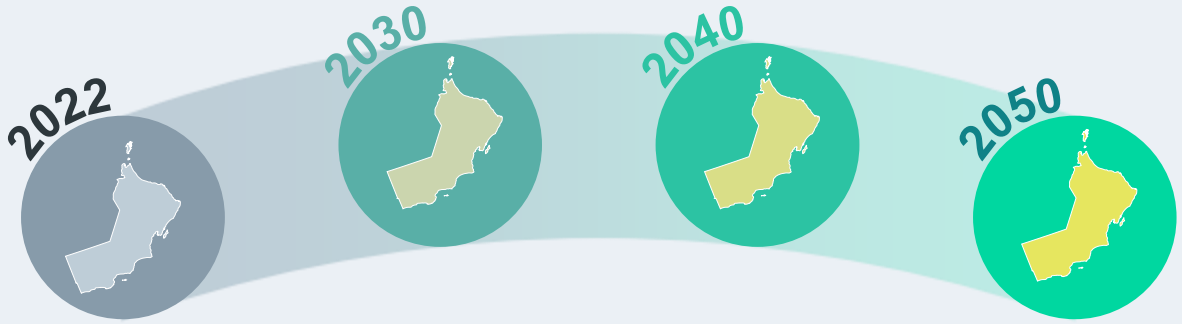
Oman Energy Transition Policy project started to drive National energy transformation

Oman Energy Transition: Guiding principles and strategic goals



Ensure Energy Security
(Timely investments inline with economic developments and environmental needs)

Decarbonize Orderly
(Adoption of Green Technologies and CCUS)

Develop transition enabling capabilities

Grow low-Carbon Economy
(Clean Hydrogen Export and local consumption)

Enhance competitiveness in energy sector
(Free-up Natural Gas for export)

Project objectives

1. Define **Energy Transition Vision** for Oman
2. Develop **Strategy & Targets** and outline **Policy Instruments** for key Energy Transition building-blocks[1)]:
   - Renewable Energy
   - Fossil Power & CCUS
   - Hydrogen Economy
   - Energy Efficiency
3. Derive **implementation roadmap & policy outlook**

1) Potential additions of building blocks to be discussed separately

 Source: Oman Energy Transition Policy project

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Source: Oman Energy Transition Policy project

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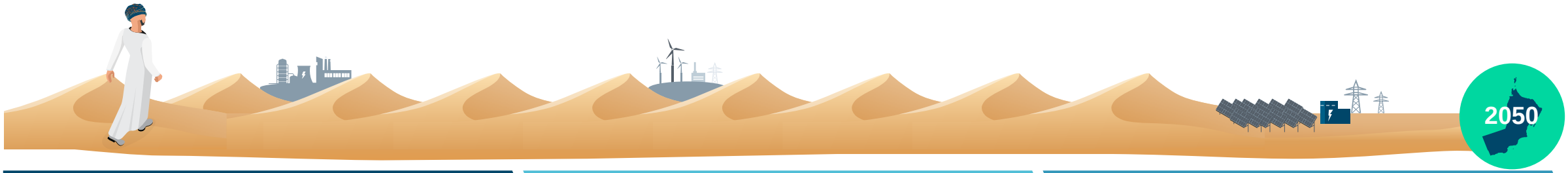
For a successful Energy Transition think big, start now and execute steadily



Energy Transition Targets

- I Set **sectoral energy efficiency** targets
- II Set **green power system** targets
- III Set **local Hydrogen Economy** targets
- IV Set **Zero Emission Vehicles** targets
- V Set **Carbon Capture** targets

Set, communicate and enforce Energy Transition Targets

Bold Strides (immediate)

1. Make **Govt. green & energy efficient**
2. Kickstart **local Green Hydrogen Economy**
3. Drive **awareness, skills & innovation**
4. Make **Funding Schemes Available**
5. Set up **governance** framework

Accelerate momentum with decisive action today

Steady Strides (long term)

Initiate & track **steady strides**

6. Energy Transition codes and standards
7. Certification schemes
8. Reporting and audit obligations
9. Decarbonization targets and quotas per sector
10. Network and storage master plan
11. Localization and Innovation master plan
12. New sustainable business models & frameworks
13. Taxes and incentives framework
14. Additional public-private alliances
15. International cooperation agreements

Execute policy roadmap with continuous action over time

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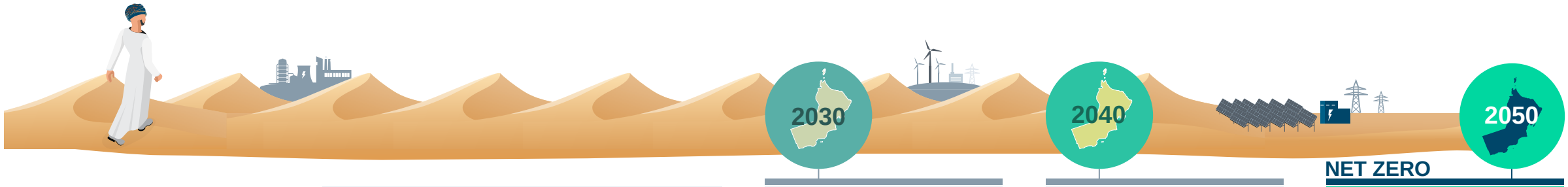
 Source: Oman Energy Transition Policy project

Set, communicate and enforce Energy Transition Targets



		2030	2040	NET ZERO
Energy Efficiency	Primary energy efficiency (Energy supply / GDP)	13 MJ/USD	9 MJ/USD	6 MJ/USD
	ACEEE[1] score	35	50	>70
Renewable Energy	Share of RE in on-grid electricity consumption	30%	70%	100%
Hydrogen Economy	Green hydrogen production	1 mtpa	3.5 mtpa	8 mtpa
	Minimum green hydrogen for local demand	0.058 mtpa	0.6 mtpa	1.7 mtpa
Zero Emission Mobility	Sales target for new Passenger ZEVs	25% (21k)	75% (104k)	100% (223k)
	Sales target for new Commercial ZEVs	30% (7k)	75% (27k)	100% (58k)
CCUS	Residual emission reduction via carbon capture in hard to abate sectors	1 Mt CO_2e	4 – 8 Mt CO_2e	8 – 16 Mt CO_2e

1) American Council for an Energy-Efficient Economy

 Source: Oman Energy Transition Policy project

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Target 1:Energy efficiency to be comprehensively implemented across sectors where sectoral and primary energy efficiency targets are mainly considered

	Today's baseline (2021)	2030 target	2040 target	2050 target	Major energy efficiency levers
Sectoral energy efficiency	*No benchmark*	**35** / 100 ACEEE points[1]	**50** / 100 ACEEE points[1]	**>70** / 100 ACEEE points[1]	• National programs / policies • Building codes & retrofits • Industrial audits & standards • Low-carbon transport
Primary energy efficiency	Energy supply: **1,300** PJ By GDP: **13.5** MJ/USD[4]	**13** MJ/USD	**9** MJ/USD	**6** MJ/USD	• Shift towards renewable energy (power & fuels) • Electrification of transport and industry
Electricity consumption efficiency	Electricity consumption (MIS): **50** TWh / year	BAU[2]: 55 TWh **vs** Efficient[3]: 47 TWh **15%** vs. BAU	BAU[2]: 75 TWh **vs** Efficient[3]: 60 TWh **20%** vs. BAU	BAU[2]: 95 TWh **vs** Efficient[3]: <75 TWh **>20%** vs. BAU	• More efficient technologies, e.g., HVACs, smart buildings, electric motors • Improved building efficiency
Governmental energy efficiency	Government electricity consumption: **4.4** TWh / year	**0.7** TWh / year SuperESCO audited savings	**>1** TWh / year SuperESCO audited savings	**>1.2** TWh / year SuperESCO audited savings	• Implementation of SuperESCO • Systematic implementation and verification of savings

1) International scorecard by the American Council for an Energy-Efficient Economy (ACEEE) 2) "Business-As-Usual" scenario considering consumption scope as-of today and simple extrapolation of growth in consumption 3) "Efficient" scenario considering comparable scope to today's consumptions, i.e., excluding special effects such as additional consumption via electric vehicle charging and industrial electrification 4) Total energy supply (TES) by GDP (nominal) in 2015 USD (source: IEA)
Source: Oman Energy Transition Policy project

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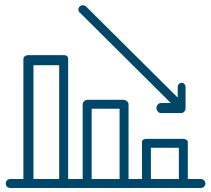
Policy-makers to address hurdles to energy efficiency to enable benefits to consumers, defer grid extension costs, and save natural gas

Energy efficiency provides benefits to consumers and Government

1 Consumer cost savings

Consumer Bill



- Energy efficiency measures will deliver **cost saving for end users** through lower kWh consumption and therefore **lower monthly bills**
- Customer savings quantification **depend on tariff bracket**

2 Oman's cost savings, e.g. due to deferred grid extensions

- Energy is **currently** fully or partially **subsidized**, hence a reduction in consumption will **lower fiscal pressure on Oman's government budget**
- Quantification of cost savings for Oman depends on the specifics of power purchase agreements with IPPs

3 Natural Gas savings due to lower production

- Reduction in energy consumption will lead to reduced natural gas consumption for power generation (**lower payments to IPPs**)
- This released capacity can be made available for **export** at international prices **(higher than paid by IPPs**)

However, key hurdles to implementation remain

Incentives Gap

- Customers require support for procuring devices and solutions
- Additional benefits and motivation needed

Information Asymmetry

- Customers lack clarity on best practices and expected payback periods
- Low understanding of risks, low appetite for investments

Lack of regulations and rules

- Project financing and business case unclear in the absence of regulatory framework

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 Source: Oman Energy Transition Policy project

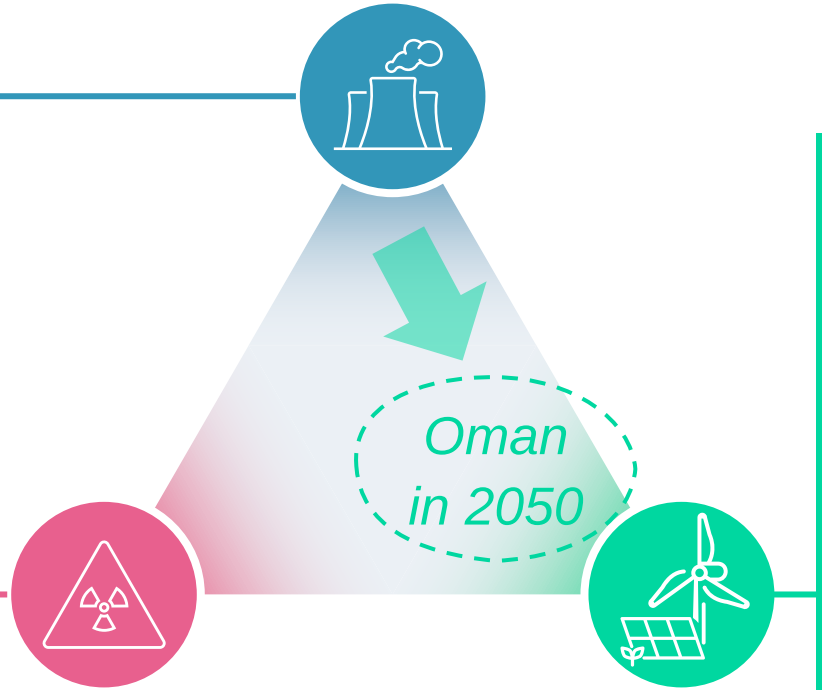
Transition starts with moving towards a greener energy system, including renewable energy and storage, to ensure reliable and affordable energy

Blue system (today)

- Based on **natural gas** for baseload and peak demand
- **Requires carbon capture** to achieve net zero

Pink system

- Based on **nuclear power** for baseload demand



Most affordable and 100% reliable

Green system

- Based on **renewable energy** for bulk of energy demand
- Utilizes **storage** (e.g., batteries) and **demand-side management** for 24/7 supply
- **100% grid security** i.e. via green hydrogen power plants (peakers), Pumped Hydro Storgae

 Source: Oman Energy Transition Policy project

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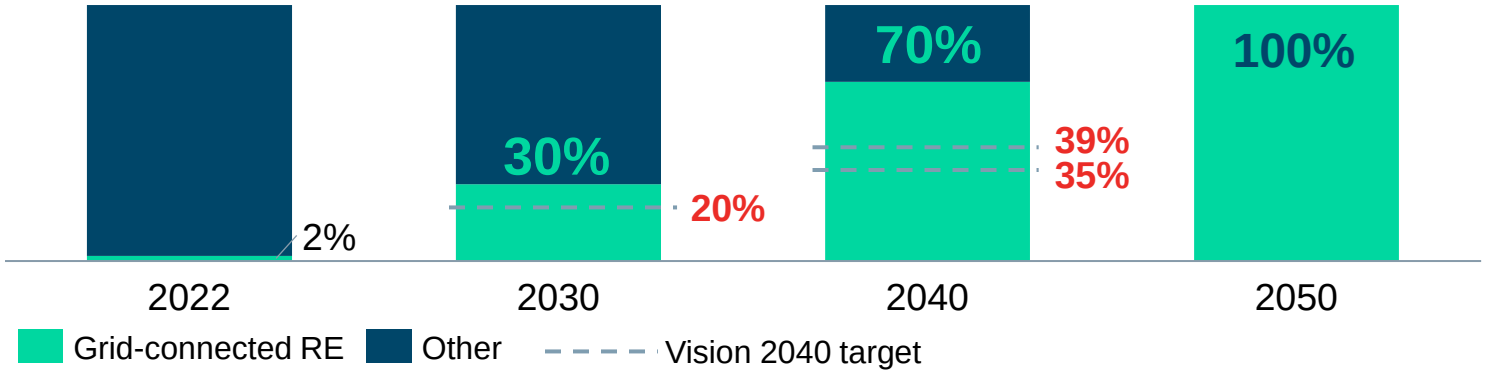
Target 2: Ensure security of supply and minimum economic cost by achieving a 100% RE grid by 2050, and raising the 2040 to 70%

Energy system options

1 "Blue" system	2 "Pink" system	3 "Green" system (100% RE)	
		a Integrated H_2 sector	b Separate H_2 sector
Gas as baseload	Nuclear as baseload		
Electricity cost [1] USD ct / kWh			
16.3	***15.2***	***3.8***	***18.2***
Cost-efficient at consistently low LNG prices and cost of abatement (CCS)	*Cost-efficient only at costs 30% below lowest benchmark costs*	***Aim for most economically efficient archetype***	*Requires storage technology at scale, higher CAPEX to implement*

Share of RE in on-grid electricity consumption



Strategic Levers

1. **Utility scale renewable energy as the main source** for electricity consumption due to lower LCOE (economies of scale) and similarity to existing centralized power model
2. **Connect fossil-based captive power to grid** or increase off-grid renewable energy generation
3. **Enable behind-the-meter renewable energy** technology to accelerate renewables implementation, leverage private initiative and reduce grid extension need
4. **Localize value chain** and **drive innovation** in technology and new business models to maximize socio-economic benefits
5. **Expand storage capacity** to enable reliable generation from renewables and maintain energy security

1) Levelized Cost of Energy (LCOE); Note: Energy system only fully modelled for 2050; intermediary values extrapolated based on available supply of natural gas for power generation and alignment with National Strategy for an Orderly Transition to Net Zero

 Source: Oman Energy Transition Policy project

Archetypical systems for Oman in 2050 investigated for security of supply and minimum economic cost

System archetypes

	1 "Blue" system	2 "Pink" system	3 "Green" system (100% RE)	
	Gas-fired plants as baseload	Nuclear as baseload	a Integrated H_2 sector	b Separate H_2 sector
Dispatchable	*Nat. Gas with CCS*	*Nuclear power plant*; *Hydrogen peaker (backup: Nat. Gas)*	*Hydrogen peaker (backup: Nat. Gas)*	*Hydrogen peaker (backup: Nat. Gas)*
Intermittent	*Renewable energy and battery storage*	*Renewable energy and battery storage*	*Renewable energy and battery storage*	*Renewable energy and battery storage*
Balancing	*H2 production*	*H2 production*	*H2 production*	*H2 production*

 Source: Oman Energy Transition Policy project

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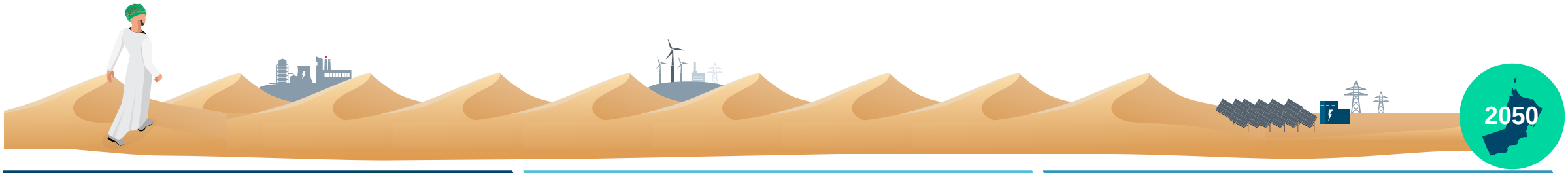

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Execute policy roadmap with continuous action over time

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 Source: Oman Energy Transition Policy project

Purpose driven 5 Bold Strides shortlisted for immediate policy implementation

	1 Make Govt. green & energy efficient	2 Kickstart local Green Hydrogen Economy	3 Drive awareness, skills & innovation	4 Make Funding Schemes Available	5 Set up governance framework
Description	A holistic initiative for **government entities to take the lead** in Energy Transition	Actions to enable and accelerate **local consumption of green hydrogen** in different sectors	A program to **promote the awareness**, to **build skills and competencies**, and excel in **research & innovation**	Monitor available **sectoral funding** from **existing** funding **schemes** for energy transition projects and initiatives	A **supporting structure** to set the direction, provide guidance and oversight for the Oman Energy Transition Policy program
Purpose	**Leads the society to embrace energy efficiency by example:** • Speed of implementation • Brings direct benefit • Demonstrates benefit to broader society • Conveys priority	**Creates local demand and contributes to success of mega projects by:** • Advancing technology • Building technological knowhow and personnel expertise • Attracting investment	**Reinforces the societal effort in Energy Transition by:** • Driving green decisions • Promoting renewable energy • Promoting e-mobility • Attracting talent for Energy Transition	**Accelerates private investment by:** • Advancing technology • Enabling emerging markets • Driving education and awareness • Identifying funding gaps and notifying relevant authorities	**Ensures robust implementation of policies by:** • Bringing different entities together to collaborate • Tracking and measuring progress
Proposed immediate Champions[1)]	وزارة الطاقة والمعادن Ministry of Energy and Minerals; *Oman Net Zero Center*	وزارة الطاقة والمعادن Ministry of Energy and Minerals; IGC	وزارة الطاقة والمعادن Ministry of Energy and Minerals; Ministry of Higher Education, Research & Innovation	*Oman Net Zero Center*	وزارة الطاقة والمعادن Ministry of Energy and Minerals

 Source: Oman Energy Transition Policy project

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