

A clean COVID-19 recovery: The global opportunity

13,000 renewable energy projects for a green recovery

Prepared by EY-Parthenon,
funded by the European Climate Foundation

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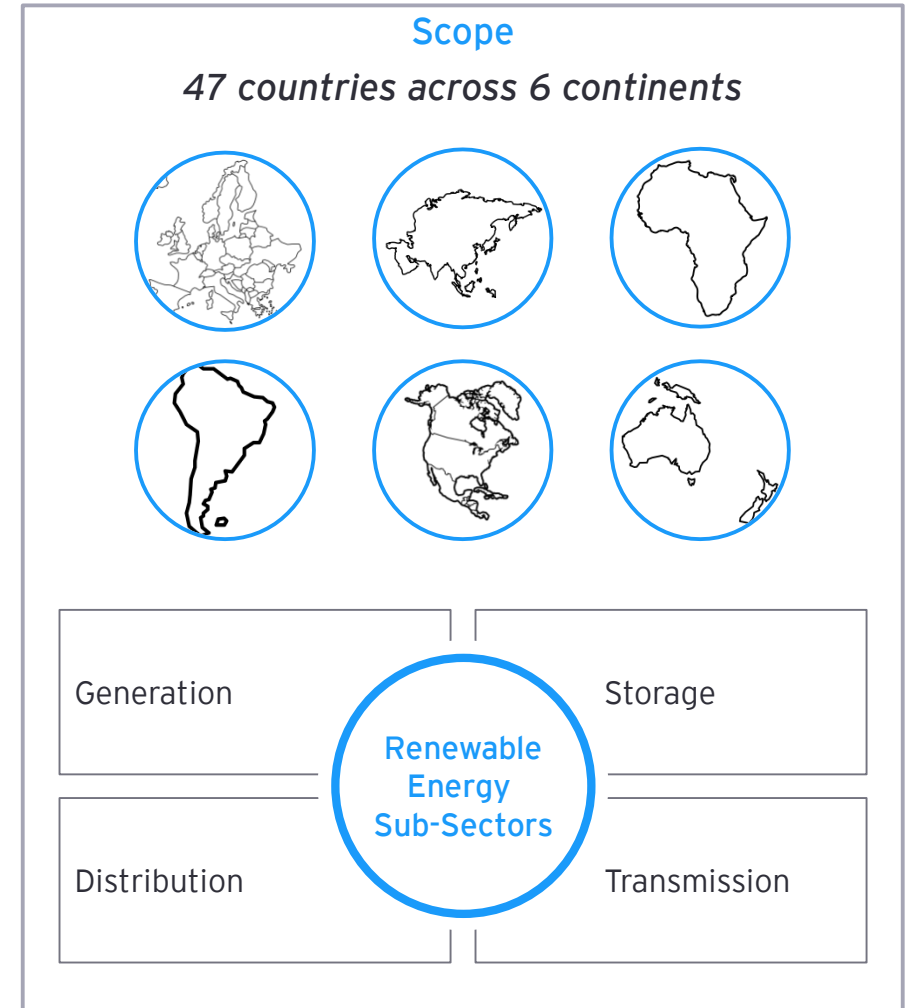
Through bottom-up research covering 47 countries, we have found 13,000 'shovel-ready' renewable energy projects that can accelerate economic recovery

Overview

- ▶ The European Climate Foundation (ECF) has commissioned EY to identify an investible pipeline of opportunities across a number of focus geographies, in order to support the development of green recovery plans
- ▶ Projects were identified across four renewable energy sub-sectors using public renewable energy pipeline databases, EY's proprietary Renewable Energy Country Attractiveness Index (RECAI) database and consultations with local stakeholders (e.g. investors and developers, think-tanks and other industry experts)
- ▶ Beyond the identification of an investible pipeline, the report also lays out key policy levers that governments can pull in order to accelerate the deployment of the investible pipeline and draw in private capital

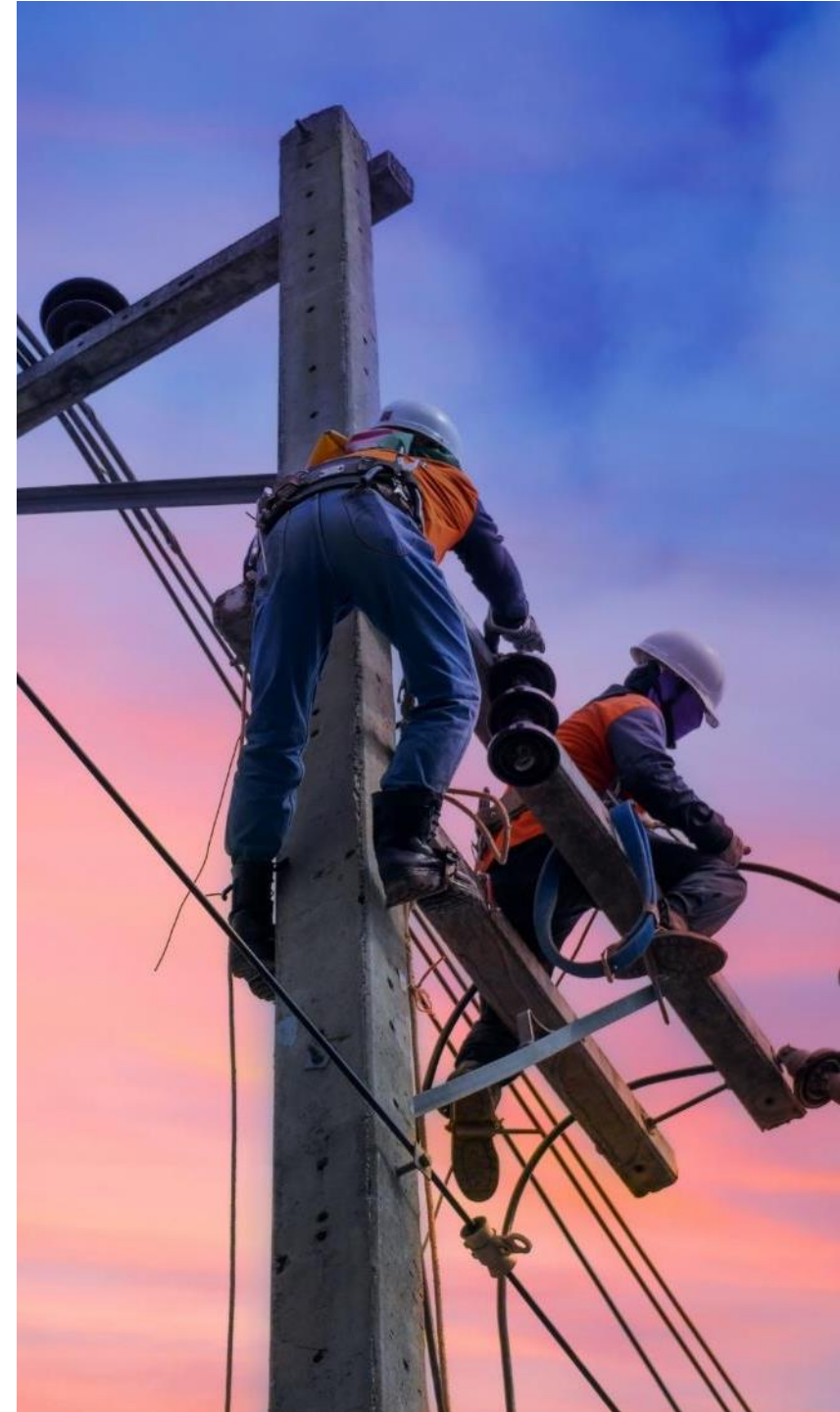
Limitations

- ▶ This work is not intended as a prediction of near-term renewables deployment, but as mapping of the potential impact of real projects that are currently in the investment pipeline. The realised impact will be lowered by many projects currently in the pipeline not being completed, but could also be increased by additional projects being deployed that are not currently visible in the pipeline.
- ▶ We have focused on projects which present short-term opportunities, i.e. projects that are expected to reach financial close in the next two to three years
- ▶ Our research covers 47 countries, and as such only lays out part of the total global opportunity, which is considerably larger



Agenda

- ▶ Executive summary
- ▶ People, Planet and Prosperity outcomes
- ▶ How to accelerate and enable these benefits
- ▶ Renewable energy policy success stories
- ▶ Appendix



A green recovery can create very large and positive impact on People, Planet and Prosperity globally, starting immediately

Potential impact from visible pipeline of 13,000 renewable energy projects

People

10m

Potential jobs created

Planet

22%

Contribution to NDC emissions reduction targets





Prosperity

\$2tn

Investment opportunities

We must act together, now, in order to unlock the opportunity

Key recommendations:

-  Renewable energy should be a top priority in post-COVID economic recovery - this is a 'no-regrets' move with major benefits for job creation, the environment, and economic growth
-  Key policy enablers need to be put in place in order to get the most out of a green recovery and unlock the full potential of private investment in renewable energy
-  The global scale of a green recovery should be used to realise large-scale infrastructure projects that underpin country-wide or region-wide transformation
-  International co-operation and co-ordination as well as collaboration between the private sector and public sector are important to unlocking the full opportunity identified

A green, post-COVID economic recovery focused on renewable energy is a 'no-regrets' opportunity to create jobs and deliver a step-change in climate action

1

People

A green recovery can deliver large-scale job creation in the near term, as well as laying the foundation for broader economic renewal and employment growth

- ▶ The visible project pipeline can create up to 10 million jobs, locally and in the supply chain
- ▶ Within countries, renewable energy can be particularly effective as a tool for creating employment opportunities outside of urban economic centres, especially when deliberate effort is put into strengthening local supply chains

13,000 projects in the pipeline

2

Prosperity

A green recovery can unlock private sector investments covering 90% or more of the \$2tn investment opportunity in the pipeline, multiplying the effect of government spending

- ▶ The existing pipeline of investable projects can enable a green recovery to begin immediately
- ▶ Recent examples of successful renewables policy show that 90-99% of the required investment for accelerated renewables deployment can be provided by the private sector
- ▶ The total investment opportunity can mitigate or reverse a substantial proportion of the economic losses due to COVID across the countries included in the study, and lay the foundation for sustainable economic growth driven by abundant, low-cost, renewable energy
- ▶ The visible pipeline also includes several transformational infrastructure projects that can have a country- or region-wide impact in enabling and accelerating further investment

1TW of renewable generation capacity

\$2tn investment opportunities

3

Planet

A green recovery can deliver a **step-change on decarbonisation and climate change**

- ▶ In some countries the visible project pipeline alone is enough to realise existing NDC targets
- ▶ Deploying the visible pipeline over a period of three years would more than double the current rate of global renewables deployment
- ▶ Beyond direct emissions abatement, decarbonising the power sector through renewable energy lays the foundation for reducing emissions in the rest of the economy through electrification

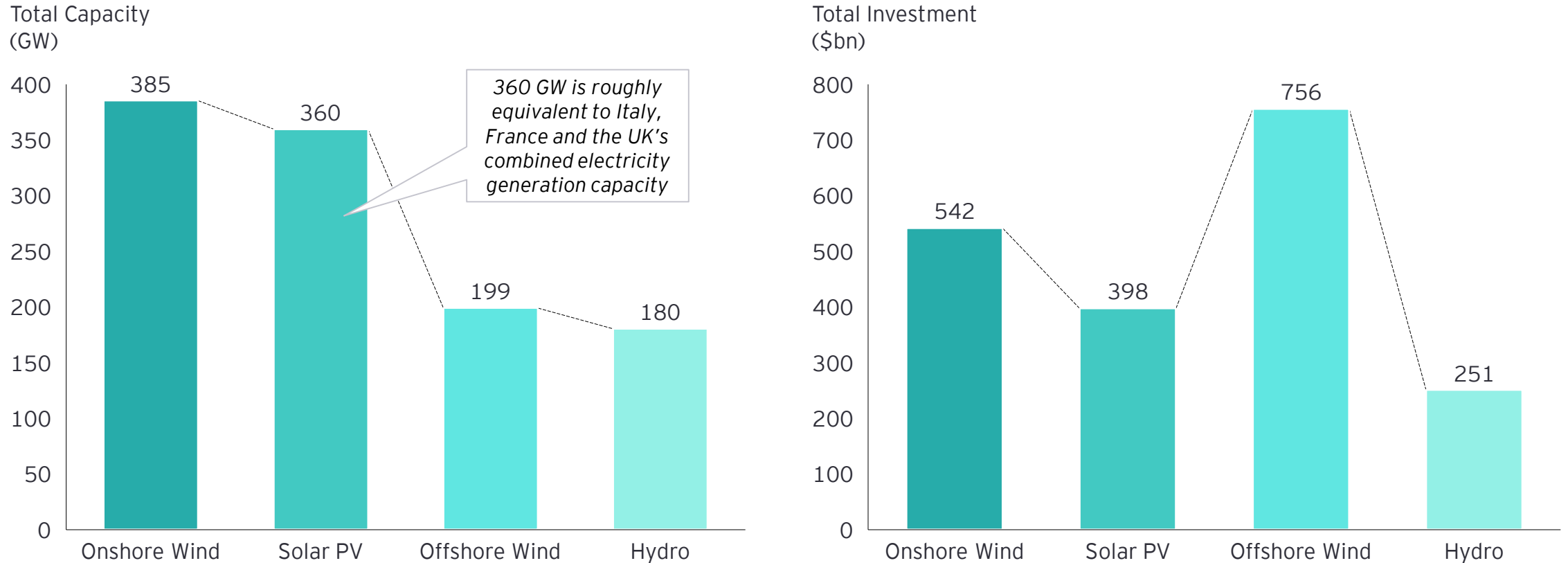
Up to 10m jobs created

2.5 GtCO₂e avoided

\$60bn recurring GDP impact

The visible pipeline of 13,000 renewable energy projects could deliver ~1TW of generation capacity for ~\$2tn

Capacity and investment breakdown of the ~13,000 projects identified, by renewable energy technology



The scale of the green recovery opportunity is driven by onshore wind, offshore wind, solar PV and hydro technology. Significant capacity can be added through each of the four technologies, potentially amounting to a total increase of 1TW

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People:
Up to 10m jobs
in renewable
energy

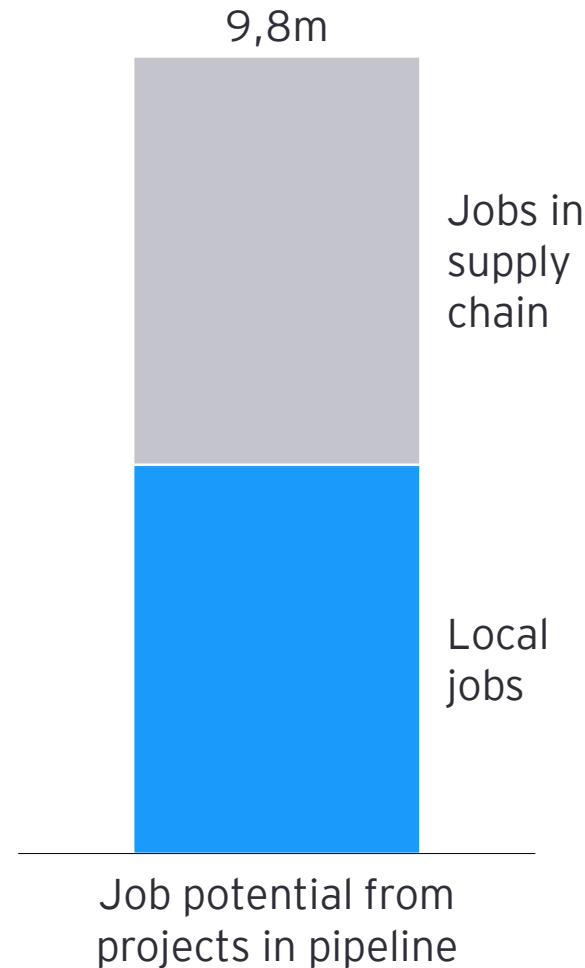


Deployment of the visible project pipeline can create up to 10m jobs in renewable energy

People
Planet
Prosperity



- ▶ The visible project pipeline is enough to create up to 10m jobs direct and indirect jobs in renewable energy
- ▶ Roughly half of these jobs are local to where the projects are, while the other half can be spread across other regions or countries, depending on where different parts of the supply chain are located
- ▶ Roughly 90% of the 10m jobs come from deploying the projects - while these jobs are limited to the time it takes to deploy the projects in the current pipeline, they will persist as long as renewables deployment continues at the same rate



- ▶ As well as lower skilled jobs created through construction, installation and manufacturing, skilled employment opportunities will also be created, in e.g. engineering and project management

10m
Potential jobs in renewable energy

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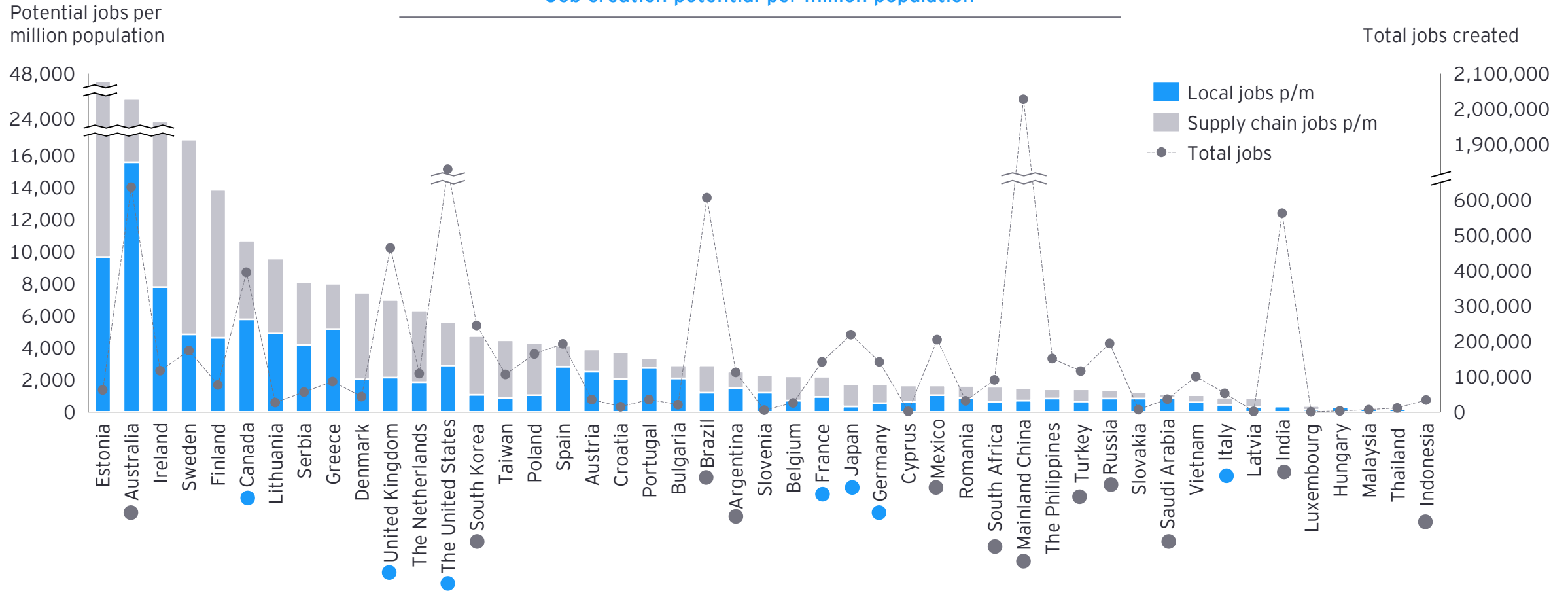
Countries that strategically develop manufacturing capability for renewables will realise more of the potential for job creation in the supply chain



There is significant potential for job creation across the economies included in the study

People
Planet
Prosperity

Job creation potential per million population



● G7 members ● G20 members

A green recovery can be a major source of jobs in targeted regions, especially if strategic efforts are made to develop local supply chains

People
Planet
Prosperity

Renewable energy investment can be targeted and is capable of creating employment opportunities in regions which may require economic support, or may be fast developing. Such employment opportunities include stable, long-term operations and maintenance (O&M) jobs servicing renewable energy plants, as well as manufacturing jobs and other high-skill employment opportunities

Case Study: The Humber Offshore Wind Cluster, UK



- ▶ The Humber has been established as a 'cluster' for offshore wind in the UK, with the objective of revitalising the region after a period of economic decline, driven by loss of jobs and industry
- ▶ The region is now home to six operational offshore windfarms (including the world's largest - Hornsea One), and is set to become one of the key drivers of completing the UK Government's commitment of 40GW offshore energy capacity by 2030

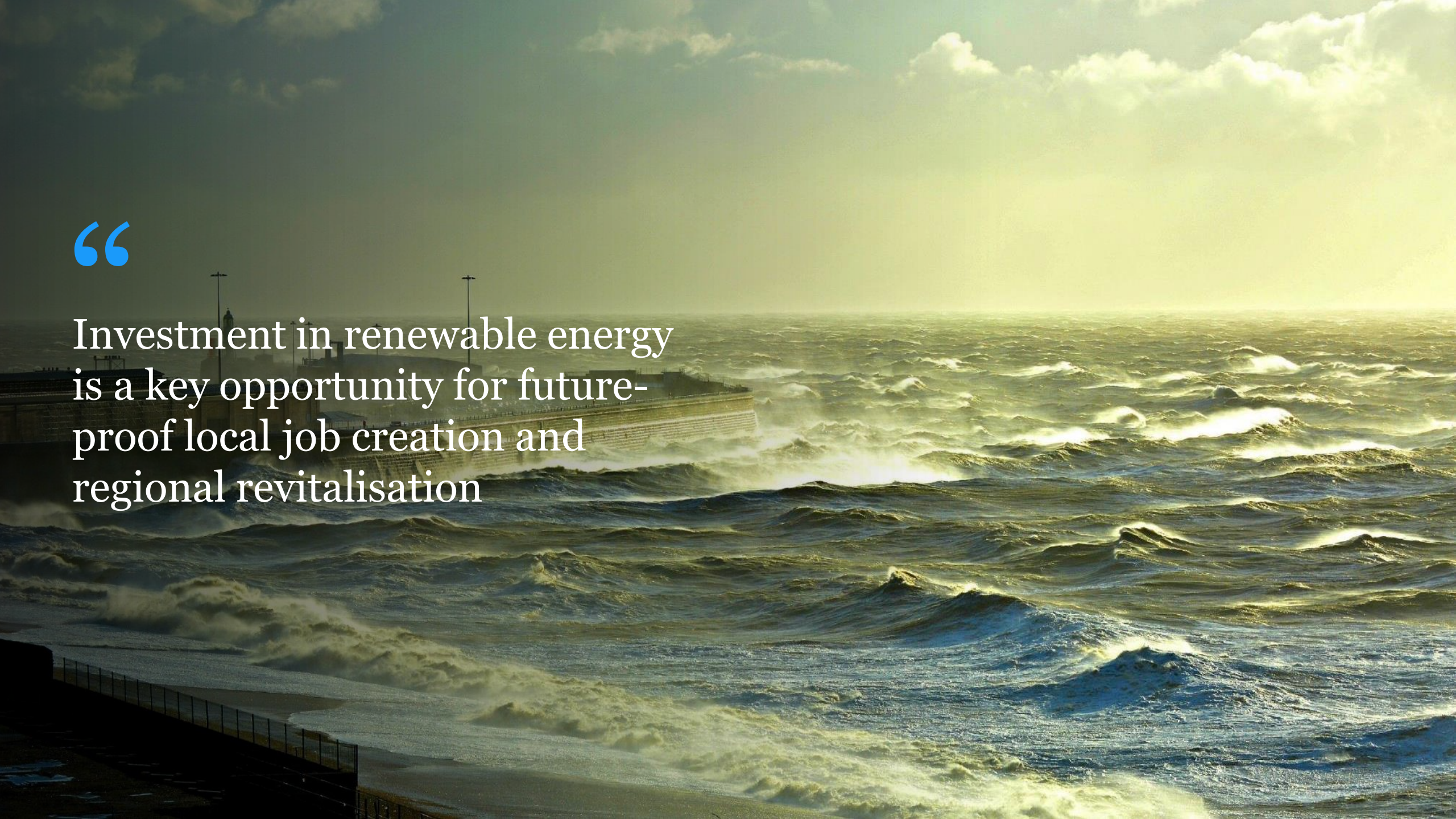
Hull City Council reported that private investment into the city has led to:

10% Improvement in local gross value added

13% Improvement in local employment

60% Reduction in local unemployment benefit claimants

30% Growth in local enterprises

A dramatic seascape at sunset or sunrise. The sky is filled with golden light and scattered clouds. In the background, a large, dark concrete structure, possibly a breakwater or pier, extends into the sea. The foreground is dominated by turbulent, churning waves with white foam, illuminated by the low sun. The overall mood is powerful and energetic.

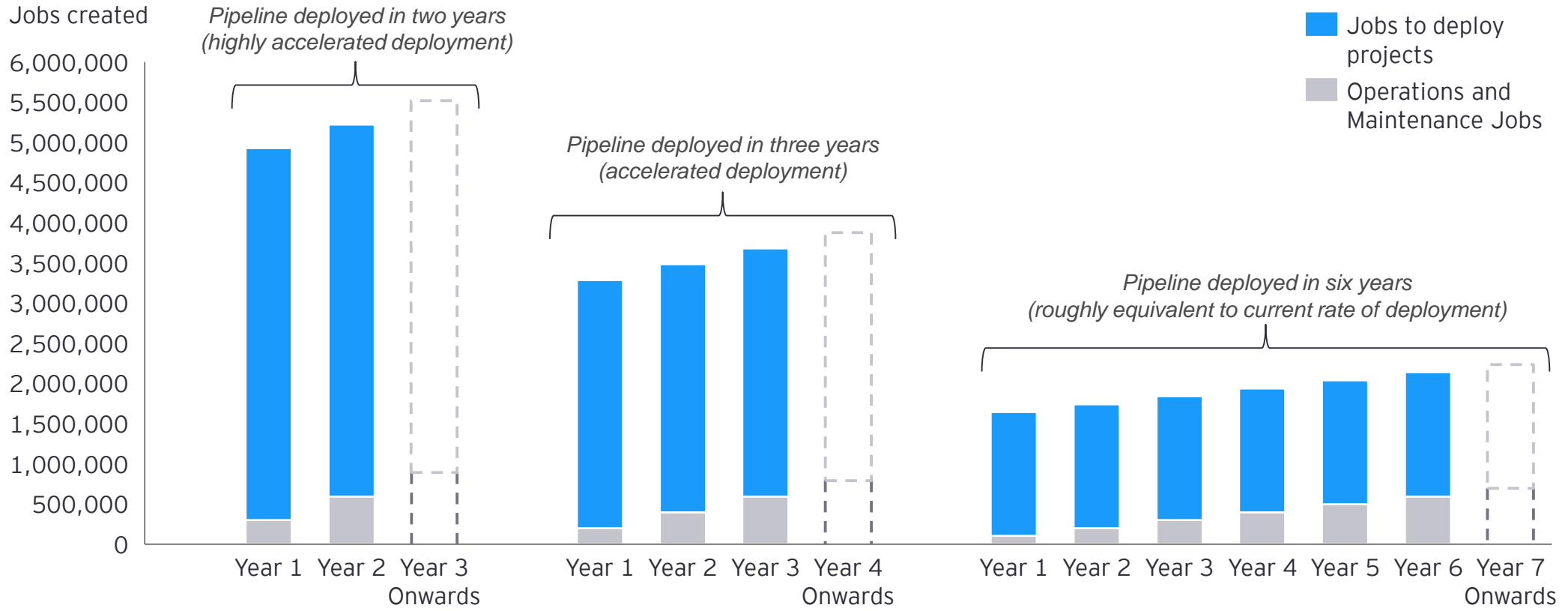
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Investment in renewable energy
is a key opportunity for future-
proof local job creation and
regional revitalisation

The faster the projects in the pipeline are deployed, the more jobs will be created

People
Planet
Prosperity

Number of jobs created, depending on project deployment timeline
(assuming constant rate of future deployment)





Planet:

22% contribution
to NDC emissions
reductions target

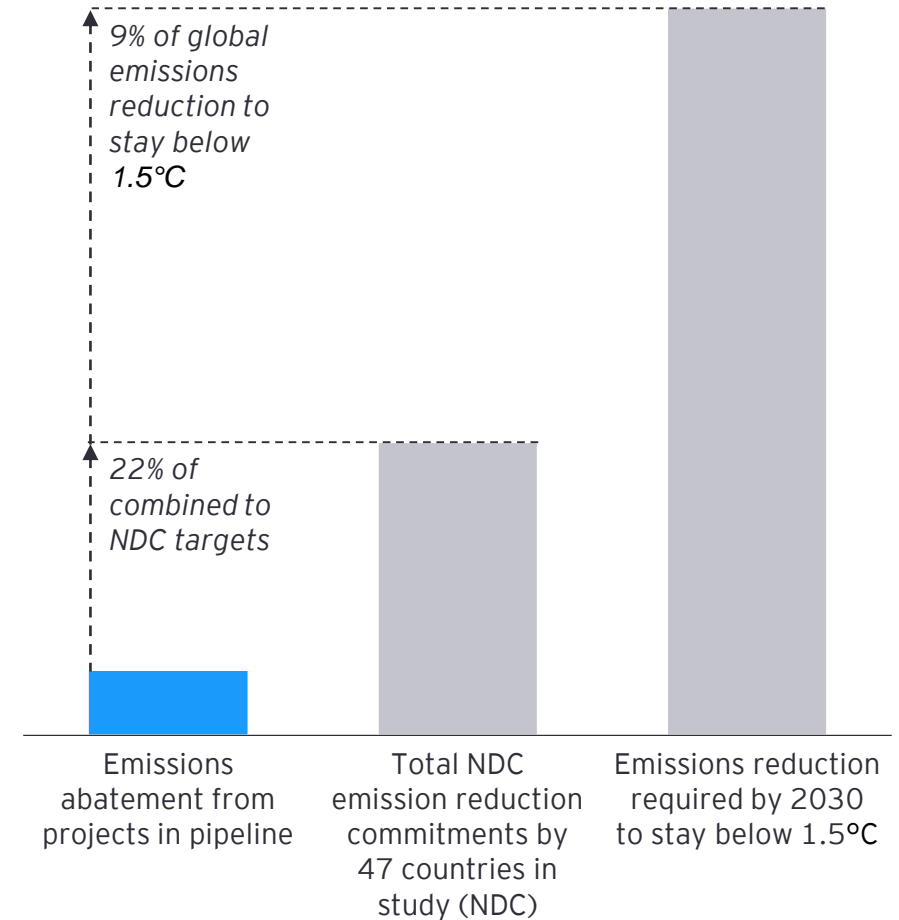


The visible project pipeline alone is enough for countries to meet 9% of required 1.5°C target

People
Planet
Prosperity

- ▶ The visible project pipeline will close 22% of the UNFCCC NDC emissions reduction target for 2030 for the 47 countries covered in this report.
- ▶ Further, the visible project pipeline could also help close 9% of the global emissions reduction target for 2030 set out by IPCC to limit global warming below 1.5°C.
- ▶ This highlights both the opportunity presented by the visible project pipeline, and scale of additional action required to meet IPCC's global targets.
- ▶ It should be noted that countries are expected to significantly revise their initial NDC targets in order to be more ambitious, meaning the visible project pipeline may contribute a smaller proportion of the total NDC reduction target in the future. The power sector will continue to play a key role in achieving such targets however.

Contribution of visible project pipeline to NDC reduction target (MtCO₂e)¹

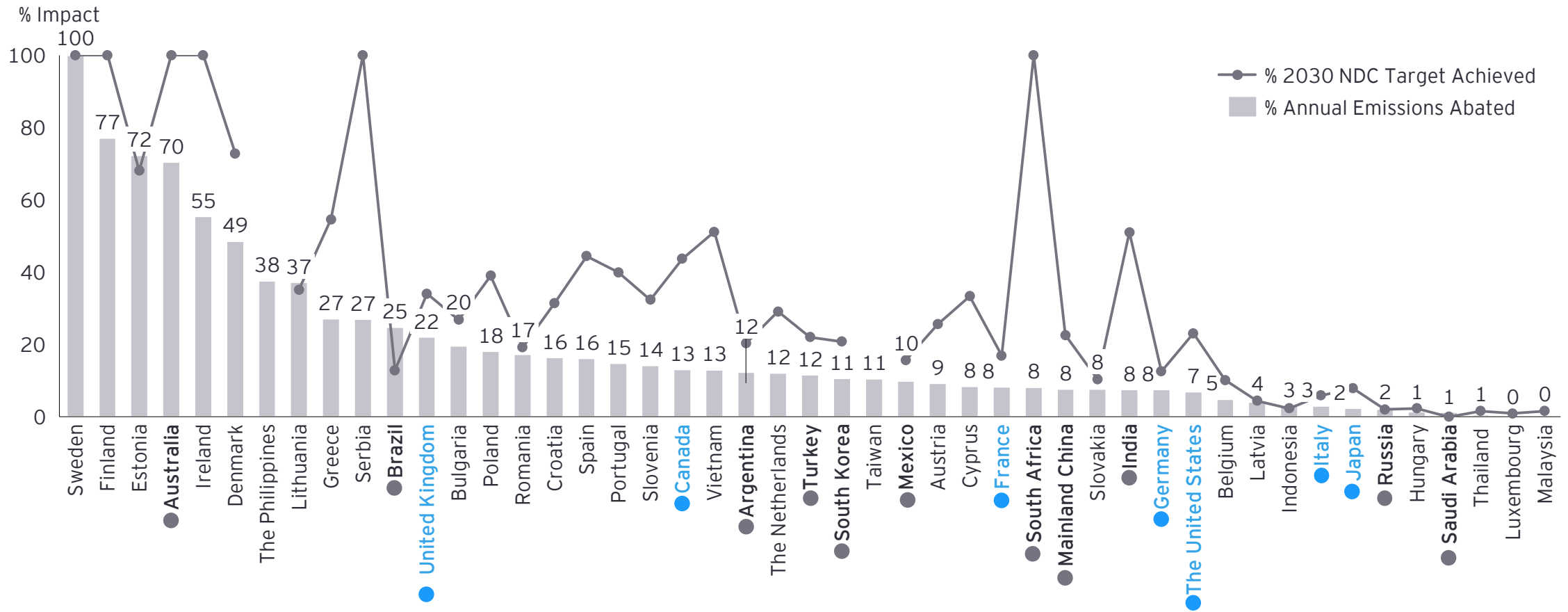


1. Total emissions reduction required by 2030 in NDCs for 47 countries covered in this report
Source: UNFCCC, IPCC, WRI, EY-Parthenon analysis

The visible project pipeline will support a substantial reduction in annual emissions



Potential impact of visible project pipeline on 2030 NDC targets and total annual emissions abated

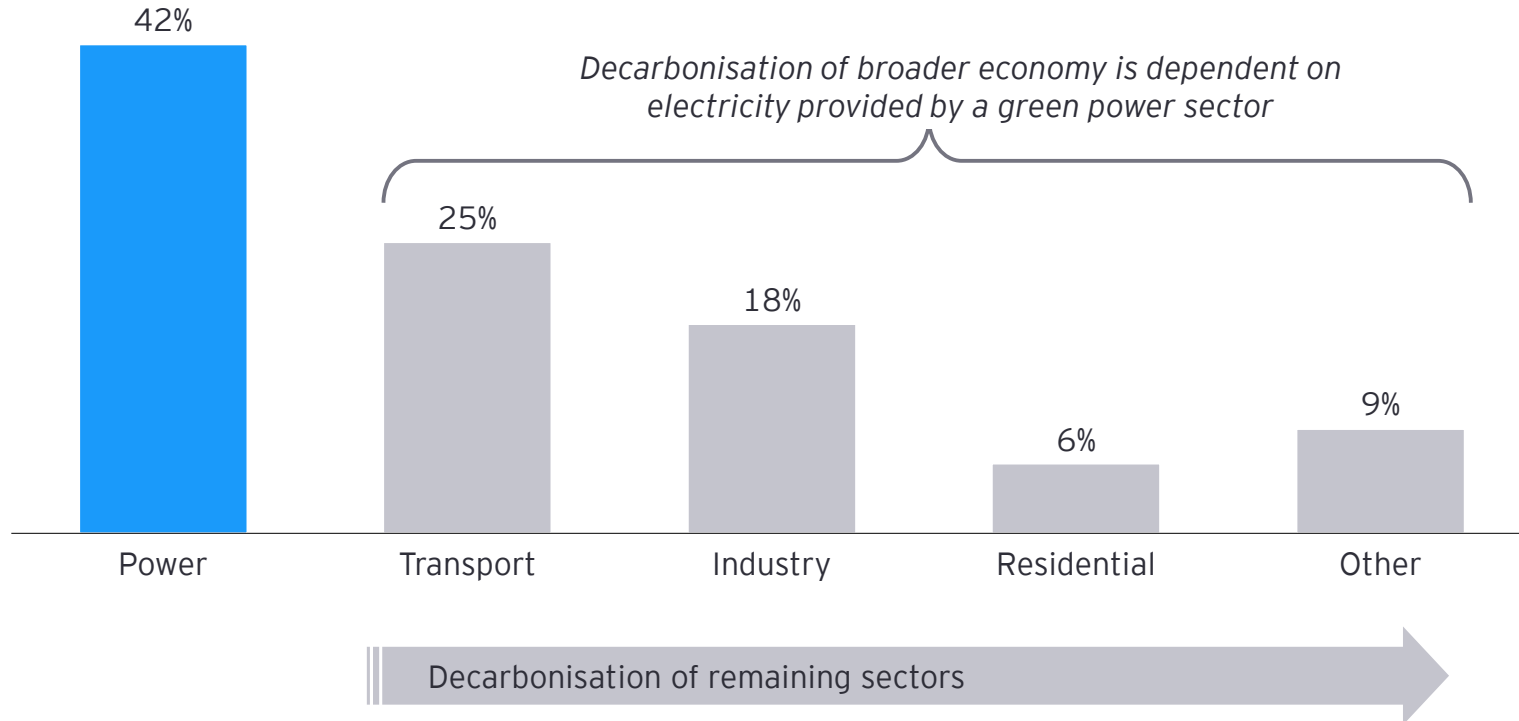


● G7 members ● G20 members

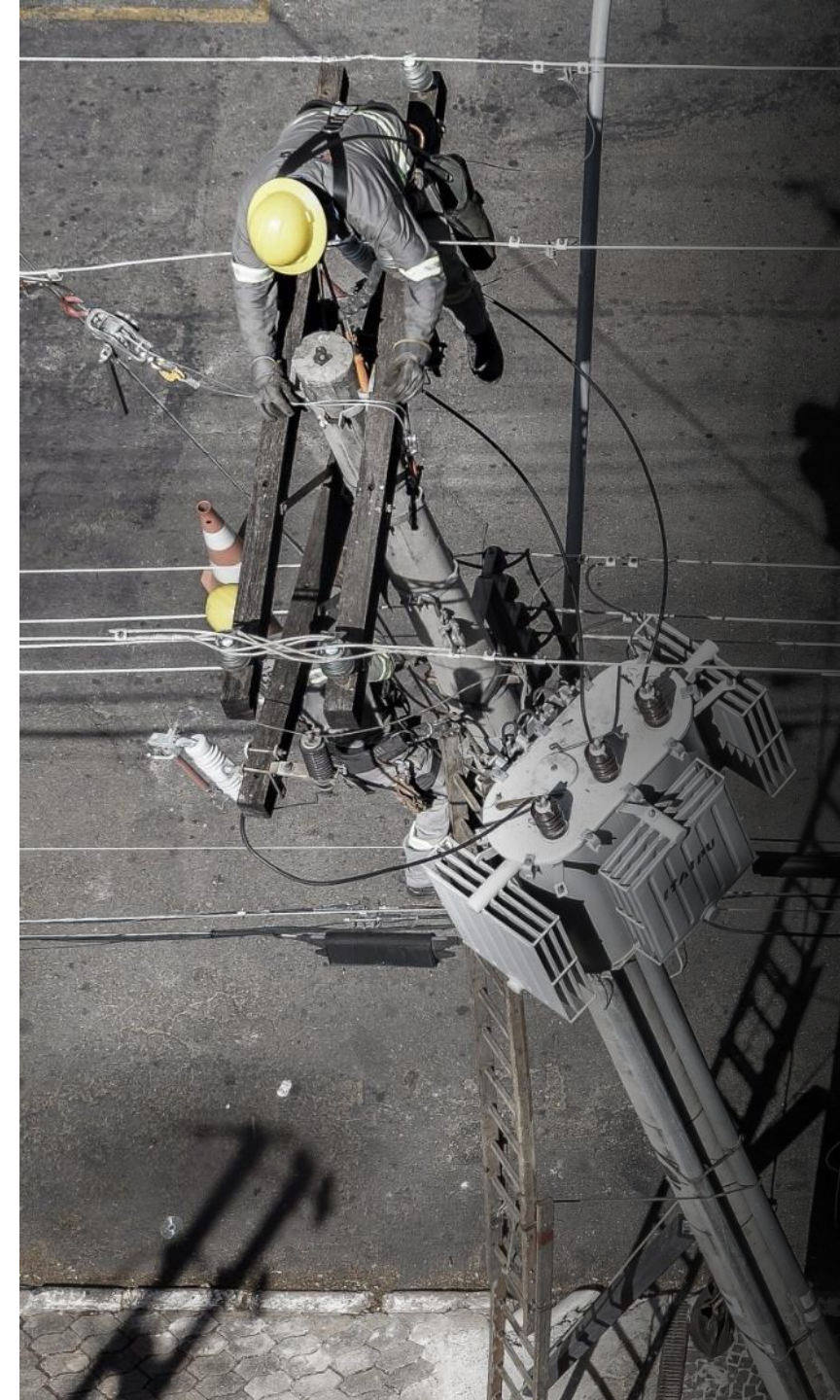
A rapid transition to renewable power enables decarbonisation of the broader economy

People
Planet
Prosperity

Share of global emissions, by sector




- ▶ Accelerated deployment of renewable energy will not only decarbonise the power sector, but have a knock on impact on broader sectors, such as transport and industry, which can take advantage of green electrification in tandem
- ▶ This firmly places large scale investment in renewable energy as a 'no-regrets' policy option



A green recovery is a unique opportunity to realise transformative infrastructure projects

People
Planet
Prosperity

The interconnection projects highlighted below are examples of transformative infrastructure projects for the renewable energy sector in their respective regions. As well as creating significant transmission capacity, they add resilience to national grids and can further accelerate renewable energy investments globally



Greenlink Interconnector
Length: 172 km
Cost: US\$0.5 billions
Capacity: 320 kV

Construction of a HVDC underwater subsea transmission link between Ireland and the UK, connecting the electricity networks of both countries, and subsequently improving energy security and energy cost competitiveness

Construction of a HVDC interconnector between the power grids of Cyprus, Greece and Israel, and an integral part of the Electricity Highway Interconnector Project connecting the European and Asian energy markets whilst supporting Cyprus in ending its electricity isolation




EuroAsia Interconnector
Length: 1,208 km
Cost: US\$3.0 billions
Capacity: 500 kV



Trans-Balkan Corridor Interconnector
Length: 321 km
Cost: US\$0.2 billions
Capacity: 400 kV

Cross-border interconnection to support the electricity markets of Serbia, Romania, Bosnia and Herzegovina, Montenegro and Italy, enhancing cross-border connectivity and enabling greater energy security across Southern and Eastern Europe

Line strengthening activity providing a major upgrade to existing T&D infrastructure in the region, whilst improving grid resilience and connectivity which could have an enabling effect in accelerating renewables investment in South Africa and the wider region



Empangeni Interconnector
Length: 150 km
Cost: -
Capacity: 400 kV

Prosperity:

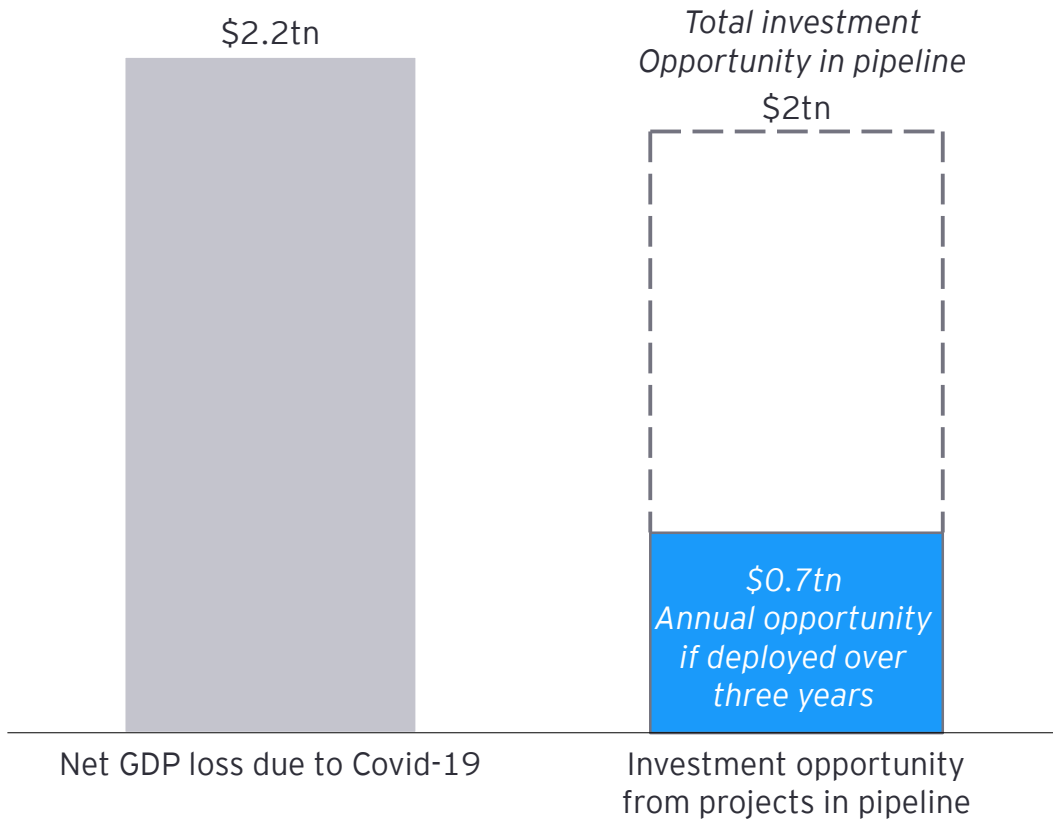
\$1.9tn of
investment
opportunities in
renewable energy



The visible renewable energy project pipeline can generate a substantial impact on economic growth

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Prosperity

Contribution of pipeline to economic recovery (\$b)

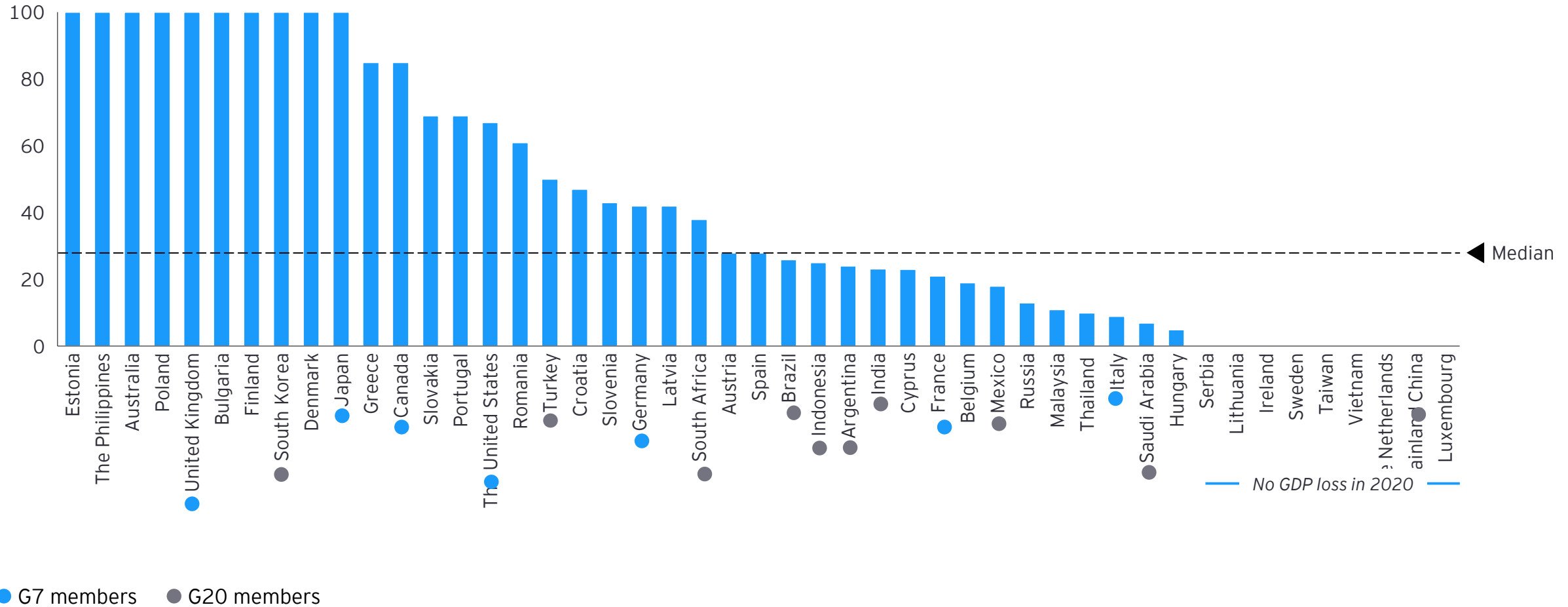


- ▶ GDP across the 47 countries declined by over \$2.2tn in 2020, largely due to the economic impact of Covid-19
- ▶ The pipeline of shovel-ready projects could provide an injection of more than \$1.9tn into the global economy over a three year period, which accounts for ~85% of the GDP lost in 2020
- ▶ Through deploying the pipeline, we estimate a permanent recurring GDP contribution of £60bn resulting from operation of the assets

The median size of the investment pipeline is equivalent to 28% of that economy's 2020 GDP loss due to COVID-19

People
Planet
Prosperity

Size of investment opportunity in pipeline as % of 2020 COVID-19 GDP loss



A wide-angle photograph of a solar farm in a desert. Rows of solar panels are mounted on metal frames, stretching into the distance. The ground is sandy and dry. In the foreground, a worker in a grey jumpsuit and a red hard hat is walking, holding a cable. Other workers in orange jumpsuits are visible further down the rows. The sky is clear and blue, and mountains are visible in the far background.

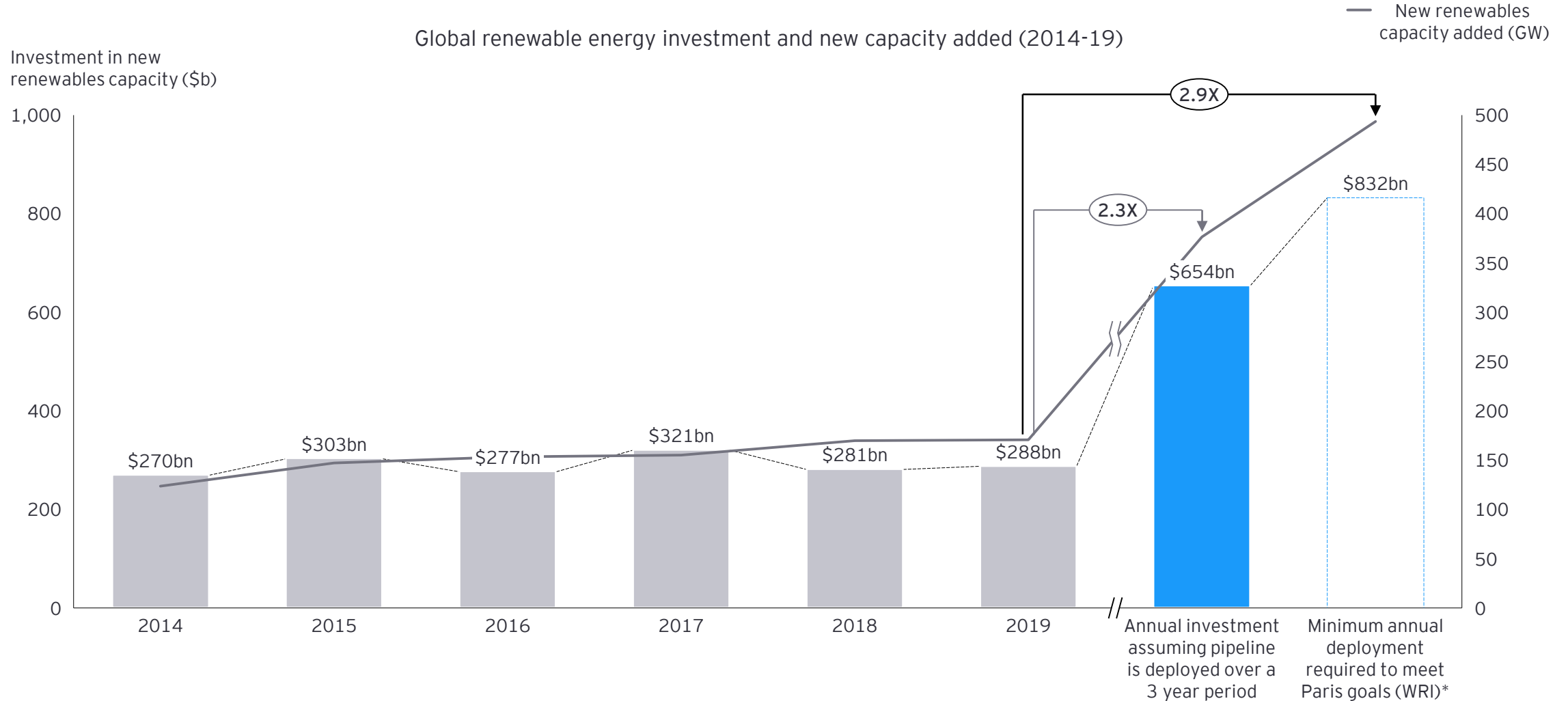
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The green recovery is a once-in-a-generation opportunity to accelerate global deployment of renewable energy at the scale necessary to meet Paris goals

Realising the pipeline in three years or less will significantly accelerate renewables deployment, closing much of the gap to meet Paris goals

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Prosperity

Global renewable energy investment and new capacity added (2014-19)

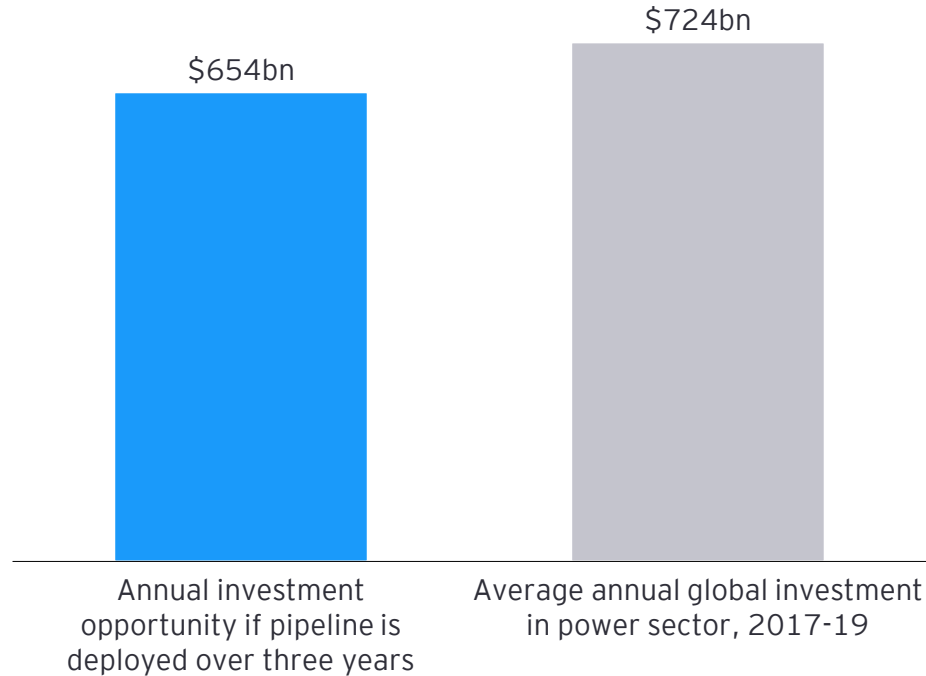


Note: *Assumes a that acceleration in the pace of deployment of renewables corresponds to WRI's estimate for acceleration in renewable share of power generation
 Source: IRENA, EY-Parthenon analysis, World Resources Institute

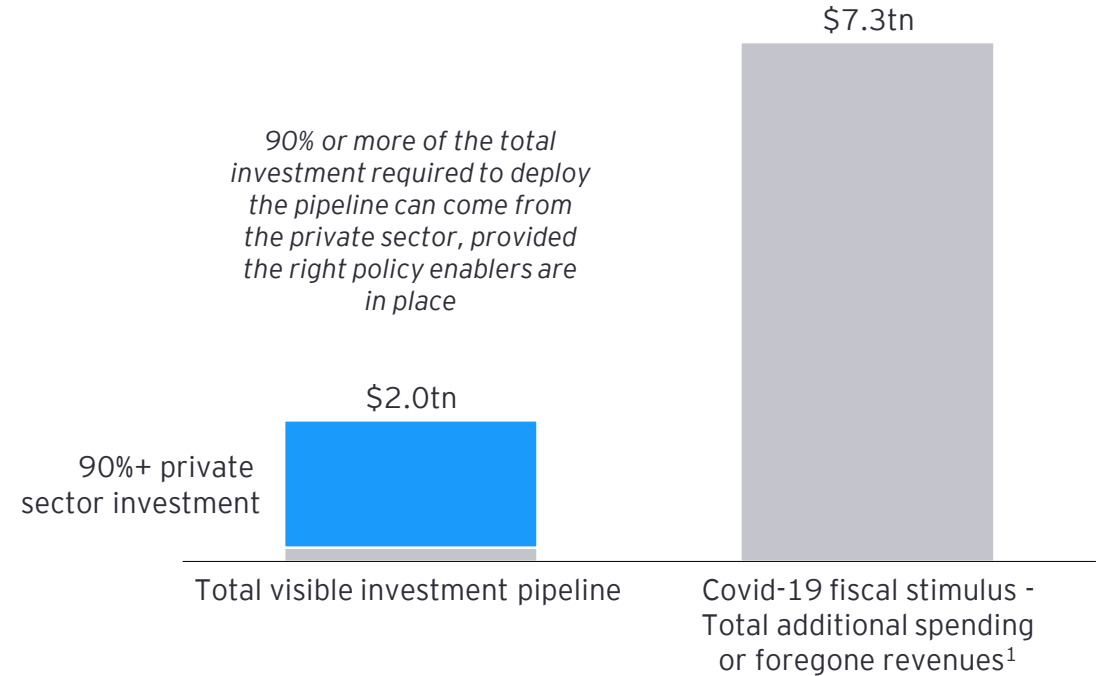
The investment required to realise the visible pipeline of projects is realistic when compared to other investments

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Visible project pipeline investment requirements vs. benchmarked global investment in power sector



Visible project pipeline investment requirements vs. Covid-19 fiscal stimulus



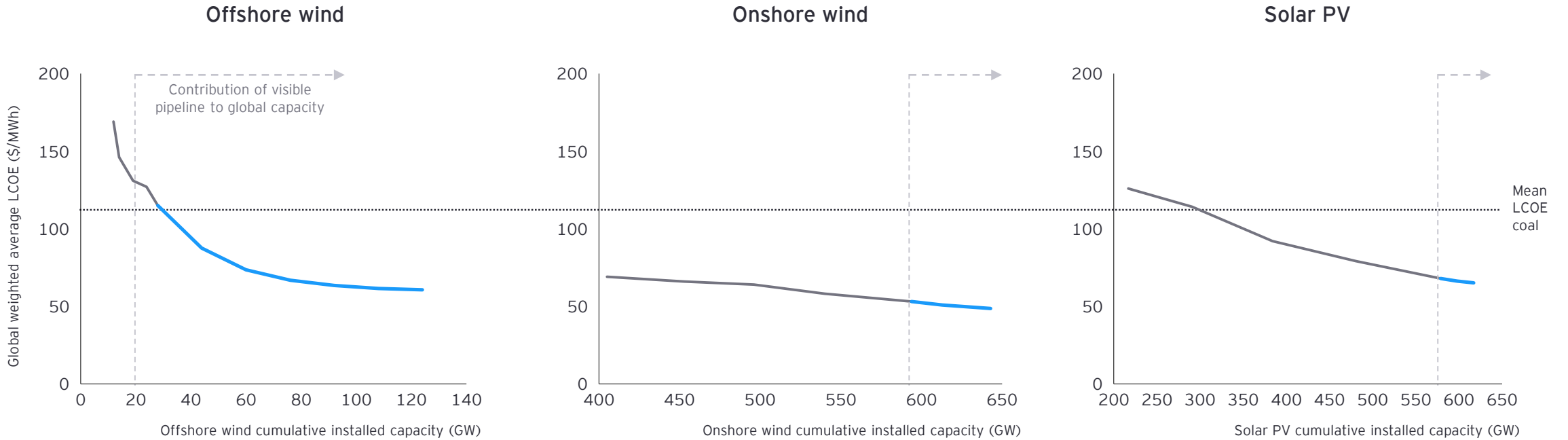
- ▶ Although substantial, the level of investment required to activate the visible project pipeline over a three year period remains lower than the average global investment going into the power sector, and a fraction of publicly funded Covid-19 fiscal stimulus
- ▶ This demonstrates that the scale of investment of the visible project pipeline is realistic and achievable

1. Total COVID-19 response above-the-line fiscal stimulus for 47 countries covered in this report
Source: IEA, IMF

A green recovery will further reduce the cost of renewable energy, in particular offshore wind

People
Planet
Prosperity

Incremental learning curve effect of deploying projects in visible pipeline



-47%

reduction in LCOE by
deploying visible pipeline

-8%

reduction in LCOE by
deploying visible pipeline

-4%

reduction in LCOE by
deploying visible pipeline



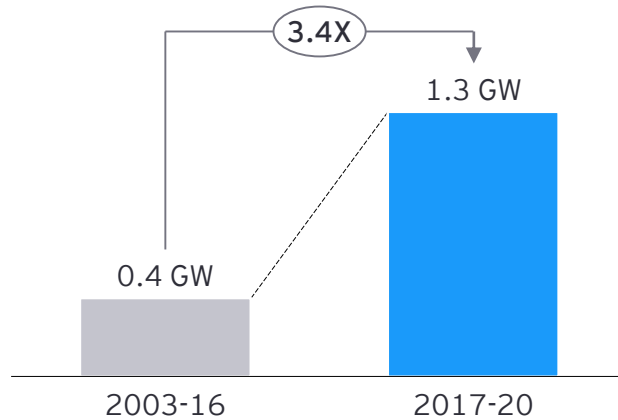
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Rapid step-changes in the pace of renewables deployment are possible, even beyond the scale of the opportunity in the visible pipeline

Several countries have demonstrated that breakthrough acceleration of renewables deployment is possible given the right policies

Case study: UK doubles offshore wind capacity in 3 years

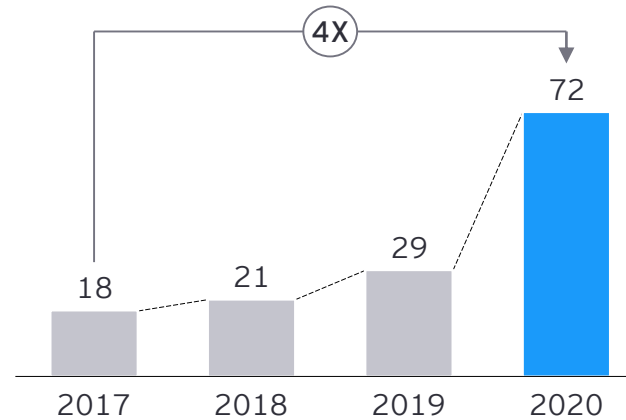
Average new offshore wind power capacity added per annum (GW)



- ▶ The UK's Contracts for Difference (CfD) scheme has been the key driver behind the recent, rapid adoption of offshore wind in the UK and has led to capacity doubling in the last three years
- ▶ The first two CfD rounds saw 1.2 GW and 3.2 GW worth of projects awarded contracts, with a further 5.4 GW of offshore wind projects awarded contracts in the third action round in 2019

Case study: China installs 72GW of wind capacity in 2020

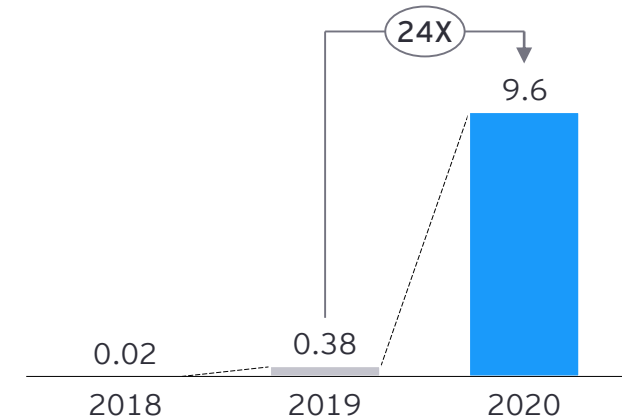
New wind power capacity added (GW)



- ▶ China's target of becoming carbon-neutral by 2060 has driven a surge in wind installations and associated enabling policy
- ▶ In 2020, China surpassed its renewable energy installations record set in 2019 with an addition of almost 72 GW of wind power
- ▶ In December 2020 alone, 48 GW of installed capacity was deployed in China

Case study: Vietnam installs 9GW of rooftop solar in 2020

Cumulative rooftop solar PV capacity (GW)

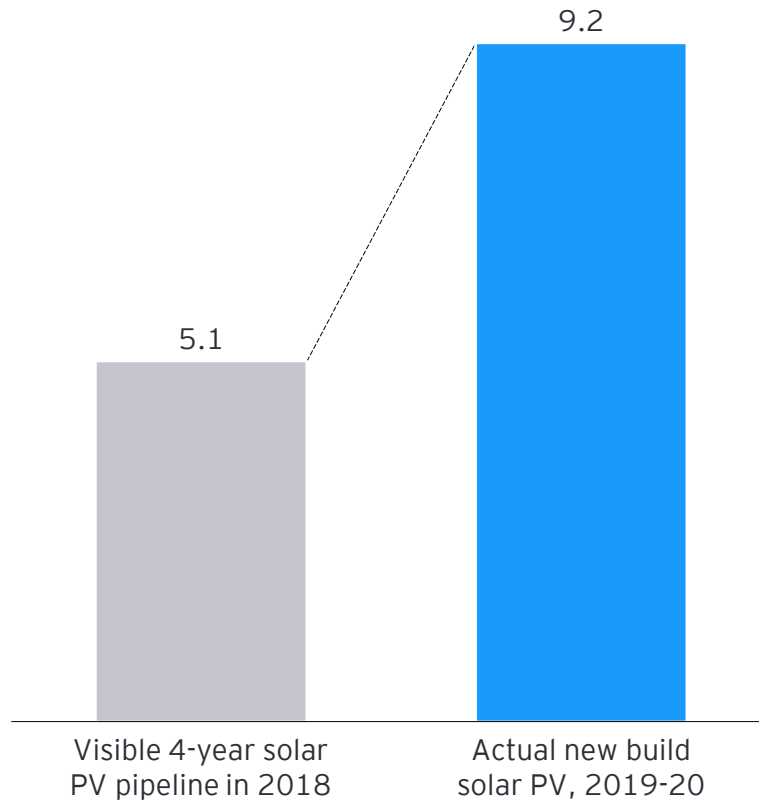


- ▶ Installations in rooftop Solar PV capacity in Vietnam have increased by 2,435% since the beginning of 2019, driven largely by a feed-in-tariff scheme
- ▶ The successful feed-in-tariff scheme concluded at the end of December 2020, which led to an increase of installed solar rooftop capacity by 6.7 GW in that month alone

Vietnam shows how deployment of off-grid and behind-the-meter projects can greatly exceed the visible pipeline

Case study: Vietnam

Comparison of visible 4-year solar PV Pipeline in 2018 vs. actual growth in solar PV from 2019-2020, GW capacity

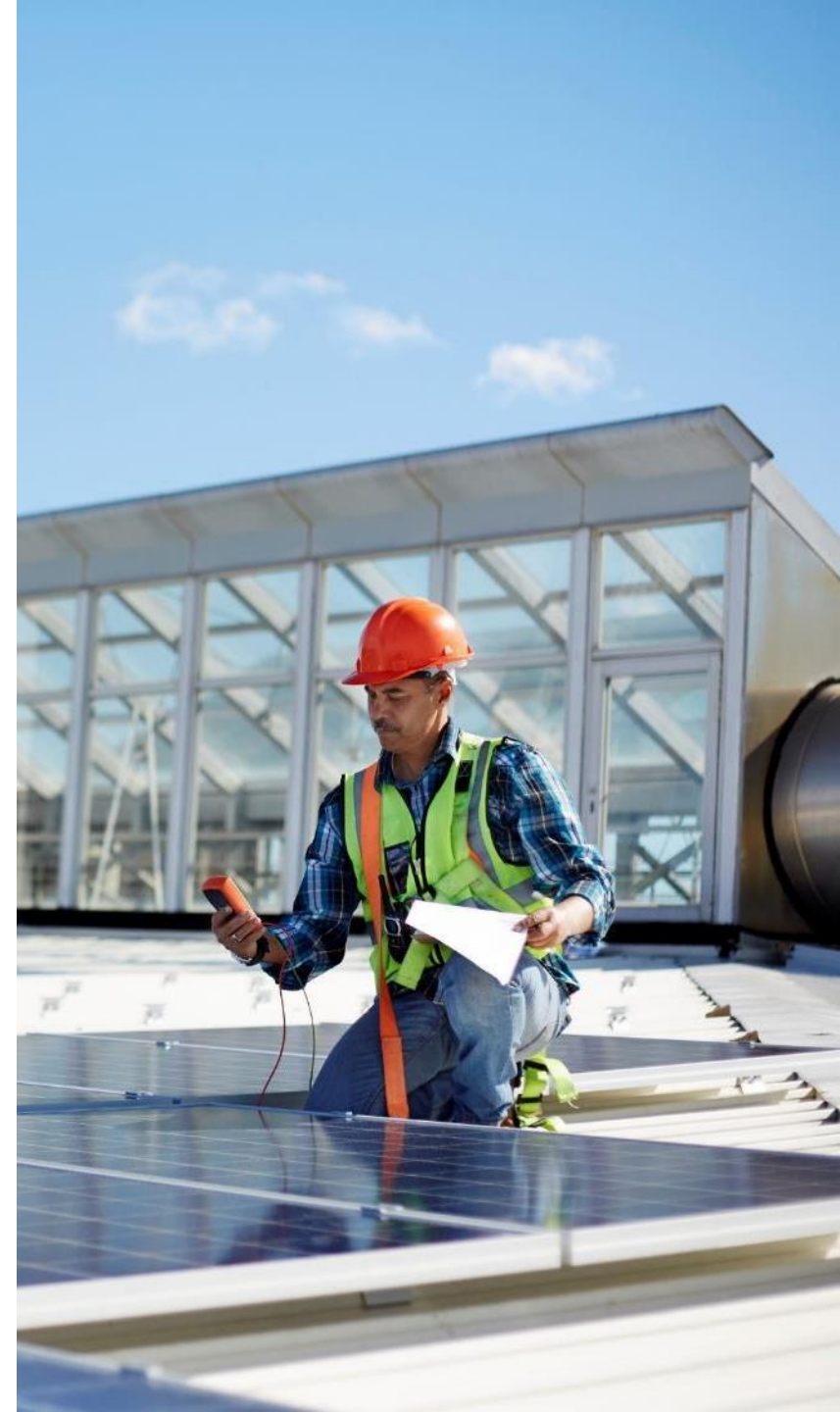


- ▶ The upside of 'shovel-ready' projects is potentially larger than what we have established in this report
- ▶ In particular, growth of installed capacity at a micro level, e.g. through off-grid and behind-the-meter commercial & industrial, has the potential to drive energy transition on a national basis
- ▶ In the case of Vietnam, the rooftop solar capacity installed from 2019-2020 exceeded the visible 4-year solar PV pipeline in 2018 by almost double

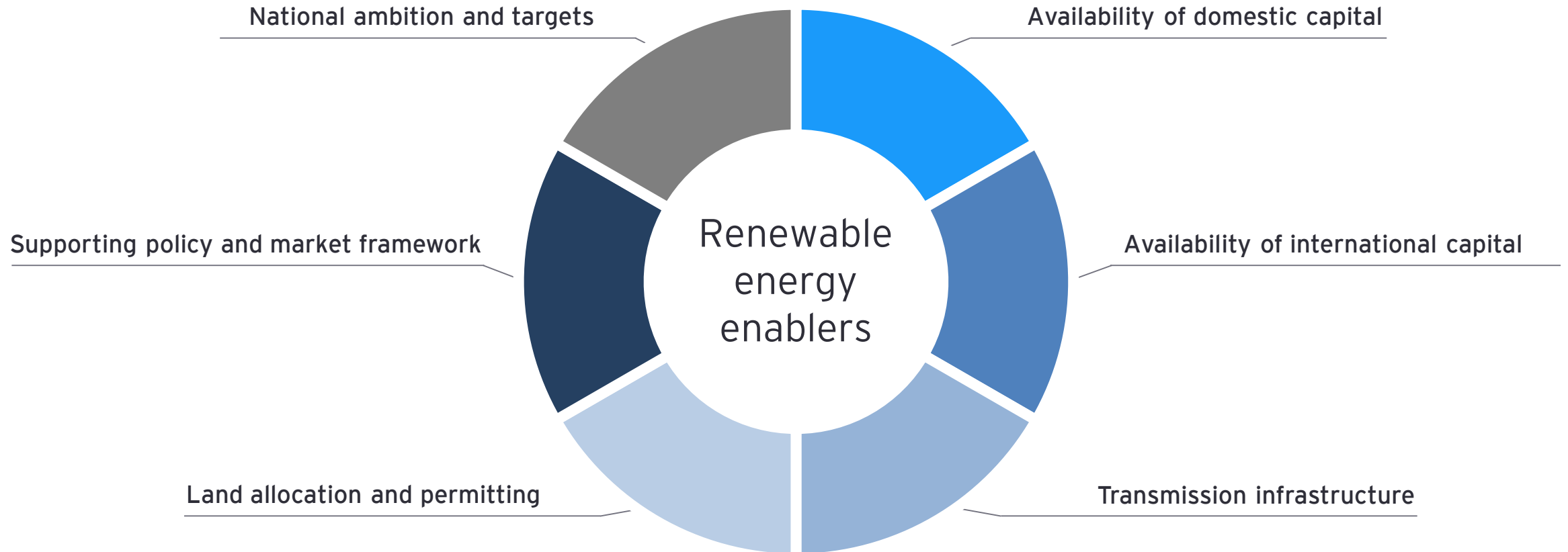


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There are six key enablers which support activation of a green recovery globally





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With the right enablers in place, the potential in the pipeline can be unlocked rapidly

Governments can use the policy enablers to accelerate renewables deployment and unlock private sector investment

Enabler 1 - National ambition and targets

- ▶ Clearly defined, challenging national targets with clear accountability
- ▶ Specific targets set for different types of renewable energy technology (e.g. onshore wind, offshore wind) to provide direction
- ▶ Renewables placed at the forefront of a country's energy strategy, helping to drive the agenda on a national and international scale
- ▶ Policy that is co-ordinated with national targets/ambition to help provide clarity on the national renewables agenda and improve investor confidence (e.g. clear offshore wind agenda over the next 10 years)

Enabler 2 - Supporting policy and market framework

- ▶ A regulatory environment that minimises uncertainty for developers and investors, and supports the lowering of renewable energy costs (e.g. renewable energy auctions that provide transparency around the competitive selection process)
- ▶ Policy that is supportive to the renewable energy supply/value chain as a whole rather than just to direct activity (e.g. talent pipeline, or port infrastructure)
- ▶ Clear relationship established between Government and industry to drive the development of supportive policy and market framework (e.g. via sector deals)

Enabler 3 - Availability of domestic capital

- ▶ Highly supportive domestic financial institutions, providing access to funding either directly or via loans from multi/bilateral organisations (with low interest rates)
- ▶ Capital made available for developers of all sizes and not just state-owned/well-established organisations

Enabler 4 - Availability of international capital

- ▶ Highly supportive international financial institutions, providing access to funding either directly or via loans from multi/bilateral organisations (with low interest rates)
- ▶ Capital made available for developers of all sizes and not just state-owned/well-established organisations

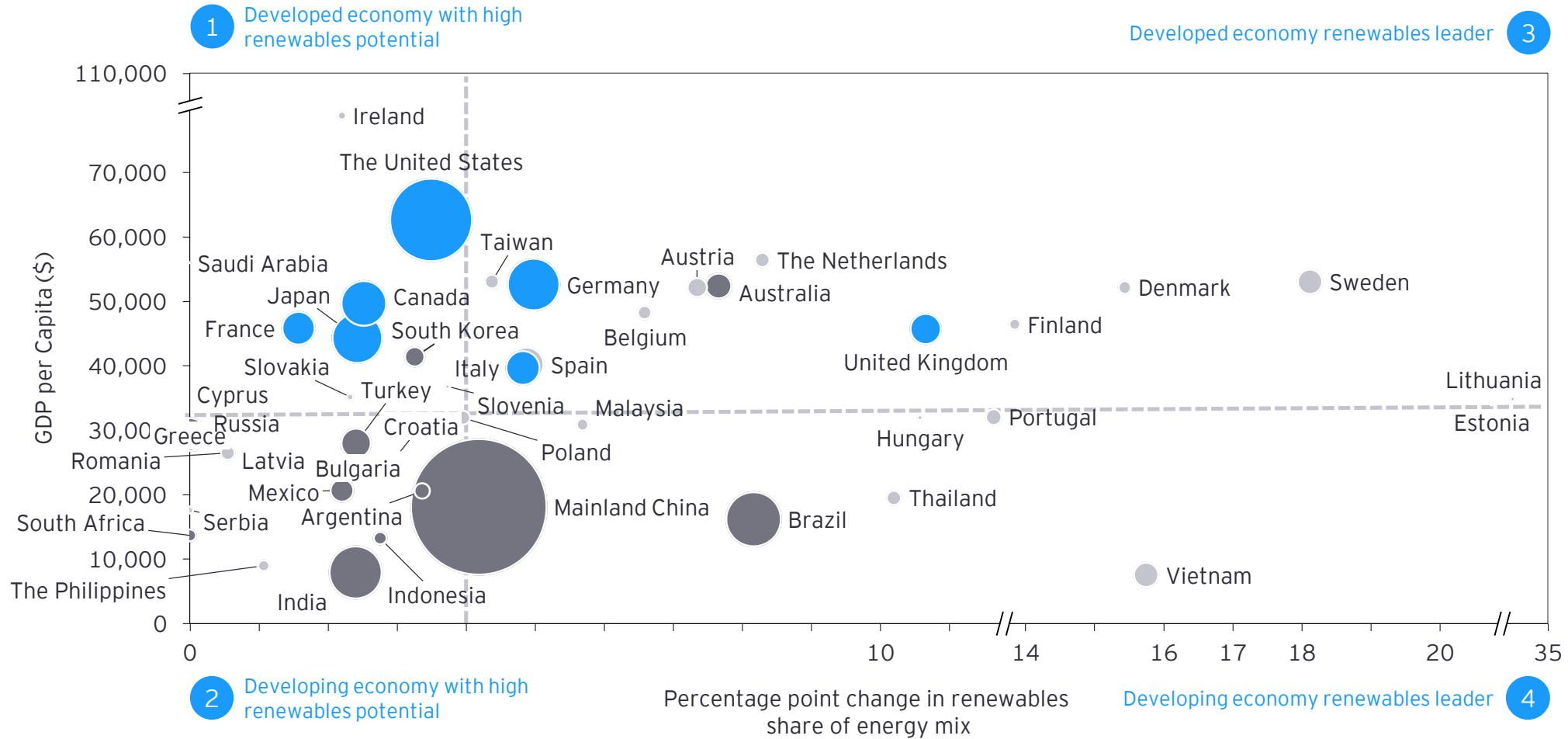
Enabler 5 - Land allocation and permitting

- ▶ A simple process for identifying land both suitable and available for the use of renewable energy, while still ensuring environmental restrictions and land ownership issues are adhered to
- ▶ Availability of land which is low cost, and holds little complexity around usage rights (e.g. a single owner)
- ▶ Availability of plots in proximity to grid connection points that are feasible from a planning, technical and economic perspective
- ▶ A simple permit application process which minimises bureaucracy, lead times and the overall development cost

Enabler 6 - Transmission infrastructure

- ▶ Expansive country (and cross-border) interconnection which is highly supportive of a country's power supply-demand balance
- ▶ Infrastructure incorporated into policy and planning activity to ensure readiness to support an increasing reliance on renewable energy technologies (often in new locations)
- ▶ Liberalised regulation that enables private providers to connect into grid and expand the network

The most important policy levers to focus on differs across jurisdictions, depending upon national circumstance, renewable energy market maturity and financial resources



Despite significant national differences, many economies share similar characteristics which require specific enablers to be activated

Key characteristics and most important policy enablers across archetypes

Archetype	Characteristics	Most important enablers for policy to focus on					
		National Ambition and Targets	Supporting Policy and Market Framework	Land Allocation and Permitting	Transmission Infrastructure	Availability of International Capital	Availability of Domestic Capital
1 Developed economy with high renewables potential	<ul style="list-style-type: none"> Minimal/unambitious targets set Restrictive regulatory environment and/or policy deterring investment and uptake 	✓	✓				✓
2 Developing economy with high renewables potential	<ul style="list-style-type: none"> Minimal/unambitious targets set Restrictive regulatory environment and/or policy deterring investment and uptake Limited capital made available from financial institutions to support growth 	✓	✓			✓	
3 Developed economy renewables leader	<ul style="list-style-type: none"> New phase of renewables land allocation required to enhance capacity, to be supported by connection to grid which may require infrastructural improvements if in an underdeveloped region 		✓	✓		✓	
4 Developing economy renewables leader	<ul style="list-style-type: none"> Infrastructural improvements required to further support increased capacity and enable decarbonisation activity of other sectors (e.g. heating, transport) 				✓	✓	✓

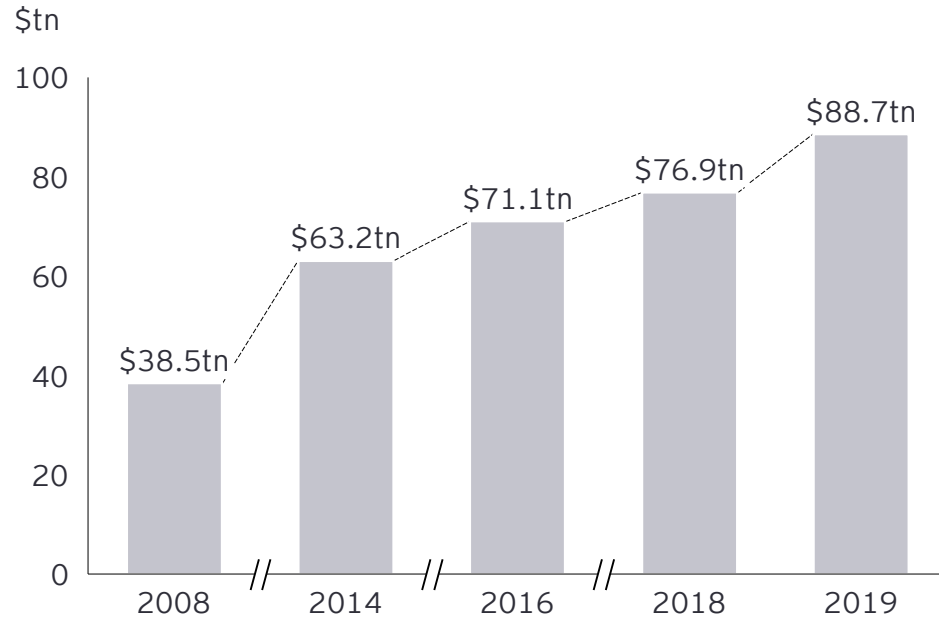


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Given the right policy, 90% or more of the investment required to deploy the visible pipeline can come from the private sector

Private sector capital for renewable energy investments is abundant, cheap, and available to multiply government recovery spending, provided key enablers are in place

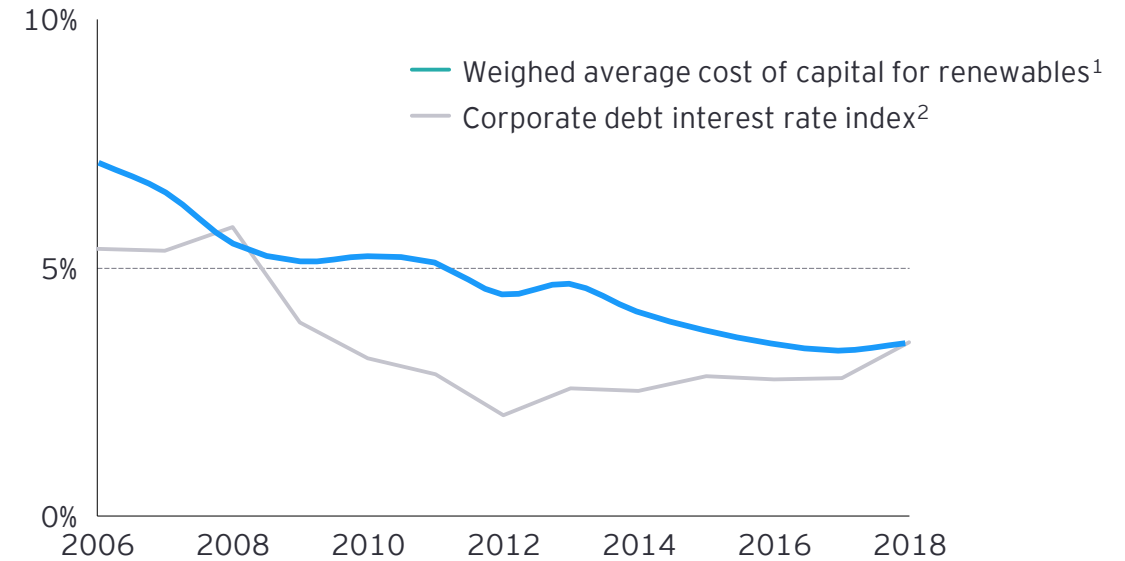
Global assets under management (\$tn)



The annual investment impact of the visible pipeline identified totals 0.7% of global assets under management (AUM) in 2019, 5% of the AUM growth between 2018-19

- ▶ Globally, capital is abundant, with total global AUM growing by 8% on average since 2008
- ▶ Policy makers are well placed to attract significant inflows of capital by creating an enabling market framework for renewables

Global cost of capital for renewables (%)



- ▶ The weighted average cost of capital for renewables projects has experienced a steady decline over time - implying the financing of renewables has become more attractive
- ▶ A global shift towards ESG investing is poised to further increase the attractiveness of renewables investment for investment managers

1. Based on IEA sample of global top 25 listed power companies, by ownership of solar and wind capacity

2. Effective yield of investment grade AA corporate debt issued in the US

Source: IEA, BCG, Bank of America, EY-Parthenon analysis

The right policy frameworks can unlock ~10-100x of government spending on renewables in private investment



Case study: UK

95x

Private sector investment to government spending

£50bn

Private sector investment since 2015, for projects allocated a CfD in auction rounds 1-3

~£540m

Government budget for CfD rounds 1-3

- ▶ The Contracts for Difference (CfD) scheme is the UK's cornerstone mechanism for supporting private-led investment into renewable capacity
- ▶ It was introduced in 2015, and has ran three auction rounds to date, supporting 35 projects with a total capacity of 12GW
- ▶ With a budget of provisions of £540m for the first three rounds the CfD scheme, the UK government has been able to promote \$50b in investment, particularly into offshore wind



Case study: Argentina

9x

Private sector investment to government spending

\$7bn

Private sector investment since 2016

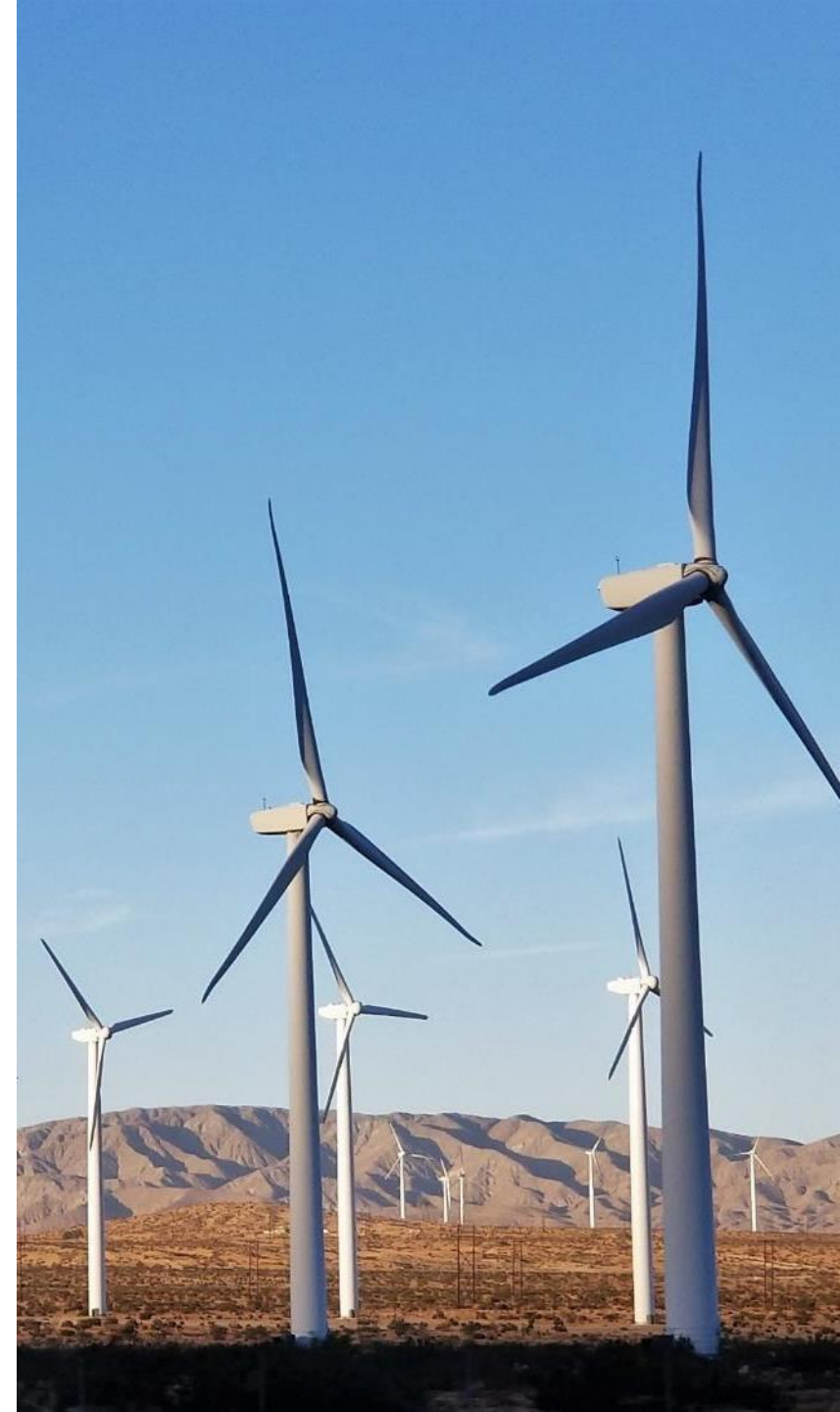
\$0.8bn

Estimated fiscal (government) cost of the RenovAr programme

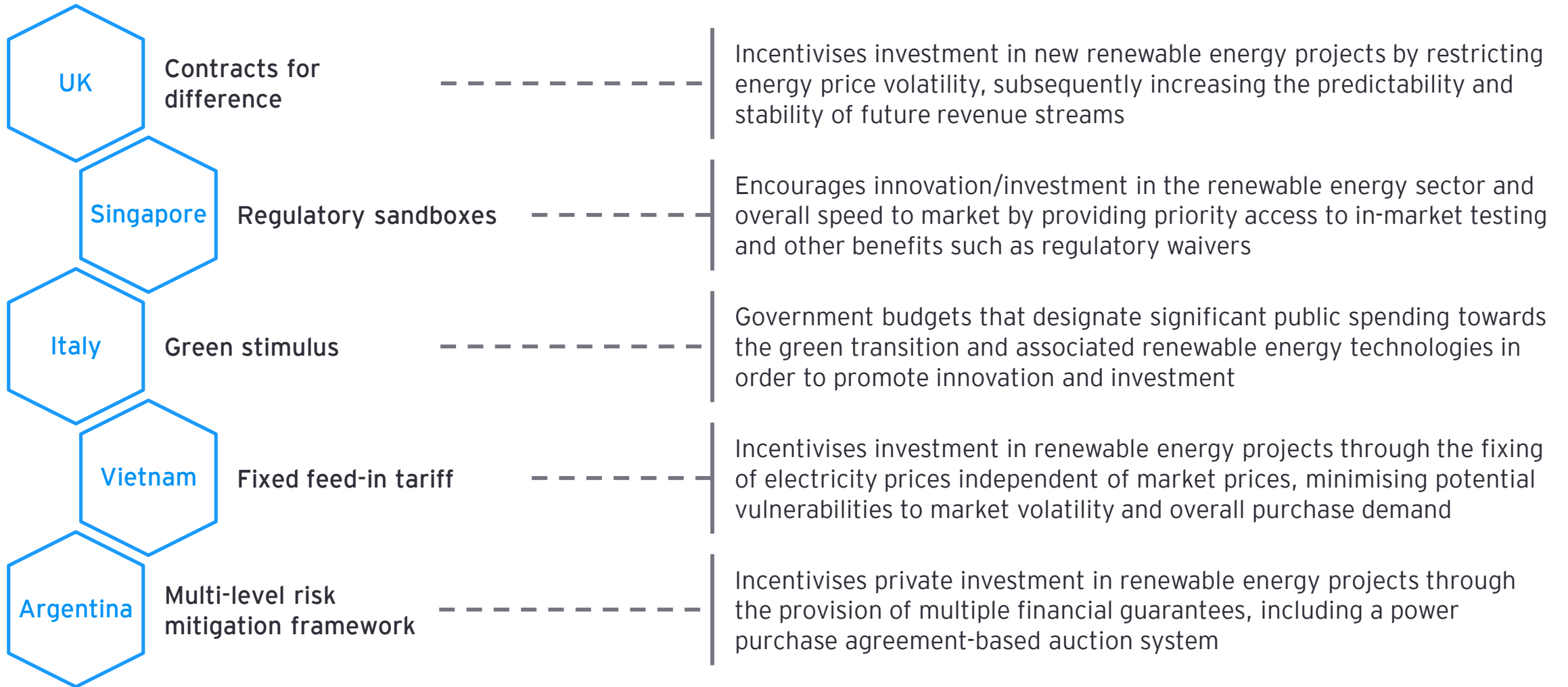
- ▶ RenovAr is a programme implemented by the Argentine government, starting in 2016 to promote private investment in renewable energy generation
- ▶ Since 2016, RenovAr has enabled investments for \$7b in 5 GW of new-build capacity in 158 projects
- ▶ The enabling market framework created has allowed Argentina to cut its energy subsidies by almost two-thirds since 2015 from \$9b to \$3bn

Agenda

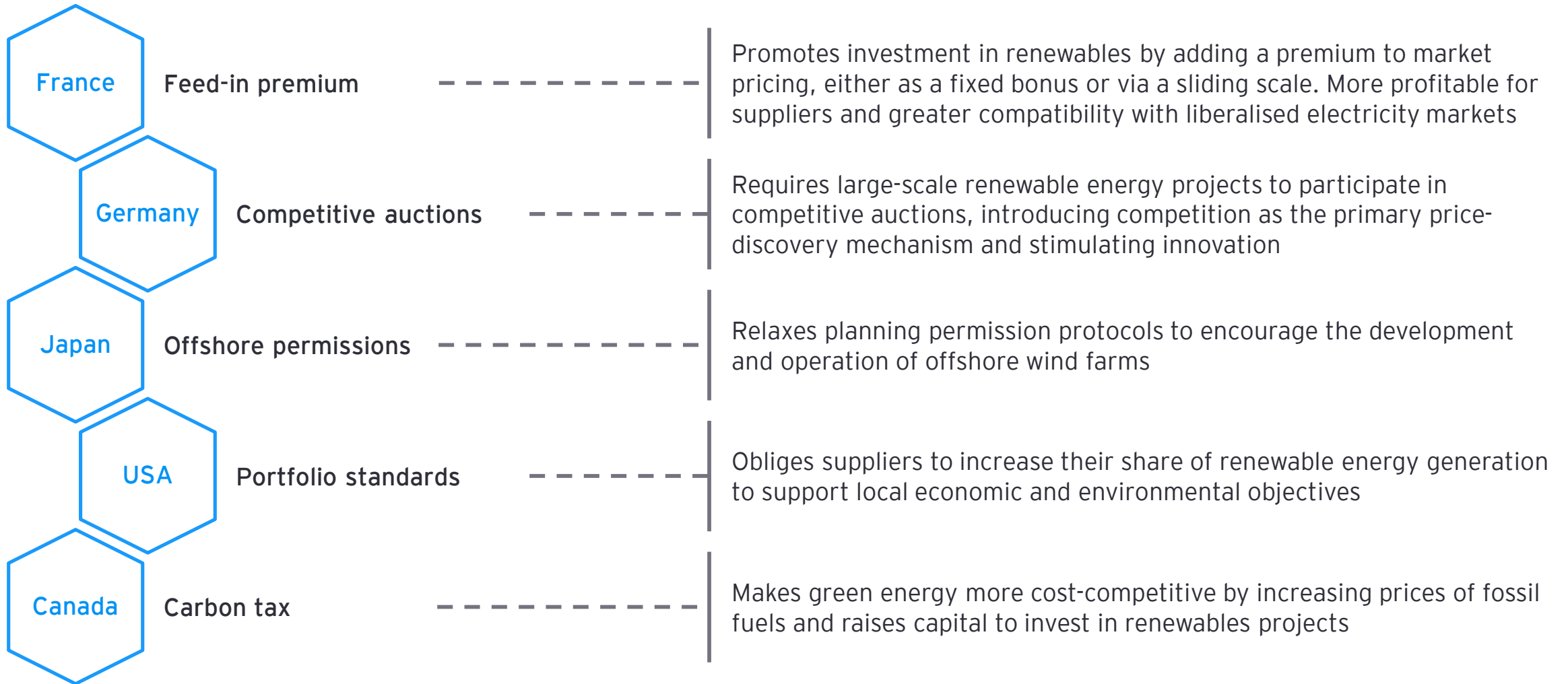
- ▶ Executive summary
- ▶ People, Planet and Prosperity outcomes
- ▶ How to accelerate and enable these benefits
- ▶ Renewable energy policy success stories
- ▶ Appendix



There are a number of examples of policies which have successfully been used to increase the pace of renewable energy investment (1/2)



There are a number of examples of policies which have successfully been used to increase the pace of renewable energy investment (2/2)





Case study 1: Contracts for Difference in the UK

Overview

- ▶ The Contracts for Difference (CfD) scheme is the UK government's main mechanism for supporting renewable energy power generation
- ▶ The scheme was launched in 2014, and to date three allocation rounds have been completed, with a fourth planned for 2021
- ▶ The purpose of the scheme is primarily to incentivise investments in new renewable energy power generation by providing an element of predictability and stability to future revenue streams
- ▶ A CfD is a long-term contract between an electricity generator (CfD generator) and a Low Carbon Contracts Company (LCCC). The contract enables the generator to stabilise its revenues at a pre-agreed level (also known as the Strike Price) for the duration of the contract
- ▶ The CfD system issues 15-year contracts at a given strike price. If the wholesale power price drops below that rate, payments are made by LCCC to the CfD Generator to make up the difference. If the wholesale price is above the strike price, the CfD generator pays the difference back to the LCCC

Notable projects supported

- ▶ The 714 MW East Anglia 1 (EA1) offshore wind farm, developed by Scottish Power Renewables, was the largest plant allocated under the first competitive auction process round of CfD in 2014
- ▶ By mid-2020, the offshore wind farm passed the milestone of operational conditions, the contractual milestone which signifies the project has satisfied the eligibility criteria required for it to start generating electricity and receiving support under the CfD

Potential for replication

- ▶ The CfD scheme does require some administrative changes at the government level in order to be replicated
- ▶ However, further to the UK, countries such as Poland and Italy have successfully implemented the scheme:
 - In 2019, the Polish government approved a new draft amendment to the RES Act that allowed development of the onshore wind farms or Solar PVs under CfD rules
 - In 2020, Italy awarded a 20 year CfD contract to EDP Renewables for wind-based technologies



Overview

- ▶ Singapore's Energy Market Authority (EMA) launched a framework known as the 'Regulatory Sandbox' in 2017 with the primary objective of supporting innovation within the energy sector
- ▶ The sandbox encourages firms to test innovative energy solutions in the market, within a specific space, for a limited duration and with a limited number of customers or transactions
- ▶ Firms submit ideas to the EMA, and if successful, are invited to apply their ideas in the market, whilst being subject to relaxed regulatory requirements (via regulatory waivers). At the same time, safeguards are introduced to minimise risks
- ▶ New energy solutions can include new technologies which may create value for electricity consumers, or to improve technologies which already exist in the market
- ▶ Further to supporting innovation and the growth of new technologies, the sandbox framework also enables the EMA to better adjust its regulatory frameworks in order to keep pace with such advances in technology

Notable projects supported

- ▶ SP Group is conducting an experiment for a compact waste gasification plant. This includes the creation of an enclosed system that will turn food waste, plastic and general waste into thermal energy. This will subsequently help to reduce the country's reliance on the Pulau Semakau landfill site, which is expected to be at capacity by 2035
- ▶ Alpha Biofuels Pte Ltd is conducting experiment for used cooking oil collection, through reverse logistics and shared resources. The trial includes the creation of a digital platform for logistics companies to efficiently collect used cooking oil from food & beverage outlets for the purposes of recycling

Potential for replication

- ▶ Regulatory sandboxes are a relatively new framework in the energy market, however have already been adopted by governments beyond Singapore, including the UK, Austria and Germany
- ▶ The framework is replicable as it often does not involve the provision of funding to participating entrepreneurs, and is more focused on providing access to the market from a testing and regulatory standpoint
- ▶ Countries looking to adopt the policy can do so inexpensively, whilst creating safeguards such as limiting the duration of the trials or the maximum number of consumers involved

Case study 3: Recovery stimulus in Italy



Overview

- ▶ The Italian government launched a national COVID-19 recovery plan in 2020, “National Plan for Recovery and Resilience” (NPRR), which will invest a total of \$378 billion into the economy
- ▶ The NPRR will focus on four stimulus areas which will aim to promote social-economic benefits based around: modernisation; the green transition; social and regional inclusion; and gender equality
- ▶ The objective of the NPRR is to double the economic growth rate of the last decade, reform some key sectors for economic and social development, increase public investment to 3% of country’s GDP, and boost R&D expenditure to 2.1% of GDP
- ▶ \$82 billion has been designated to the ‘green transition’ stimulus area to help drive a green revolution and ecologic transition

Notable projects supported

- ▶ The NPRR was approved by the Italian cabinet in January 2021, to be finalised pending parliamentary discussion and voting

Potential for replication

- ▶ The NPRR is a EU-centric initiative, and the EU recently unveiled a wider \$821 billion recovery package to support the economies of member nations during the COVID-19 pandemic
- ▶ Funds will be borrowed by the European Commission from the market, to be disbursed largely in grants, and the remainder in loans
- ▶ As well as Italy, Spain has also been a major beneficiary of the EU NPRR to date
- ▶ Despite the NPRR scheme being an EU funded initiative for EU member states, the relative replicability of the structure is high on a global scale





Case study 4: Feed-in-tariff in Vietnam



Overview

- ▶ The Vietnamese government launched feed-in-tariffs (FiT) in 2017 to help the development of solar projects in the country. Since the launch of the programme, the solar market within Vietnam has witnessed an unprecedented level of growth
- ▶ The programme involves the fixing of electricity prices that are paid to renewable energy producers, which are above the usual market price
- ▶ The FiT programme has been carried out in two phases:
 - In phase 1, projects included in the scope were on-grid, rooftop, insular, off-grid and net-metering models
 - In phase 2, projects were extended to grid-connected solar power plants
- ▶ The scheme ended in December 2020 which led to an increase of installed solar capacity by 6.7 GW in that month alone

Notable projects supported

- ▶ Two large-scale floating PV power plants on Gia Hoet 1 and Tam Bo irrigation lakes were grid-connected in December 2020. Both plants total 70 MW capacity, and were developed under the FiT scheme which offered a rate of \$0.0769/kWh
- ▶ The 50 MW Phong Dien II ground-mounted PV plant (developed by Thai-based Gunkul Engineering) started commercial operation in December 2020, obtaining a FiT rate of \$0.0709/kWh over a 20 year period

Potential for replication

- ▶ The feed-in-tariff scheme is highly replicable, as it is based on an agreement between a power purchaser and power producer to buy electricity at a pre-defined rate in order to safeguard the investment of the power producer from the vulnerability of market
- ▶ Other than Vietnam, many other countries have implemented similar feed-in-tariff schemes including: Australia, Austria, Canada, France and Germany



Case study 5: Multi-level risk mitigation framework in Argentina

Overview

- ▶ In early 2016, the Argentinian government launched the “Renewable Energy Auction Programme of Argentina” (RenovAr) to help promote private investment in renewable energy technology
- ▶ The RenovAr Programme is funded by the World Bank, who have provided a financial guarantee of \$480m into a “Fund for the Development of Renewable Energies” (FODER) to help mitigate government default risk
- ▶ The guarantee offered is only an optional/partial support for investors who are willing to pay for it, and covers the FODER obligations to purchase a project if the investor’s right to sell the project is exercised
- ▶ Winning projects within the auction receive a PPA contract for a 20 year period if completed within the predefined timeframe
- ▶ By the end of 2019, Argentina had successfully conducted four auction rounds with 4.1 GW of total contracted capacity

Notable projects supported

- ▶ Total Eren, a renewable energy independent power producer based in France, was one of the first European developers to be active in Argentina following the first round of the RenovAr programme in 2016
- ▶ The company now owns three solar and wind power plants totalling 180 MW in operation (or under construction) in the country, all of them benefiting from a 20-year power purchase agreement (PPA) with CAMMESA, an Argentine wholesale electricity market clearing company

Potential for replication

- ▶ The model can be replicated for developing countries where the financing process for the purposes of renewable energy project development may not be as robust as that of developed nation
- ▶ Argentina have had the most success in using the support of the World Bank as part of an energy auction programme. Vietnam are now also looking into a competitive bidding program for solar with the support of World Bank





Case study 6: Feed-in premiums in France

Overview

- ▶ In 2016, the French Government reformed its feed-in tariff to a 'feed-in premium' system (FIP) as part of the Energy Transition for Green Growth Act
- ▶ The main objective was to ensure cost-competitiveness of renewable energy and increase its market share by guaranteeing that Electricity de France (EDF) would purchase renewable energy at above-market prices, ensuring suppliers a reasonable return on invested capital
 - Large-scale and mature renewable electricity technologies need to be tendered with a feed-in premium to complement the market price, e.g. biomass over 300 kW, biogas over 500 kW, solar PV and offshore wind
 - Certain technologies are exempt from tenders and benefit from feed-in premiums on direct marketing, e.g. waste and thermal energy
- ▶ The reform is part of France's broader goal of shifting its energy mix away from nuclear and towards renewables

Notable projects supported

- ▶ In 2020, France guaranteed tariff support to 341 MW of solar projects with prices offered by winning bidders 7-14% lower than the prior auction. The drop in prices "confirms the drop in costs, the dynamism and the competitiveness" of renewables, according to France's Ministry of Ecological Transition
- ▶ In 2019, the French Government awarded 576 MW of onshore wind projects in an oversubscribed tender. Each project will receive a 20-year feed-in premium contract

Potential for replication

- ▶ Feed-in premium policies are highly replicable, and are being increasingly adopted as an alternative to the more commonplace fixed feed-in tariff
- ▶ There is some risk around managing premiums to avoid overcompensation in the case of high market prices, or under-compensation in low market prices. This risk can be slightly mitigated by sliding scale FIP systems
- ▶ Similar feed-in premium systems have been introduced in other European countries, e.g. Finland, Czech Republic, Italy and Spain



Overview

- ▶ The Renewable Energy Sources Act (EEG) is Germany's main renewables policy and has been used to support growth in renewables since 2000, with particular support for onshore wind and solar
- ▶ In 2017, the EEG was revised requiring all systems greater than 750 kW to participate in competitive auctions, marking a major shift as competition became the primary price-discovery mechanism for renewable energy projects
- ▶ Today, large-scale solar, onshore and offshore wind, and biomass projects are all required to run competitive auctions, with contracts awarded to the lowest bidder. Only hydropower, geothermal, and small PV roof systems still have fixed FITs

Notable projects supported

In 2017, Germany's total installed capacity of renewables surpassed fossil fuels and nuclear combined for the first time, with this milestone in part attributed to the introduction of competitive auctions reducing average prices (112 GW vs. 105 GW respectively)

- ▶ The first auction for offshore wind was held in 2017 for 1.5 GW. The largest three projects were awarded at €0/MWh, i.e. a 'zero' premium on wholesale market prices, reflecting the specific nature of this first offshore wind auction and increasing competitiveness
- ▶ Reducing average prices for solar PV have been particularly effective, with winning auction prices almost halving from €80-90/MWh in 2015 to €40-50/MWh in 2018

Potential for replication

- ▶ Competitive auctions are highly replicable, and increasingly used to drive competitive pricing pressure in renewables. They are a key contributor to falling global prices for long-term renewables contracts
- ▶ There is some execution risk around running effective auctions. They require good planning, procurement, and contracting capacity. They can involve high transaction costs, or attract too little bidding interest, resulting in high prices and delays to financial close
- ▶ Auctions are becoming increasingly popular in more nascent renewables markets e.g. sub-Saharan Africa, since they deliver more investment at lower prices than any other contracting method in the region

Case study 8: Offshore wind permissions in Japan



Overview

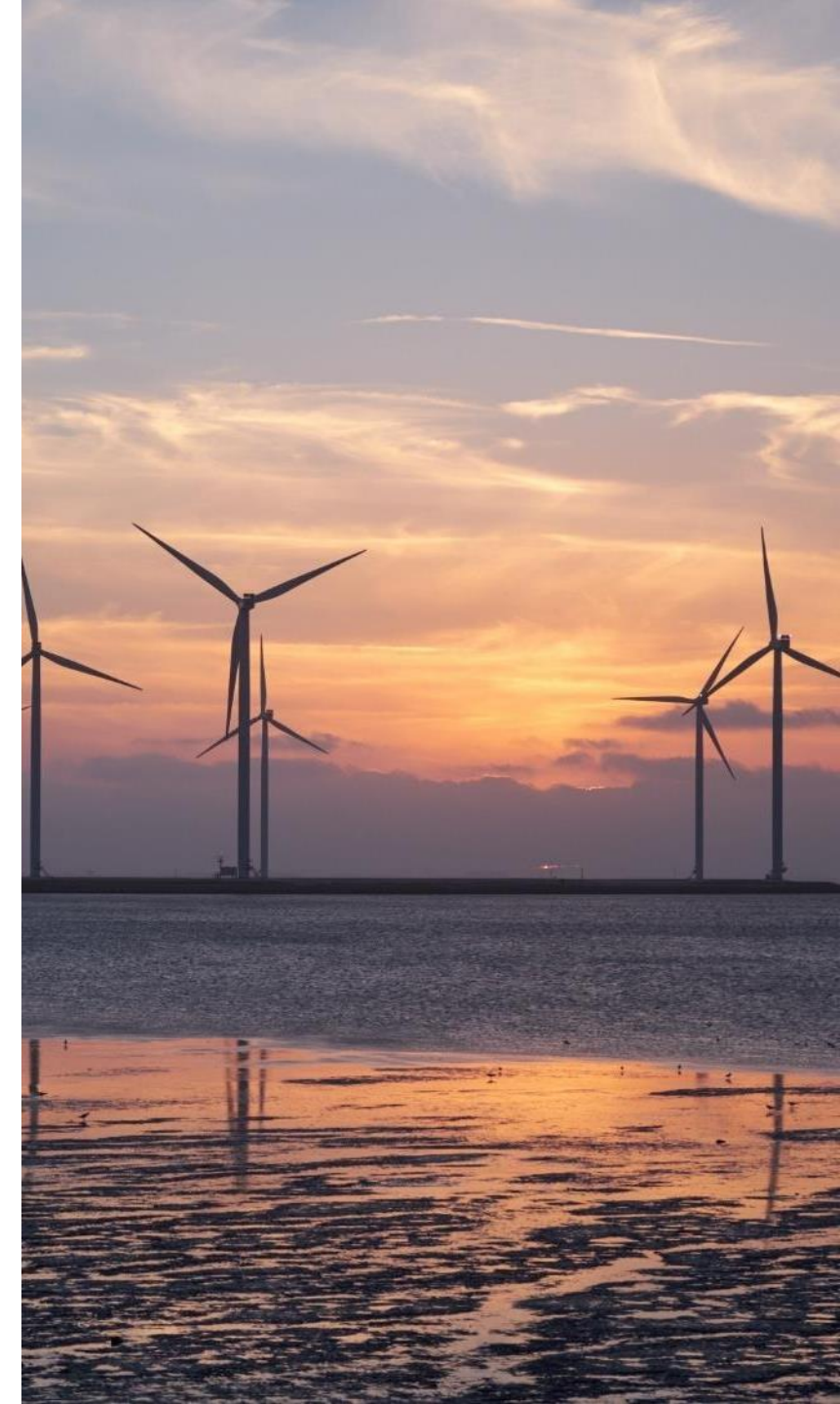
- ▶ The Japanese Government has funded renewables as a priority to reduce dependence on fossil fuel imports, and to shift away from nuclear following the 2011 Fukushima disaster
- ▶ In 2019, the government passed a bill permitting wind farms to operate in Japanese waters for up to 30 years, signalling a long-term investment in wind power
- ▶ The legislation follows plans laid out in 2017 to increase the country's percentage of power from renewable sources and increase government oversight to ensure their efficiency

Notable projects supported

- ▶ The Japanese firm Orix has committed \$903m to build a 200 MW wind farm off the coast of China Prefecture. It is due to begin production in 2025
- ▶ In 2019, E.ON signed an agreement with domestic firm Kyuden Mirai to expand their offshore wind facilities from 189 MW to 700 MW

Potential for replication

- ▶ Offshore wind has received significant investment in Europe, Taiwan, and the US; however, it faces specific challenges to implementation compared to other renewables, such as:
 - Greater public scepticism about cost competitiveness vs. alternative renewables
 - Challenge of requiring floating platforms in regions with deep coastal waters and earthquake zones





Overview

- ▶ Renewable energy portfolio standards (RPS) are policies designed to increase the use of renewables for electricity generation by requiring suppliers to provide their customers with a stated minimum share from clean sources. They have been gradually introduced by states since Iowa first adopted the policy in 1983
- ▶ As of 2021, 30 states have passed enforceable RPS. A national policy has been proposed, although has not yet passed at this level
- ▶ 8 states have mandated that their RPS policies deliver 100% clean energy by 2050, including Maine, California, Hawaii, and New Mexico
- ▶ State policies vary in programme structure, enforcement mechanisms, size, and target organisations (e.g. private utility companies vs. all). They are tailored to state-specific objectives, e.g. economic growth, energy diversification, or environmental concerns
- ▶ RPS rely almost entirely on the private market for implementation, given it is a market mandate. The programmes tend to encourage price competition, efficiency, and innovation, allowing renewables to compete with cheaper fossil fuel sources
- ▶ A common feature of RPS policies is renewable electricity credits, which can be traded between suppliers to reduce cost of compliance

Notable projects supported

- ▶ Since 2000, 62% of growth in American non-hydro renewables has been undertaken to satisfy state-level RPS requirements
- ▶ States have actively increased their minimum renewable shares over the last 20 years as they met interim targets. For example:
 - The Texas RPS mandated 2 GW of renewables by 2009 and 10 GW by 2025; however, the state's installed capacity reached 10 GW in 2010, 15 years ahead of schedule
 - California has exceeded its RPS minimum every year since 2011. In 2017, the three major utilities companies reached 36% renewable generation, three years ahead of target

Potential for replication

- ▶ RPS policies are replicable at the state-level, with flexibility to adapt the policy to specific state objectives. They are more challenging to standardise at national level in fragmented regulatory markets (such as the USA)
- ▶ RPS are also viewed to offer attractive cost-benefit ratios, and to be easier to implement than carbon taxes



Case study 10: Carbon tax in Canada

Overview

- ▶ Following success of carbon tax schemes at the province level, Canada implemented a federal carbon tax in 2019 as part of its Greenhouse Gas Pollution Pricing Act
- ▶ Key objectives for the federal scheme included making renewables more cost-competitive with fossil fuels, and raising capital to invest in renewables across provinces
- ▶ The tax added \$20/tonne of CO₂ to carbon-based fuel purchase prices, rising at +\$10/tonne per year until it reaches \$50/tonne in 2022. As a result of the tax, petrol prices are to rise by ~8%, natural gas by ~50%, and coal prices are expected to double
- ▶ ~90% revenue from the tax will be rebated to consumers, supporting growth in disposable income and the economy, and encouraging switching to low-carbon consumption, e.g. renewables. Rebate growth is expected to outpace taxation costs resulting in net gain for households
- ▶ The remaining revenue will be reinvested in the economy, helping to drive down emissions by supporting low-carbon efforts e.g. renewables coal phase out, and clean tech innovation

Notable projects supported

- ▶ In 2020, the Trudeau administration announced C\$15bn additional funding to support renewables R&D e.g. green hydrogen and renewables energy storage, with part of the fund generated by tripling federal carbon tax
- ▶ Revenue-neutral carbon tax schemes have been successful at the province level in supporting local renewable projects
 - In 2017-18, Alberta channelled \$676m into low-carbon projects like renewable energy generation, coal phase-out, and green infrastructure, using funds generated by its carbon tax (~50% tax revenues, the remainder was redistributed to consumers through rebates)

Potential for replication

- ▶ Carbon pricing schemes have been increasingly adopted globally, and are estimated to now drive \$50b (World Bank)
- ▶ However, in many countries, overcoming resistance to higher taxes is a major challenge in implementation of carbon pricing, leading to high variation in effectiveness of such schemes. All countries except Sweden price carbon below \$75/tonne of CO₂, estimated to be ~50% the estimated 'social cost of carbon'¹

1. Social cost of carbon is an estimate of the cost of future climate damage per tonne by economists
Source: Citizens' Climate Lobby, Pembina Institute, Carbon Brief, World Bank, EY-Parthenon analysis

Agenda

- ▶ Executive summary
- ▶ People, Planet and Prosperity Outcomes
- ▶ How to accelerate and enable these benefits
- ▶ Renewable energy policy success stories
- ▶ [Appendix](#)



Methodology: Research Approach

Primary Research - ECF Commissioned Reports

- ▶ This report aggregates the research and findings from four previous reports commissioned by the ECF, which covered:
 - EU27
 - Indonesia, Japan, Malaysia, South Korea, Taiwan, Thailand, The Philippines, Vietnam
 - UK (as excluded from initial EU27 study) and 3 heavily coal dependent nations (Serbia, Turkey, South Africa)
 - India
- ▶ For each of these reports, projects were identified using publicly available renewable energy pipeline databases, and backed up through consultations with local stakeholders to both validate and expand on the publicly available information

Secondary Research - Remaining G20 Nations and Supporting Research

- ▶ Analysis of the G20 nations not covered within the previous four reports commissioned by the ECF has also been added to this report
- ▶ This list of nations covers: Australia, Argentina, Brazil, Canada, China, Mexico, Russia, Saudi Arabia and the United States of America
- ▶ A simplified research approach was agreed for these nations, using EY's 'Renewable Energy Country Attractiveness Index' (RECAI) as the primary data source
- ▶ RECAI was also used to expand on the previous EU27 report, as the methodology applied focused on six energy sub-sectors, meaning the number of renewable energy projects identified was low in proportion to the amount of countries researched

Assumptions and Sources: Investment Required

1 Base assumptions

- ▶ Assumptions are based on each MW capacity in the pipeline
- ▶ Values are provided on a region-by-region, technology-by-technology basis where available

Technology	Region	Investment per MW (\$m)
Onshore wind	Global	3.80
Offshore wind	Global	1.47
Solar PV	Global	1.00
Hydro	Brazil	1.46
	China	1.26
	Europe	1.84
	Africa	3.17
	Middle East	1.67
	North America	2.74
	Oceania	3.90
	South America	2.03
	Eurasia	1.84

2 Levelised cost adjustment

- ▶ As assumptions for investment intensity are based on 2019 values, a further adjustment has been made to account for the reducing cost of renewable energy technology over time
- ▶ A 3-year average reduction cost (2017-19) was calculated for each technology to identify the adjustment required

Technology	3YA cost reduction (%)
Onshore wind	16
Offshore wind	7
Solar PV	7
Hydro	3

3 Adjustment to base assumptions

- ▶ The 3 year average reduction cost was then applied to the base investment assumptions in order to complete the calculations

Technology	Region	Investment per MW (\$m)
Onshore wind	Global	3.52
Offshore wind	Global	1.37
Solar PV	Global	0.84
Hydro	Brazil	1.42
	China	1.23
	Europe	1.79
	Africa	3.08
	Middle East	1.62
	North America	2.66
	Oceania	3.78
	South America	1.97
	Eurasia	1.78

Investment cost estimates for India have been made using local benchmarks, please see EY country report for India for details

Assumptions and Sources: Potential jobs

1 Base assumptions

- ▶ Assumptions are based on person-years required per MW of new capacity, for a) deployment (planning, manufacturing, transportation, construction, and installation) and b) operations & maintenance
- ▶ For deployment one job is equivalent to one job-year. While these jobs by definition are limited in time, they will persist as long as renewables deployment continues at the same rate or higher
- ▶ For operations and maintenance, one job is equivalent to one job-year in the first year of operation. We have assumed that operations and maintenance jobs will be created in the same year an asset is deployed.

2 Calculation

- ▶ Calculations were made based on the total MW capacity in the pipeline for each country, by technology

Technology	Total jobs per MW	Of which:			Source
		Supply chain jobs per MW	Local jobs per MW	Of which:	
				O&M jobs per MW	
Solar PV	9.06	4.48	4.59	1.13	IRENA '17 and '18 (Leveraging local capacity)
Onshore wind	4.96	1.65	3.31	0.22	
Offshore wind	12.90	10.52	2.38	0.21	
Hydropower	11.10	3.50	7.60	0.20	Rutowitz, et. al. 2015

Assumptions and Sources: Emissions Avoided

1 Base assumptions: Emissions

- ▶ Assumptions are based on g/KWh
- ▶ Values provided at a global level, per technology

Technology	Emissions
Coal	1,001
Gas	477
Onshore wind	11
Offshore wind	11
Solar PV	44
Hydro	7

2 Base assumptions: Capacity factor

- ▶ Values provided at a global level, per technology

Technology	Capacity factor
Onshore wind	47%
Offshore wind	50%
Solar PV	28%
Hydro	49%

3 Calculations

- ▶ Calculations were made based on the MW capacity pipeline for each renewable energy technology
- ▶ The pipeline capacity was firstly converted to MWh based on the capacity factor of the renewable energy technology
- ▶ Subsequently, the difference in emissions between a 'dirty' energy source (i.e. coal or gas) and the renewable technology was calculated on the MWh value to provide an output abatement total
- ▶ *Note: A default 'dirty' energy source was defined on a country by country basis*

Assumptions and Sources: Recurring GDP Impact

1 Base assumptions

- ▶ Base assumptions were defined to account for local content proportions, investment multipliers for renewable energy, and the proportion of annual investment attributed to operations & maintenance

Assumption	Value
Local content proportion	60%
Renewable energy investment multiplier	1.75
O&M investment p/a	3%

2 Calculation

- ▶ Calculations of O&M recurring GDP were made on the total \$m investment, adjusting for local content production and a renewable energy investment multiplier using the base assumption values

EY Renewable Energy Country Attractiveness Index (RECAI): Rankings by Market

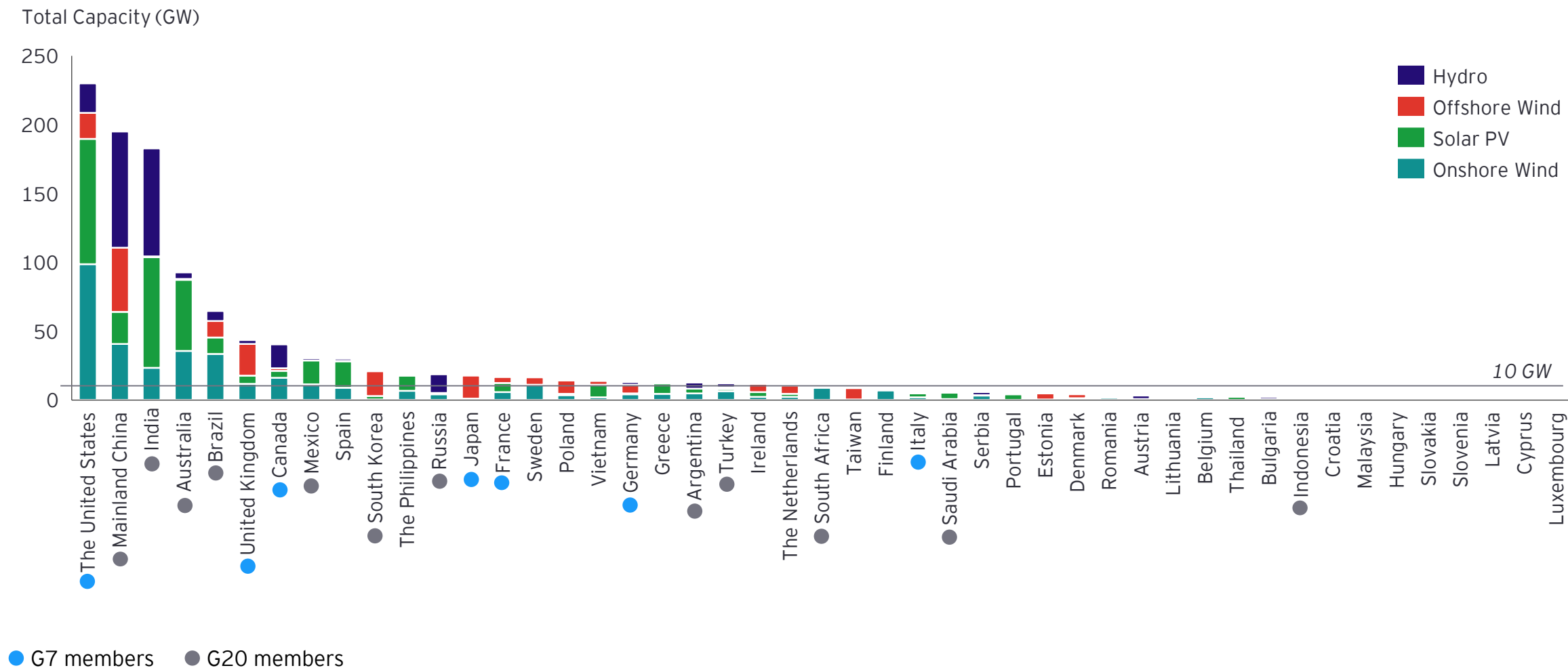
1 Overview

- ▶ Ranks countries worldwide on the attractiveness of their renewable energy investment and deployment opportunities
- ▶ Approximately 100 markets are analysed and scored
- ▶ Released 6-monthly, RECAI also provides leading market commentary and analysis on the global renewable energy sector. This includes insight on specific markets and key finance, transaction and policy trends
- ▶ Now in its 17th year, RECAI has established itself as an industry standard, and is frequently cited by governments and industry leaders
- ▶ It has become a key tool for developers, investors and corporate decision makers on market entry strategies and transactions. It is also used by governments and multilateral organisations to help inform policy decisions
- ▶ Each report is sent directly to 8,000+ EY clients and third parties, and reaches c.750,000 energy stakeholders via press and social media. It is publicly available online at ey.com/recai.

Market	Ranking	Market	Ranking
The United States	1	Turkey	30
China	2	Greece	31
Australia	3	Mexico	33
India	4	Vietnam	34
United Kingdom	5	South Africa	37
Germany	6	Austria	40
France	7	Thailand	41
Japan	8	Saudi Arabia	42
The Netherlands	9	Hungary	44
Spain	10	Indonesia	46
Denmark	12	Russia	48
South Korea	13	Malaysia	53
Ireland	14	Romania	61
Brazil	15	Bulgaria	66
Canada	16	Slovenia	69
Argentina	19	Estonia	70
Italy	17	Lithuania	72
Taiwan	21	Slovakia	73
Portugal	22	Croatia	75
Finland	23	Serbia	77
Belgium	24	Cyprus	92
Sweden	25	Latvia	N/A
Poland	28	Luxembourg	N/A
The Philippines	29		

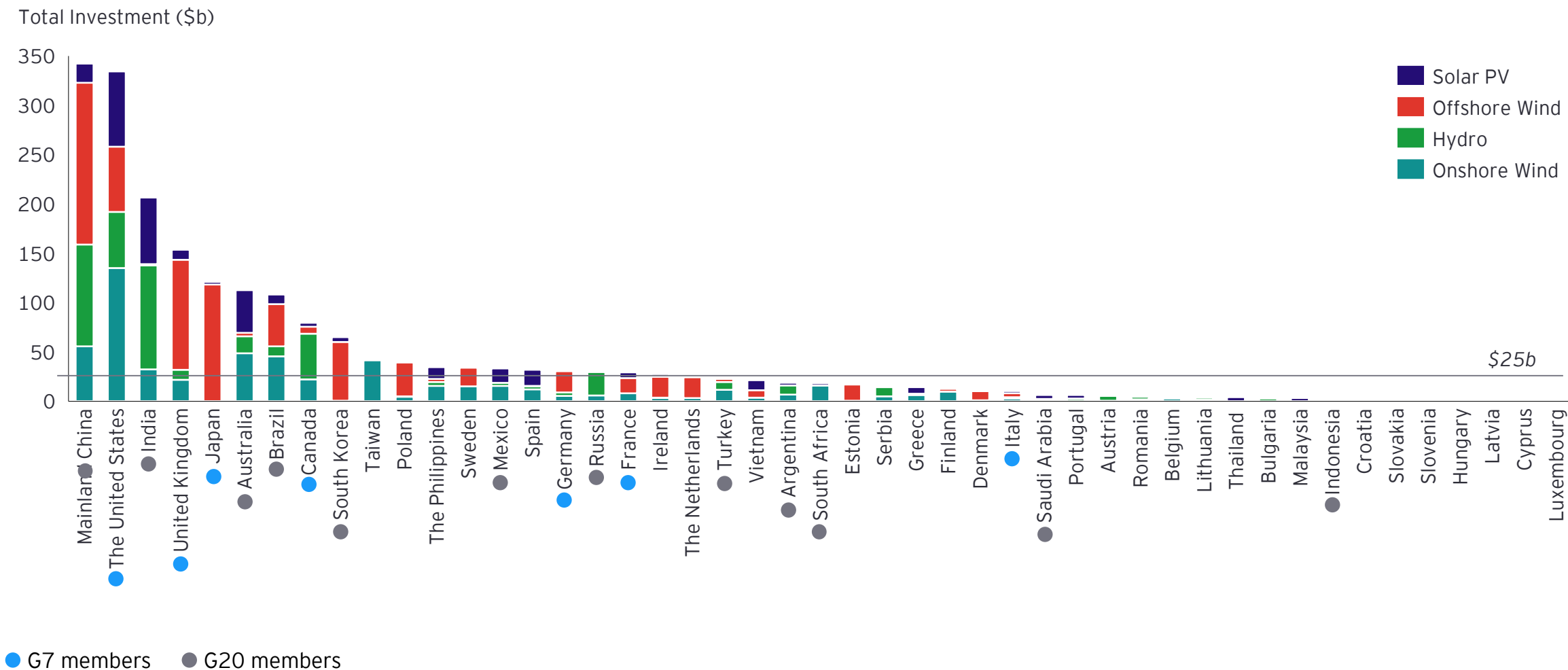
There is potential for significant amounts of global installed capacity to be added through the economies included in the study

Capacity breakdown of the ~13,000 projects identified, by economy and renewable energy technology



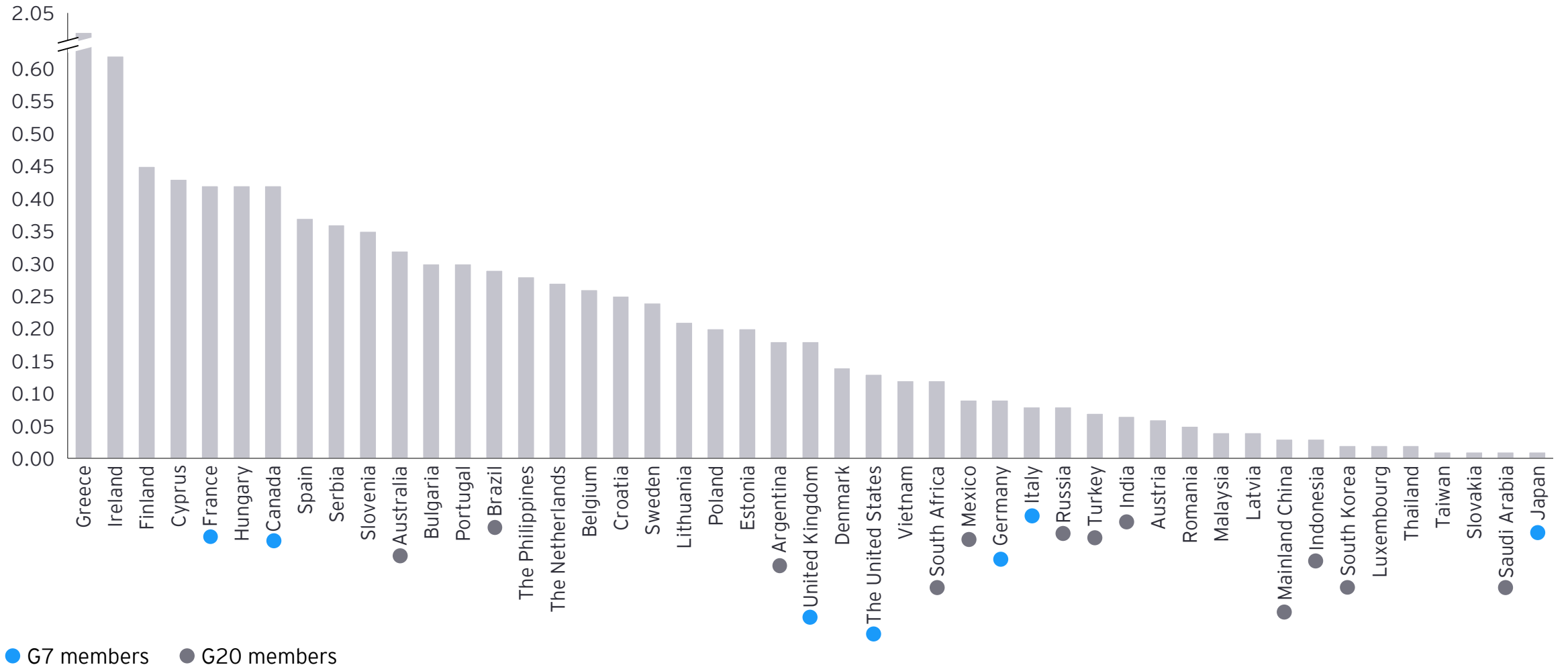
There are significant investment requirements to help fulfil the project pipeline identified across the economies included in the study

Investment breakdown of the ~13,000 projects identified, by economy and renewable energy technology

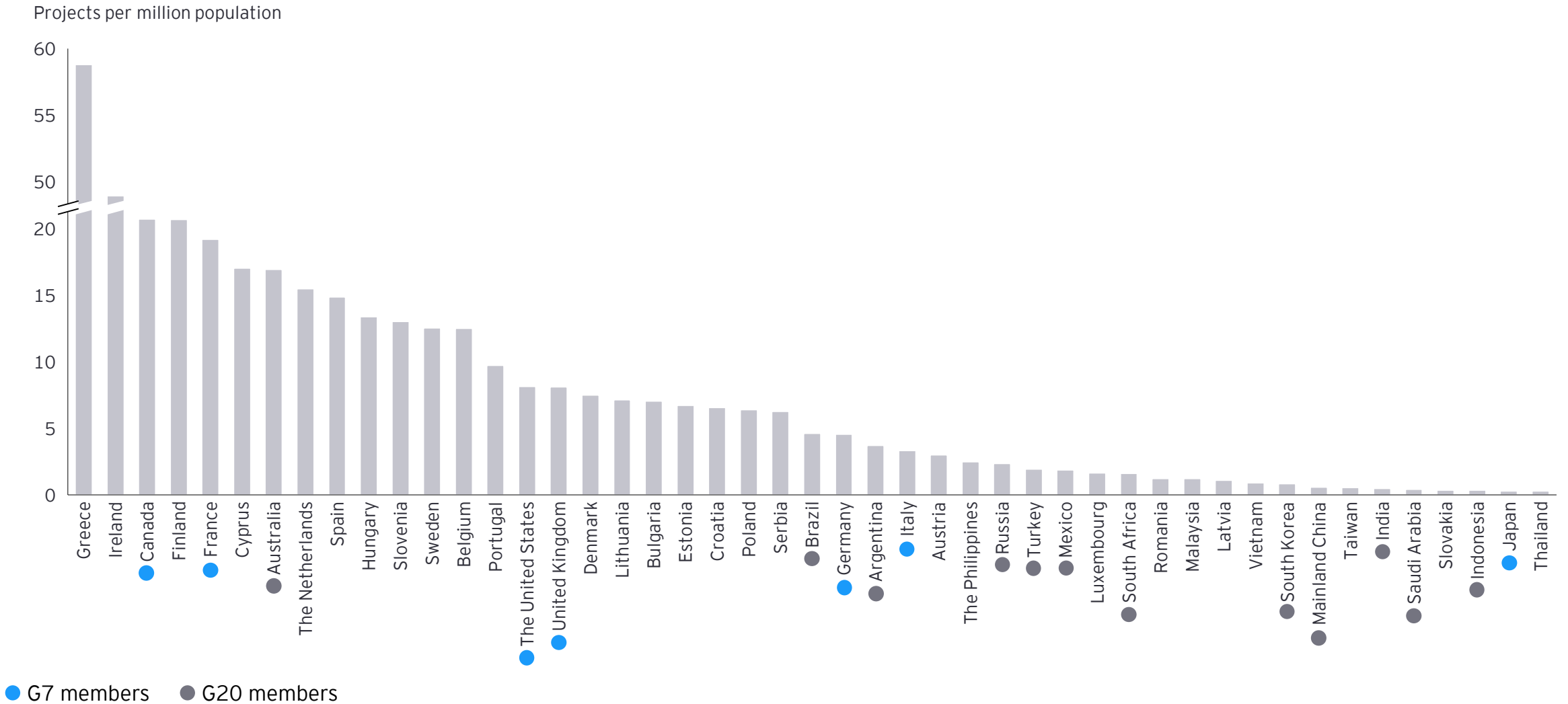


Visible project pipeline analysis: Number of projects per \$b GDP

Projects per \$b GDP

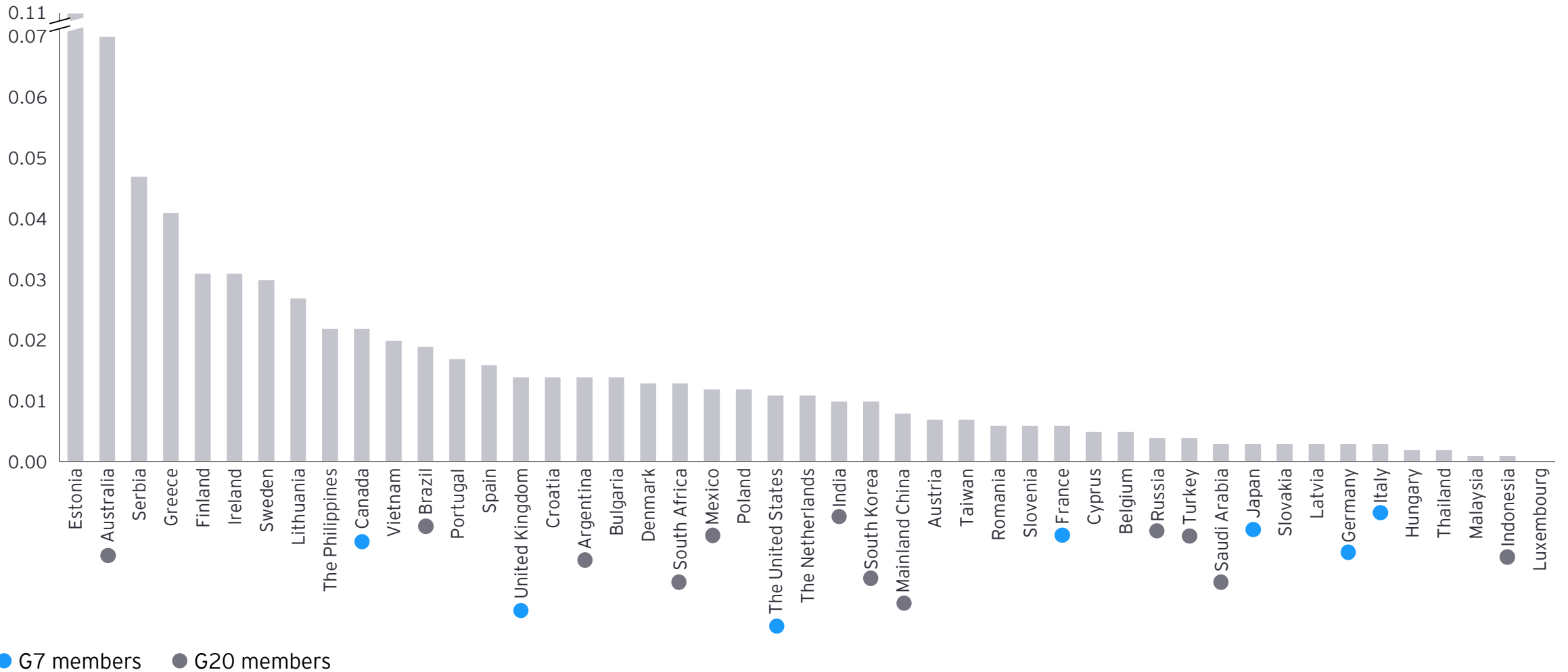


Visible project pipeline analysis: Number of projects per million population

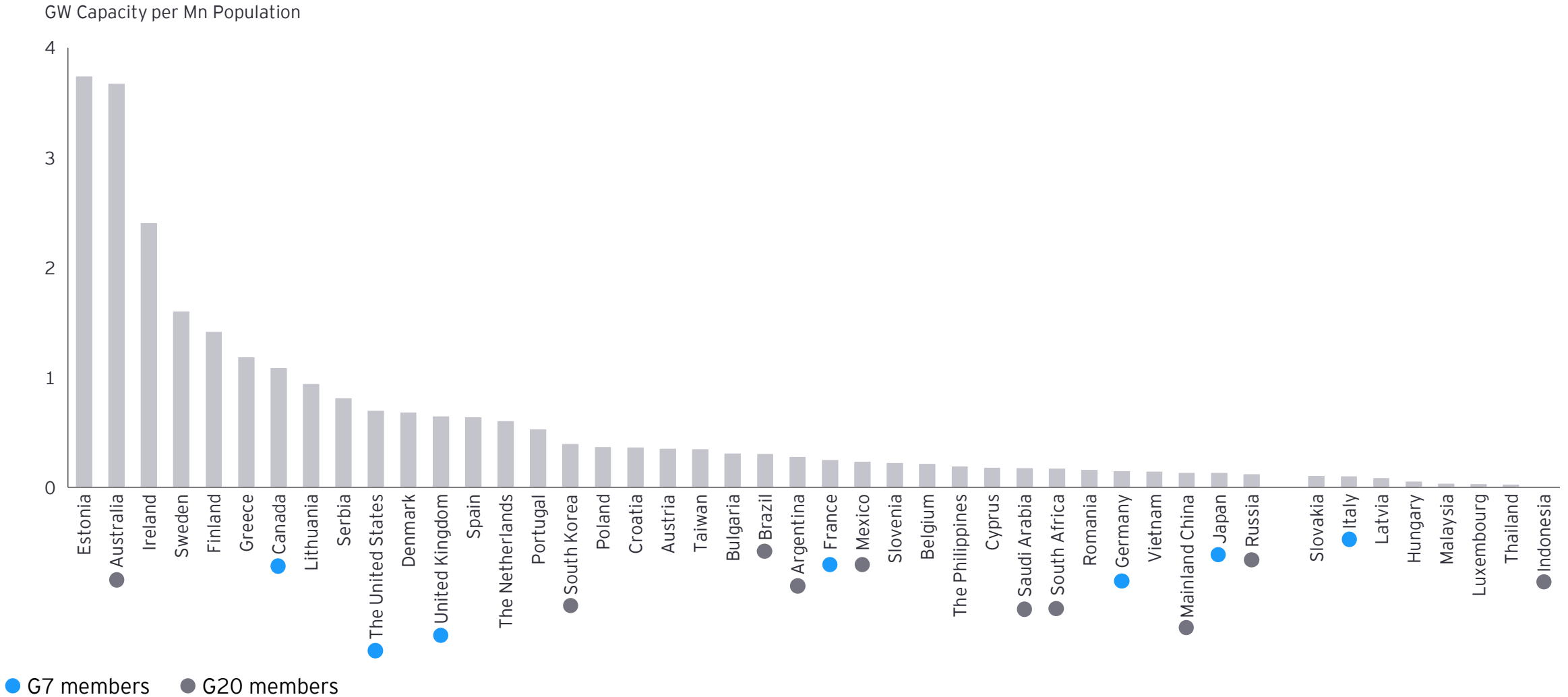


Visible project pipeline analysis: Total capacity in pipeline per \$b GDP

GW Capacity per \$b GDP

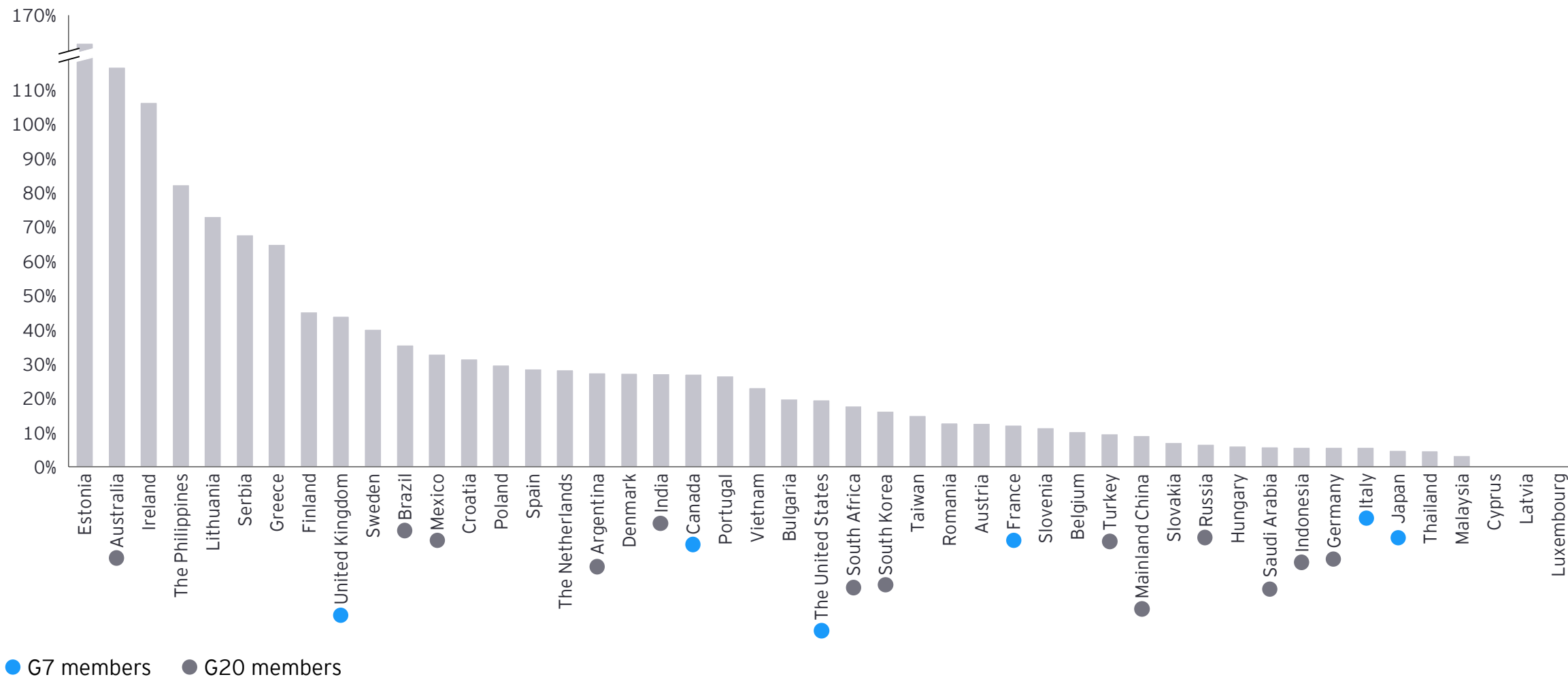


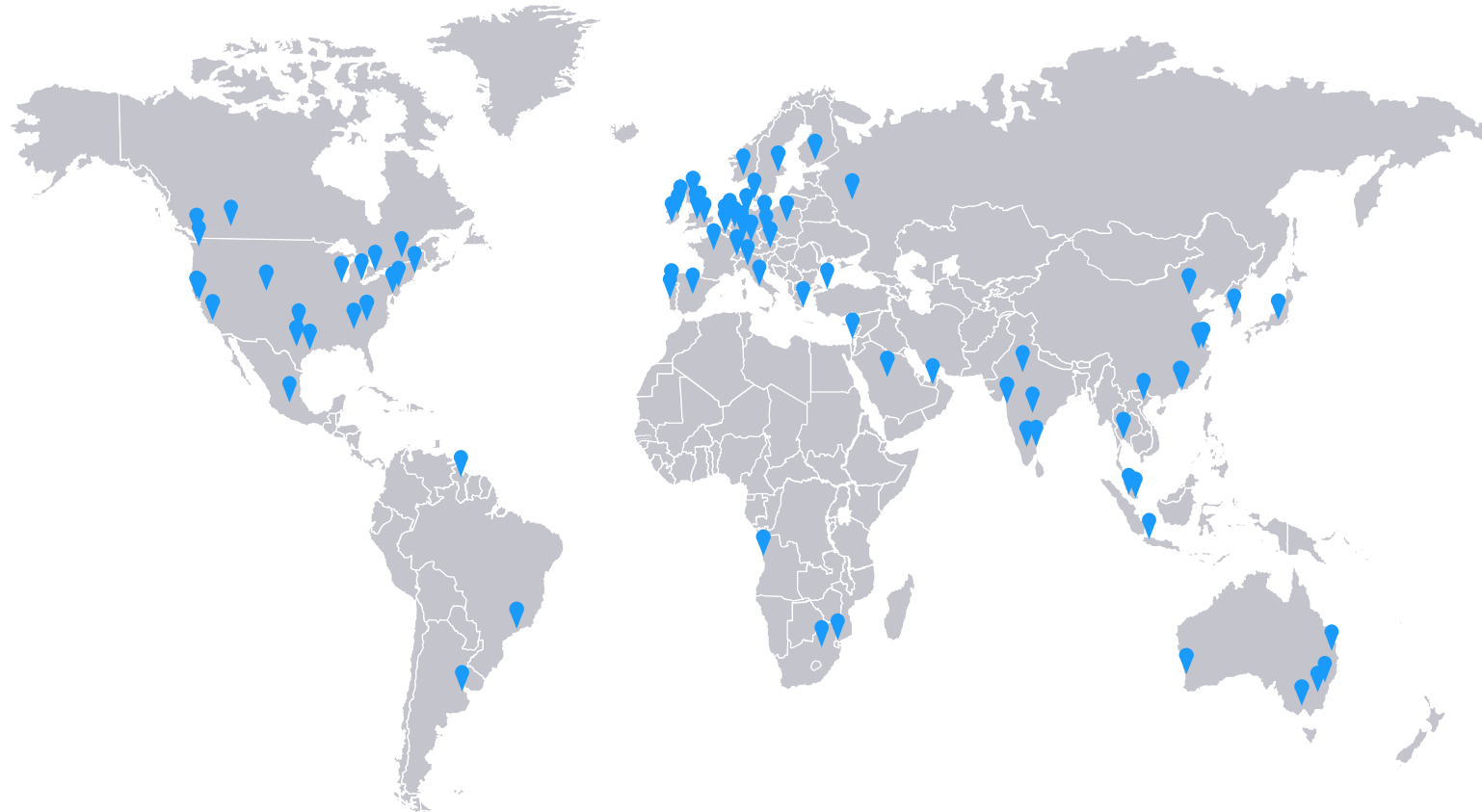
Visible project pipeline analysis: Total capacity in pipeline per million population



Visible project pipeline analysis: Total capacity in pipeline against existing installed capacity

Size of Pipeline Capacity against Existing Capacity





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