MISSION INNOVATION

Accelerating the Clean Energy Revolution

Strategies, Progress, Plans, and Funding Information Submitted by Mission Innovation Members

Updated June 6, 2017

AUSTRALIA ▪ BRAZIL ▪ CANADA ▪ CHILE ▪ CHINA ▪ DENMARK ▪ EUROPEAN UNION ▪ FINLAND ▪ FRANCE ▪ GERMANY ▪ INDIA ▪ INDONESIA ▪ ITALY ▪ JAPAN ▪ KINGDOM OF SAUDI ARABIA ▪ MEXICO ▪ NETHERLANDS ▪ NORWAY ▪ REPUBLIC OF KOREA ▪ SWEDEN ▪ UNITED ARAB EMIRATES ▪ UNITED KINGDOM ▪ UNITED STATES

Assembled by: Mission Innovation Secretariat

www.mission-innovation.net

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INTRODUCTION

Mission Innovation (MI) Members[1] agreed to provide information on strategies and plans for their respective governmental and/or state-directed clean energy research and development investment over five years. New investments are focused on transformational clean energy technology innovations that can be scaled to varying economic and energy market conditions that exist in participating countries and in the broader world.

Information sharing promotes transparency and integrity. It allows for broad stakeholder engagement, gives rise to opportunities for collaboration, and can inspire and inform investment decisions by the private sector.

Accordingly, MI Members have shared narratives describing the nature of its clean energy research, development, and demonstration (RD&D) investments; current strategies, priorities, and needs; Mission Innovation funding and progress; and plans for future growth.

MI Members initially submitted narrative and funding information prior to the Inaugural MI Ministerial in June 2016. MI Members submitted updated information in November 2016—at the one year anniversary of the MI launch in Paris—and then prior to the Second MI Ministerial in June 2017. The updated information provides recent developments in Mission Innovation plans, funding, and activities.

This document provides a compilation of the most recent information that has been submitted by each of the 23 MI Members. In addition to promoting transparency and integrity, it is hoped that the information shared in the document will facilitate collaboration among Members and encourage further private sector engagement.

[1] Mission Innovation Members, as of 6 June 2017, include 22 countries and the European Commission on behalf of the European Union. A complete list is provided at http://mission-innovation.net/countries/.

SUMMARY

OVERVIEW OF MISSION INNOVATION FOCUS AREAS BY COUNTRY

Mission Innovation Clean Energy R&D Focus Areas

	AUSTRALIA	BRAZIL	CANADA	CHILE	CHINA	DENMARK	EUROPEAN UNION	FINLAND	FRANCE	GERMANY	INDIA	INDONESIA	ITALY	JAPAN	KINGDOM OF SAUDI ARABIA	MEXICO	NETHERLANDS	NORWAY	REPUBLIC OF KOREA	SWEDEN	UNITED ARAB EMIRATES	UNITED KINGDOM	UNITED STATES
INDUSTRY & BUILDINGS	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
VEHICLES & OTHER TRANSPORTATION	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●		●
BIO-BASED FUELS & ENERGY	●	●	●			●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●
SOLAR, WIND & OTHER RENEWABLES	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
NUCLEAR ENERGY	●	●	●		●											●			●		●	●	●
HYDROGEN & FUEL CELLS	●	●	●		●	●	●	●	●	●	●			●	●	●	●	●	●			●	●
CLEANER FOSSIL ENERGY		●	●		●	●		●		●	●	●			●		●		●				●
CO_2 CAPTURE, UTILIZATION & STORAGE	●	●	●		●	●	●		●	●	●	●		●	●	●	●	●	●		●	●	●
ELECTRICTY GRID	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●
ENERGY STORAGE	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
BASIC ENERGY RESEARCH	●		●			●	●		●	●	●	●	●	●	●		●	●		●	●		●

Indicators are for key areas of R&D investment, but do not imply a comprehensive representation of a country's full R&D portfolio.

BASELINE INVESTMENT FOR MISSION INNOVATION CLEAN ENERGY R&D

Country	Baseline Amount Declared in June 2016, unless otherwise noted	
	(million currency as declared, per year)	(million USD per year[1])
Australia[2]	108 AUD	81
Brazil	600 BRL	150
Canada	387 CAD	295
Chile	4.1856 USD	4
China	25,000 RMB	3,800
Denmark	292 DKK	45
European Union	989 EUR	1,111
Finland	54.9 EUR	58
France	440 EUR	494
Germany	450 EUR	506
India	4700 INR	72
Indonesia	16.7 USD	17
Italy	222.6 EUR	250
Japan	45,000 JPY	410
Kingdom of Saudi Arabia	281.3 SAR	75
Mexico	20.71 USD	21
Netherlands	100 EUR	113
Norway	1132 NOK	140
Republic of Korea	490 USD	490
Sweden	134 SEK	17
United Arab Emirates	10 USD	10
United Kingdom	200 GBP	290
United States[3]	6415 USD	6,415
Total		14,864

Notes

1. Currency conversions are based on exchange rates when the baseline amounts were submitted, between Nov 2015 and June 2017.

2. Australia updated its baseline amount from AUD 104 million, as reported in June 2016, to AUD 108 million in June 2017.

3. U.S. is currently reviewing the funding levels for its Mission Innovation activities.

AUSTRALIA

Narrative

The Australian Government is committed to addressing climate change while at that same time ensuring we maintain energy security and affordability.

Australia recognises that supporting the development, demonstration and deployment of clean energy technologies is necessary to transition the world's energy sector to low emissions over the course of the century.

Along with other Mission Innovation members, Australia has pledged to double government clean energy research and development expenditure by 2020 while encouraging greater levels of private sector investment in transformative clean energy technologies.

Australian Policy Context

The Australian Government has ratified the Paris Agreement and set a target of reducing emissions by 26 to 28 per cent below 2005 levels by 2030. This target amounts to a halving of per capita emissions and a two thirds reduction in emissions intensity of economic activity. It is among the strongest targets of major economies on that basis.

In announcing Australia's 2030 target, the Government committed to review its climate change policies during 2017. The review aims to ensure policies remain effective in achieving Australia's 2030 target and Paris Agreement commitments. The review has commenced and will conclude by the end of 2017.

The 2017 climate change review is monitoring and being informed by other work which have been ongoing over the course of the last year:

- The CSIRO's Low Emissions Technology Roadmap for Australia will make recommendations on Australia's future clean energy research and development opportunities, including where to focus domestic research and to collaborate internationally to deliver clean energy solutions for Australia.
- In addition, Australia's Chief Scientist Dr. Alan Finkel is conducting an independent review into the security and reliability of the National Electricity Market, and will provide advice to the Council of Australian Governments on a coordinated, national reform blueprint.

Clean Energy Innovation Support

Australia has a set of targeted government programmes working together to support research and development and to help emerging technologies to make the transition from demonstration to commercial implementation.

Research and development grants are provided by the Australian Renewable Energy Agency (ARENA), the Australian Research Council, CSIRO and universities.

Seed funding for emerging technology is provided by the Clean Energy Innovation Fund and ARENA.

Projects near commercial deployment can access debt and equity from the Clean Energy Finance Corporation (CEFC).

Emissions reduction policies, such as the Renewable Energy Target and Emission Reduction Fund, help to pull innovations through to widespread market diffusion.

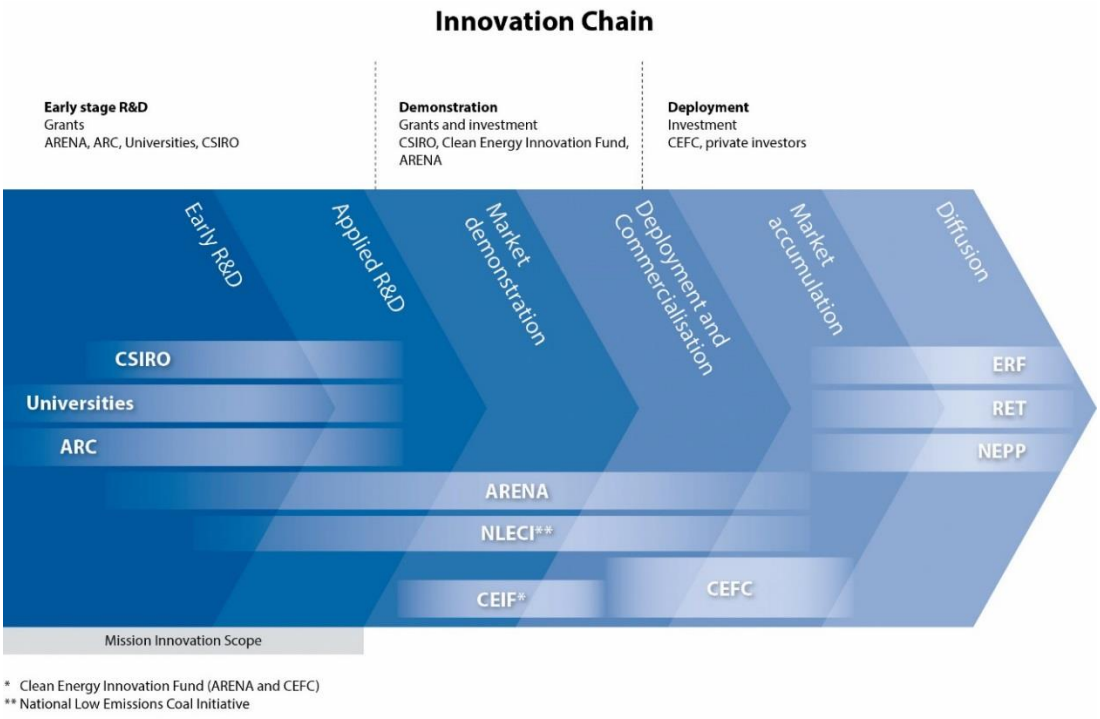

Figure 1: Australian Government measures across the innovation chain

Through policy frameworks and institutions, Australia is making important strides towards achieving our Mission Innovation pledge.

In September 2016, the Government reinstated $800 million in funding to the ARENA over five years, commencing from the 2017-18 financial year. This adds to the funding already available for ARENA's existing projects and pipeline of projects. Altogether, ARENA will have about $1 billion to spend towards its objectives over the next five years.

On 1 May, the ARENA Board released a detailed Investment Plan, setting out four investment priorities that will guide how these new funds are directed over the coming years. These are:

1. Delivering secure and reliable electricity
2. Accelerating solar PV innovation
3. Improving energy productivity
4. Exporting renewable energy.

On 22 May 2017, ARENA opened a new grant funding round of approximately $20 million targeting research and development projects that accelerate solar PV innovation.

The Clean Energy Innovation Fund provides financial support for innovative and emerging clean energy

technologies to become commercially viable. It is funded from the CEFC's capital allocation and has now committed $25 million of its $200 million allocation in its first year of operation.

This including a $10 million cornerstone investment in a Clean Energy Seed Fund administered by Artesian Venture Partners. The Seed Fund targets scalable, high growth potential start-ups fuelling innovation and creating opportunities in the development of clean technology.

The CEFC continues making clean energy investments in later stage commercialisation and deployment projects on a commercial basis.

Since its establishment on 1 July 2013, the CEFC has made cumulative commitments of more than $3 billion to projects worth over $8.3 billion. These investments are collectively earning a return above the cost of borrowing.

Consistent with advice from the International Energy Agency, the Government is considering options to give CEFC and ARENA flexibility to make technology-neutral investments in the future.

International Collaboration Priorities

Australian scientists and researchers are making world-leading contributions to the development of clean energy technologies, including in solar PV, solar thermal, wave energy, biofuels and hydrogen.

Case study: CSIRO Hydrogen Membrane

The Commonwealth Science and Industry Research Organisation has developed a metal membrane which allows high-purity hydrogen to be separated from ammonia. The technology, now being trialled on an industrial scale in Australia, will allow hydrogen to be transported and used as an energy source.

Hydrogen is difficult to transport over long distances because it has such a low density. Ammonia is a good way of transporting hydrogen because it is denser than liquid hydrogen. The technology the CSIRO has developed can then be applied at the point of delivery, converting ammonia back into hydrogen for use in transport fleets or electricity generation.

Australia is excited by the opportunities for future research and development collaboration under the Mission Innovation's seven Innovation Challenges. Australia has active research underway in many clean energy technologies relevant to the Innovation Challenges, and is particularly interested in collaboration opportunities under the Converting Sunlight, Smart Grids, Carbon Capture Use and Storage, and Heating and Cooling challenges.

We are committed to driving innovation and deployment of clean energy technologies on the world stage. Australian innovation has long been successfully commercialised in the global marketplace - for example, it is projected that University of New South Wales photovoltaics innovation will be embedded in almost half of all new solar panels sold globally by 2020.

Our world class universities and research institutions will continue to collaborate with international colleagues and organizations to unlock new ideas and transitional pathways in the energy sector.

We will continue to build international partnerships to improve commercial opportunities for Australian renewable energy technology, such as the Australia-US Solar Thermal Research Initiative and the Australia-US Institute for Advanced Photovoltaics.

Other Policy Settings that Support Low-Emissions Innovation

Table 1: Policies supporting low-emissions technology and innovation

National Innovation and Science Agenda	The Agenda is a blueprint to transform Australia into a leading innovation nation. The Agenda includes new tax incentives for research and development, co-investment from the CSIRO Innovation Fund to commercialise new technologies and establishing Industry Growth Centres in key sectors of competitive advantage like oil, gas and energy resources. http://www.innovation.gov.au/page/agenda
Commonwealth Scientific and Industrial Research Organisation	CSIRO pioneers low-emissions technologies and provides knowledge which will help guide Australia towards a smart, secure energy future. CSIRO's current key research areas include low-emissions coal mining and energy production, energy storage, solar energy, electricity grid modelling and carbon capture and storage. https://www.csiro.au/en/Research/EF
Australian Research Council	The ARC provides Government support for research in Australia. It delivers policy and programs that advance Australian research and innovation globally and benefit the community. The National Competitive Grants Program, administered by the ARC, provides, on average, around $800 million a year in research support across the economy including to projects that contribute to reducing emissions. http://www.arc.gov.au/welcome-australian-research-council-website
National Climate Science Advisory Committee	The Committee provides the strategic direction for Australian climate science research to address business needs and policy development.
Clean Energy Finance Corporation	The CEFC uses financial products and structures to address the barriers inhibiting investment in clean energy technologies. The CEFC invests for a positive financial return. As at May 2017, the CEFC had made cumulative commitments of almost $3 billion. These projects and programs are catalysing a further $8.3 billion in other investment. CEFC commitments include more than 60 direct investments. http://www.cleanenergyfinancecorp.com.au/
Australian Renewable Energy Agency	ARENA's objectives are to improve the competitiveness of renewable energy technologies and increase supply of renewable energy in Australia. As at October 2016, ARENA had provided $1.1 billion in grant funding for more than 270 projects, drawing in a further $1.6 billion in other investment. Investments have spanned the commercialisation pathway. ARENA has $800 million of new funding available over the next five years. https://arena.gov.au/about-arena/

Support for low-emissions technology and carbon capture and storage	As at 31 December 2016, the Government is delivering $590 million of funding to low-emissions support programs and continues to encourage industry to reduce emissions through a range of low-emission technology measures. These are administered by the Department of Industry, Innovation and Science. The Government has contributed funding and support for an industry-led Carbon Capture and Storage Roadmap for Australia, released in February 2017. https://industry.gov.au/resource/LowEmissionsFossilFuelTech http://www.co2crc.com.au/comprehensive-support-carbon-capture-storage-australia/
Global Innovation Linkages program	The Global Innovation Linkages program provides funding to help Australian businesses and researchers to collaborate with global partners on strategically focused, leading-edge research and development projects. It supports projects focused on developing high quality products, services or processes that will respond to industry challenges. The program provides funding for business and researchers to collaborate with global partners on research and development projects. Projects must focus on priority areas and priority economies. The program is delivered by AusIndustry. https://www.business.gov.au/assistance/global-innovation-linkages-programme
Global Connections fund	The Global Connections Fund provides initial funding support to promote Australian Researchers and Small to Medium Enterprises (SMEs) collaboration The Program consists of two forms of funding: Priming Grants and Bridging Grants which are designed to: • increase linkages and collaborations with key global economies; • promote researcher-industry engagement and knowledge transfer; and • encourage translational activities, end use development and commercialisation outcomes. The fund is administered by the Australian Academy of Technology and Engineering. https://globalconnectionsfund.org.au/

Australia's Emissions Reduction Policies

Table 2: Australian Government emissions reduction policies

Emissions Reduction Fund	The Emissions Reduction Fund provides incentives for emissions reduction activities across the Australian economy. Under the Fund, a range of activities are eligible to earn Australian carbon credit units. Projects must comply with an approved method that measures verifiable reductions in emissions and sets out the rules for activities which can earn carbon credits. The Government purchases credits through a reverse auction system. The first four Emissions Reduction Fund auctions have contracted 178 million tonnes of emissions reductions at an average price of $11.83 per tonne. https://www.environment.gov.au/climate-change/emissions-reduction-fund
Safeguard Mechanism	The Safeguard Mechanism is part of the Emissions Reduction Fund. It is designed to ensure emissions reductions purchased by the Government are not offset by significant increases in emissions above business-as-usual levels elsewhere in the economy. The Safeguard Mechanism puts limits (baselines) on the emissions of facilities that emit more than 100,000 tonnes of emissions a year. These baselines cover around half of Australia's emissions, including facilities in the manufacturing, electricity, mining, oil and gas, transport and waste sectors. A single sectoral baseline applies to grid-connected electricity generators. https://www.environment.gov.au/climate-change/emissions-reduction-fund/about/safeguard-mechanism
Renewable Energy Target	The Renewable Energy Target scheme aims to encourage additional generation of electricity from renewable sources and reduce emissions in the electricity sector. The scheme provides a financial incentive for investment in new renewable energy projects. It aims to grow the share of renewable energy to around 23 per cent of electricity supply by 2020. The RET has two components. The Large-scale Renewable Energy Target of 33,000 GWh by 2020 encourages investment in large-scale projects. The Small-scale Renewable Energy Scheme helps home-owners and small businesses to install eligible small-scale renewable energy systems and solar hot water systems. https://www.environment.gov.au/climate-change/renewable-energy-target-scheme

National Energy Productivity Plan	The NEPP provides a framework and an initial economy-wide work plan designed to accelerate delivery of a 40 per cent improvement in Australia's energy productivity by 2030. The NEPP aims to boost competitiveness and growth, help families and businesses manage their energy costs and reduce emissions. The NEPP is driving change and accelerating energy productivity improvement through measures which support: smarter energy choices (by providing more efficient incentives, empowering consumers and promoting business action) better energy services (by driving greater innovation, more competitive and modern markets and updating consumer protections and standards). https://www.environment.gov.au/energy/national-energy-productivity-plan
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National Carbon Offset Standard	The National Carbon Offset Standards provide benchmarks for organisations seeking to make their operations, products, services, buildings, precincts or events carbon neutral. The Carbon Neutral Program provides a framework for certifying carbon neutrality against the National Carbon Offset Standards. http://www.environment.gov.au/climate-change/carbon-neutral
Solar communities	The Solar Communities program will support local responses to climate change and deliver lower electricity costs for community organisations. It will provide $5 million in funding for community groups in selected regions to install rooftop solar panels, solar hot water and solar-connected battery systems for community-owned buildings. https://www.environment.gov.au/climate-change/renewable-energy/solar-communities

Australia's international climate policies	Australia plays a leading role in global efforts to reduce emissions, including through the Asia Pacific Rainforest Partnership and the International Partnership for Blue Carbon. Australia supports the building of climate resilience in our region through the aid program. Australia shares expertise to support developing countries through capacity building programs on measurement, reporting and verification, particularly national inventories and in the forests and land sector. This work improves transparency and confidence in global mitigation efforts, including through international cooperation. https://www.environment.gov.au/climate-change/rainforest-recovery http://bluecarbonpartnership.org/

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2015
- Baseline Funding Amount: AUD $108 million (USD $80 million)
- Doubling Target-Year: 2020
- Doubling Target Amount: AUD $208 million (USD $156 million)

Methodology for Defining Baseline

Australia nominated a Mission Innovation baseline of $104 million, based on the 2015 figures reported to the International Energy Agency (IEA) for combined research and development into the following focus areas:

- renewable energy
- energy storage
- fuel cells
- smart grids
- energy efficiency
- nuclear
- carbon capture and storage.

This baseline has since been revised to AUD $108 million, reflecting differences between projected spend and actual spend in financial year 2015-16, as well as improved data in relation to the above activities.

The baseline excludes research and development spending on fossil fuels, electricity transmission and distribution networks, recoupable investments made by the Clean Energy Finance Corporation (CEFC), and expenditure on later stage deployment.

Country-Definition of Clean Energy R&D Investment

Research and development in low carbon technologies, including end use energy efficiency, renewable energy, nuclear energy, electric grid technologies, carbon capture and storage, and advanced transportation systems and fuels. Investments are implemented through a number of mechanisms including cost-shared projects with the private sector, research and development activities at the National Laboratories, grants to universities, and support for collaborative research centers targeted to key energy technology frontiers.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	●
Hydrogen & fuel cells	●
Cleaner fossil energy	
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

The Government's Innovation and Science Agenda outlines how we will transform our approach to innovation and science right across the economy with major new initiatives.

"The Australian Government recognises the importance of science, innovation and technology to our future prosperity and economic security as a nation in a rapidly expanding and diversifying global economy." Prime Minister Malcolm Turnbull, 27 October 2015.

The Australian Government's support for clean energy extends well beyond the research and development stage, and includes a comprehensive suite of policies to drive innovation and large-scale uptake across the energy supply chain.

More detail is available from the Prime Minister's website here.

Prime Minister Turnbull on Mission Innovation:

"We do not doubt the implications of the science, or the scale of the challenge. But above all we do not doubt the capacity of humanity to meet it - with imagination, innovation and the prudence that befits those, like us, who make decisions that will affect not just our own children and grandchildren but generations yet unborn.

Here in Paris Australia supports a new – and truly global – climate agreement. It is an agreement that must drive humanity's capacity for inventiveness and a new wave of technological advances. We firmly believe that it is innovation and technology which will enable us both to drive stronger economic growth and a cleaner environment.

We are a highly social and innovative species and so the more we share innovative technologies, the better they will become. Today Australia joins with many other countries in supporting Mission Innovation which aims to double investment in clean energy innovation over the next five years."
Full statement

Related websites:

Prime Minister's website

Department of the Environment and Energy

BRAZIL

Narrative

Brazil will seek to double its government and/or state directed investment in clean energy technology innovation over the next five years, focusing on renewable and clean energy technologies with the potential to reduce the cost, accelerate public and private partnerships for research, development, demonstration and deployment, and achieve meaningful scale to meet our energy security, economic prosperity, environment sustainability and climate change challenges.

The participation of renewables in the Brazilian energy matrix is around 45%, where the flagships are the sugar-cane ethanol and hydropower. The share of renewable energy sources in our electricity mix varies between 70% and 90%, which includes hydropower, biomass, wind power, and more recently, solar PV. In line with its goal to expand the use of renewable energy sources, Brazil intends that its total energy matrix reaches, by 2030, a share of 28% to 33% from renewable sources (electricity and biofuels) other than hydropower. Brazil also intends to increase the share of renewables – beyond hydropower – in its electricity generation mix to the level of at least 23% by 2030.

In 2015 the Brazilian Government spent approximately R$ 600 million (US$ 150 million) on clean energy technology research, development and demonstration activities. Brazil will seek to double this figure over the next five years. The full suite of low carbon technologies will be considered, including end use energy efficiency, renewable energy, biofuels, nuclear energy, electric grid technologies, carbon capture and storage and advanced transportation systems.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): FY 2015
- Baseline Funding Amount: BRL 600 million (USD $150 million)
- Doubling Target-Year: FY 2020
- Doubling Target Amount: BRL 1.2 billion (USD $300 million)
- First-Year Mission Innovation Funding Amount: BRL 720 million (USD $180 million)
- First-Year Mission Innovation Funding Increment: BRL 120 million (USD $30 million)
- First-Year Funding Percent Increase: 20%

Methodology for Determining Baseline

Survey on clean technologies investments implemented in 2015.

Country-Definition of Clean Energy R&D Investment

Research, development and demonstration in low carbon technologies, including end use energy efficiency, renewable energy, biofuels, nuclear energy, electric grid technologies, carbon capture and storage, and advanced transportation systems and fuels.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	●
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Related websites:

National portal

Ministry of Mines and Energy

CANADA

Narrative

All around the world, people are embracing innovation and the opportunities it brings - opportunities to rethink everything from how we build our cities, to how we grow our economy. Innovation can do more than just drive strong economic growth. It also has the potential to solve the big challenges that face Canadians and their communities.

Innovation and clean technologies are key components of the Government of Canada's approach to promoting sustainable economic growth and will play a crucial role in Canada's transformation into a low-carbon economy. Investing in the research, development and demonstration (RD&D) of new clean energy technologies accelerates the innovation required to bring these technologies closer to commercialization.

Through its participation in Mission Innovation, the Government of Canada aims to:

- Double federal investment in clean energy research and development over five years, from C$387 million in 2014-2015 to C$775 million by 2019-2020;
- Encourage private sector investment in early-stage clean energy innovation companies in Canada; and
- Increase domestic and international collaboration to advance Mission Innovation goals.

"Canada is proud to be a partner in this ambitious global initiative. By working together, we will deliver real benefits for our environment while also strengthening our economy, including through the creation of more middle class jobs.

A strong economy and healthy environment go hand-in-hand, and we are committed to leaving our children and grandchildren with a more sustainable and prosperous country. Mission Innovation will tap into the vast economic opportunities of our environment by helping to create the growth and jobs Canadians need."

– Rt. Hon. Justin Trudeau, Prime Minister of Canada

English text
French text

Implementation

Doubling Canada's federal funding for energy research, development and demonstration (RD&D) requires a whole of government approach. Natural Resources Canada (NRCan) plays a leadership role in federal RD&D activities as a funder, through the Office of Energy Research and Development, and performer, through its CanmetENERGY and CanmetMATERIALS laboratories.

In carrying out its activities, NRCan works in collaboration with many other departments, agencies and federally-funded, arms-length organizations. In all, 18 federal organizations fund energy RD&D, with the following organizations accounting for over 90 percent of the Government of Canada's energy RD&D spending in 2015-2016:

- Natural Resources Canada
- Atomic Energy of Canada Limited
- Natural Sciences and Engineering Research Council of Canada
- Sustainable Development Technology Canada; and
- National Research Council

The remaining federal investment in energy RD&D is shared between thirteen organizations: Canada Foundation for Innovation, Transport Canada, Atlantic Canada Opportunities Agency, Western Economic Diversification, Agriculture and Agri-foods Canada, Environment and Climate Change Canada, the Canadian Nuclear Safety Commission, Defence Research and Development Canada, the Canadian Mortgage and Housing Corporation, Federal Economic Development Agency for Southern Ontario, Federal Economic Development Initiative for Northern Ontario, Genome Canada, and Polar Canada.

Canada's federal energy RD&D investments target greenhouse gas reductions in Canada's five highest emitting sectors:

- Electricity generation
- Transportation
- Buildings
- Oil and gas
- Emissions-intensive industries (e.g., cement, chemicals, iron and steel)

Baseline and Progress

Canada's baseline of C$387 million is based on federal energy RD&D expenditures as identified in the *International Energy Agency's Survey of Energy RD&D Expenditures*. The baseline is composed of reported federal expenditures for fiscal year 2014-15 of Natural Resources Canada and 14 other federal departments, agencies and organizations.

In 2015-16, Canadian federal departments, agencies and organizations increased their energy RD&D expenditures by 24% relative to the baseline year (2014-15). In all, 18 federal organizations reported expenditures of C$479M. This increase was largely driven by capital investments in research infrastructure at Canada's national nuclear laboratories, as well as the construction of first-of-kind large demonstration-scale facilities for the production of next-generation renewable fuels.

Highlights

Since the UN Climate Change Conference (COP21) in Paris, the Government of Canada has moved quickly to take the necessary steps to begin implementation of its Mission Innovation commitment.

Over the past year, the Government of Canada has implemented several targeted clean energy programs announced in Budget 2016, including to support RD&D of clean energy technologies; to reduce GHG

emissions from the oil and gas sector; to advance technology for charging electric vehicles; to advance clean technology projects that address climate change, air quality, clean water, and clean soil; and to enhance regional development agencies' support for clean technology development. Investments in these initiatives are expected to total around $280 million over two to four years. The Government of Canada has also committed investments of $800 million over five years to revitalize infrastructure at Chalk River Laboratories – Canada's largest science and technology complex – some of which will fund important clean energy infrastructure such as the Harriet Brooks Building, a state-of-the-art nuclear materials and process research facility named after Canada's first female nuclear physicist.

In December 2016, the Government of Canada signed a Pan-Canadian Framework on Clean Growth and Climate Change with provinces and territories, which will serve as the basis for action to meet or exceed Canada's 2030 emissions targets and transition Canada to a stronger, more resilient low-carbon economy. Accelerating innovation to support clean technologies and create jobs was a key pillar of the Framework, alongside pricing carbon pollution, complementary measures to further reduce emissions, and measures to adapt to the impacts of climate change and build resilience.

Going forward, the Government of Canada has announced significant spending to deliver on the Pan-Canadian Framework on Clean Growth and Climate Change and to boost the growth of Canada's clean technology sector:

- $400 million over 5 years to support projects across Canada to develop and demonstrate new clean technologies that promote sustainable development, including those that address environmental issues such as climate change.
- $229 million over 4 years to continue R&D activities through existing clean energy and clean transportation innovation programming.
- $200 million over 4 years to support clean technology research, and the development, demonstration and adoption of clean technology in Canada's natural resources sectors.
- $75 million over 2 years for a new mission- or "challenge"-based approach to accelerate efforts toward solving Canada's big challenges, such as helping Canada's rural and remote communities reduce their reliance on diesel as a power source.

Canada also plans to invest $21.9 billion over the next 11 years in green infrastructure, including through bilateral agreements with provinces and territories, through the creation of a Canada Infrastructure Bank, and through a series of national programs that support clean technology demonstrations.

The Government of Canada is also working to increase domestic and international collaboration to advance Mission Innovation goals. Domestically, under the Canadian Energy Strategy (CES), provincial and territorial Ministers have welcomed the collaboration of the federal government in the areas of energy technology and innovation, energy efficiency and energy delivery. As part of an annual Energy and Mines Ministers' Conference, to be held in August 2017, federal, provincial and territorial governments are exploring opportunities for collaboration in clean technology, and enhancing partnerships and collaboration on international energy issues, including opportunities to enhance provincial and territorial engagement in Mission Innovation.

Underpinning these domestic efforts is "Generation Energy", a national dialogue on Canada's path to a low-carbon future recently launched by the Minister of Natural Resources. The dialogue invites all Canadians to share their ideas and participate in helping to define Canada's energy future, ultimately

leading to the development of an approach focused on how the federal government can work with the provinces and territories to create the affordable energy and innovative jobs Canadians want.

Internationally, the Government of Canada continues to explore opportunities for collaboration with international partners. We have a strong history of collaboration with our North American neighbours. In February 2017, Canada's Prime Minister and the President of the United States issued a joint statement noting close cooperation in the area of clean energy innovation. Canada also works with the United States and Mexico in a trilateral context framed by a Memorandum of Understanding Concerning Climate Change and Energy Collaboration that was signed in Winnipeg on February 12, 2016. In June, 2016, Canada, the United States, and Mexico recognized Mission Innovation as a key initiative to accelerate clean energy innovation in a leader's statement on a North American Climate, Clean Energy, and Environment Partnership.

Other key Mission Innovation country partners with whom Canada also collaborates include China, South Korea and India. On February 25, 2016 a Joint Declaration on Canada-China Clean Technology Cooperation was signed in Ottawa. On September 1, 2016, as part of Prime Minister Trudeau's first official visit to China, Canada and China announced their intention to establish a working group under the Joint Declaration on Clean Technology. At its inaugural meeting in Ottawa on May 17, 2017, the Canada-China Clean Technology Working Group agreed on a Terms of Reference and identified technology areas for collaboration. Canada is also collaborating with China on a nuclear energy cooperation Work Plan under a Memorandum of Understanding signed November 8, 2014. Natural Resources Canada signed a Memorandum of Understanding on Cooperation in Innovation and Energy Technologies with the Korean Ministry of Trade, Industry and Energy on March 3, 2016 at the GLOBE Summit in Vancouver. On September 9, 2016, Natural Resources Canada released a Joint Statement on Enhancing the Canada-India Energy Dialogue in collaboration with India's Ministry of Petroleum and Natural Gas and Ministry of New and Renewable Energy. Together, these instruments frame bilateral laboratory, regulatory, government, and industry engagement to meet a variety of clean energy research, policy development, and trade objectives.

Finally, Canada also participates alongside Mission Innovation members in multilateral fora to promote clean energy solutions, exchange information and expertise, and advance technological development. These fora include, among others, the Clean Energy Ministerial, the International Energy Agency, the Nuclear Energy Agency, and the Generation IV International Forum.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): FY 2014-15
- Baseline Funding Amount: CAD $387 million (USD $295 million)
- Doubling Target-Year: FY 2019-20
- Doubling Target Amount: CAD $775 million (USD $590 million)

Methodology for Determining Baseline

Based on federal energy RD&D expenditures as identified in the *International Energy Agency's Survey of Energy RD&D Expenditures*. The baseline is composed of reported federal expenditures for fiscal year 2014-15 of Natural Resources Canada and 14 other federal departments, agencies and organizations. Of these 15 federal contributors to the Mission Innovation baseline, the following six organizations constituted over 90% of Government of Canada spending on energy RD&D:

- Through collaboration with academia, industry and other governmental partners, **Natural Resources Canada** (NRCan) is a performer and a funder of research, development and technology demonstrations to find innovation solutions to environmental challenges in the energy sector.
- With a focus on discovery research and innovation, the **Natural Sciences and Engineering Research Council** (NSERC) facilitates partnerships between Canada's universities, colleges and industry, and the training of Canada's next generation of scientists and engineers.
- **Atomic Energy of Canada Limited** (AECL), a federal Crown corporation responsible for enabling nuclear science and technology at its nuclear laboratories through a Government-owned, Contractor-operated model.
- As a federally-funded, arms-length organization focused on technology development and demonstration, **Sustainable Development Technology Canada** works to bring economically viable clean technologies closer to market.
- The **National Research Council** is a national research and technology organization that works with clients and partners to provide innovation support, strategic research, and scientific and technical services.
- Through investments in research infrastructure – including state-of-the-art equipment, databases, and laboratories – the **Canada Foundation for Innovation** allows researchers to push the boundaries of knowledge, explore the unknown and generate exciting outcomes that benefit humankind.

The remaining federal investment in energy RD&D is shared between nine organizations: Transport Canada, Atlantic Canada Opportunities Agency, Western Economic Diversification, Agriculture and Agri-foods Canada, Environment and Climate Change Canada, the Canadian Nuclear Safety Commission, Defence Research and Development Canada, Indigenous and Northern Affairs Canada, and the Canadian Mortgage and Housing Corporation.

Country-Definition of Clean Energy R&D Investment

The research, development, and demonstration of technologies that provide solutions covering the span of energy supply (e.g., fossil fuels, wind, bioenergy, nuclear), energy transmission (e.g., smart grid, energy storage), and energy use (e.g., buildings, transportation); as well as solutions that improve operational performance or process efficiency, while reducing energy use, waste or environmental pollution.

Federal investments are implemented through a number of mechanisms including: cost-shared projects with the private sector that often leverage provincial and territorial funding programs, research and development activities at National Laboratories and Research Centers, and grants to universities.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	
Vehicles & other transportation	
Bio-based fuels & energy	
Solar, wind & other renewables	
Nuclear energy	
Hydrogen & fuel cells	
Cleaner fossil energy	
CO_2 capture, utilization & storage	
Electricity grid	
Energy storage	
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Webinar:

Clean Energy Innovation in Canada, November 2016

Related websites:

Prime Minister's website

Mission Innovation – Natural Resources Canada

Canada Doubles Government Investment in Clean Energy Research and Development, June 2, 2016

Prime Minister Announces Action on Clean Jobs and Energy, November 30, 2015

Canada's Participation in Mission Innovation, November 30, 2015

Ministry of Natural Resources

CHILE

Narrative

Overview: The Long Term Energy Policy 2050

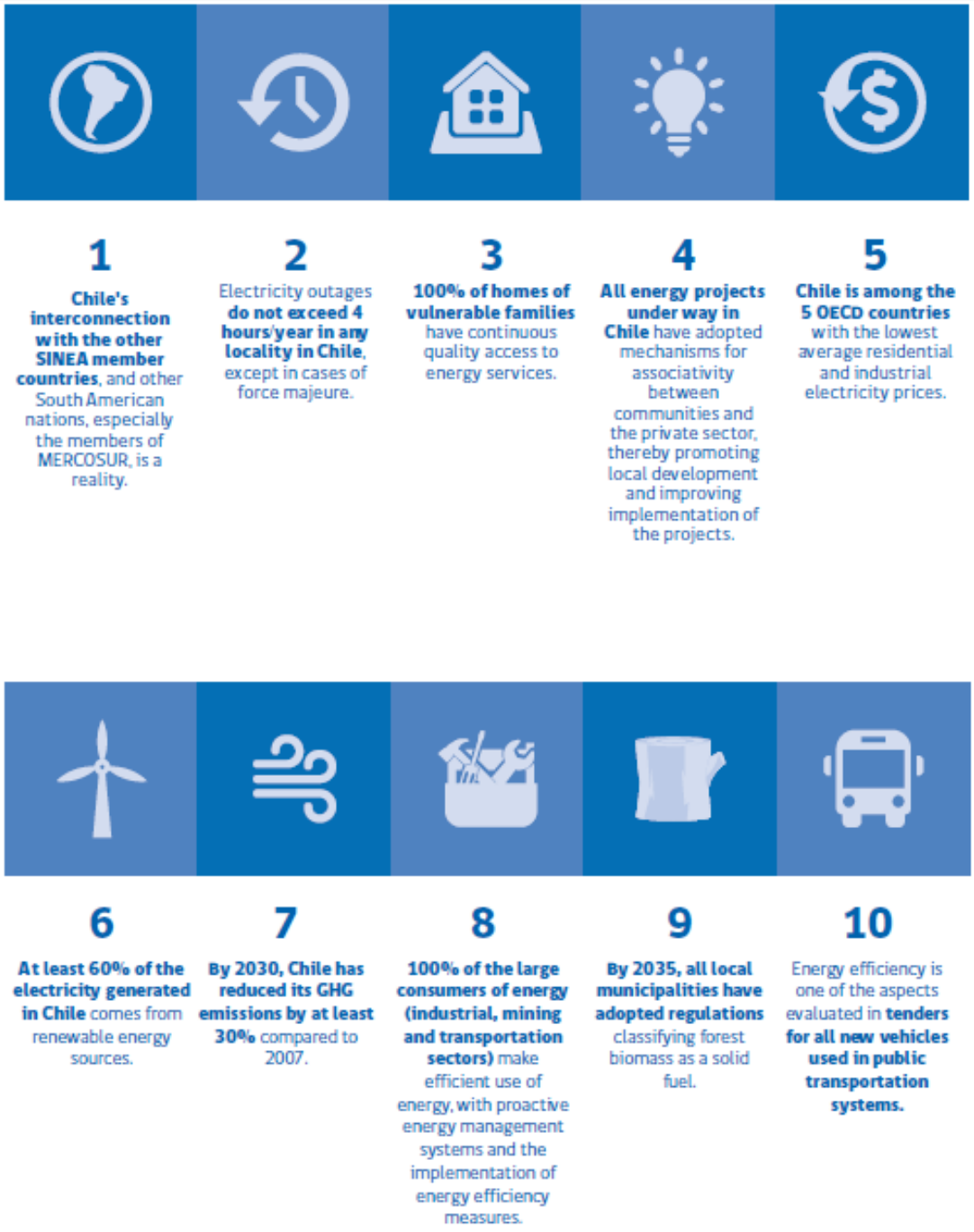
For Chile and its path to development, energy is a key strategic factor for reaching the economic and social development goals. When energy is obtained and used optimally, a virtuous circle is generated, and directly impacts economic growth, offers opportunities to care for the environment, and favors people's well-being, thus allowing society to move towards equitable and sustainable development.

In the context of the Energy Agenda, -a road map for the development of our country´s actions in this sector- a discussion process was carried out including key stakeholders from the public sector, industry, academia, civil society, people from a number of regions of the country, and a variety of representative citizens. The goal was to develop the country's long-term Energy Policy. An Advisory Committee led by the Minister of Energy and composed of key participants from the sector was convened with regional and national representation. The members form part of various ministries and public institutions, trade associations, civil society, and Chilean universities.

The Energy Policy proposes a vision of Chile's energy sector by the year **2050** as being **reliable**, **inclusive**, **competitive** and **sustainable**. This vision is part of a systemic approach in which the main goal is to achieve and maintain the reliability of the entire energy system while meeting sustainability and inclusion criteria and contributing to the competitiveness of the nation's economy. These attributes will allow us to move forward towards sustainable energy in all of its dimensions.

In order to make this vision a reality by 2050, the Energy Policy is sustained by four pillars**: Security and Quality Supply, Energy as a Driver for Development, Environmentally-friendly Energy**, and **Energy Efficiency and Energy Education**. The proposed measures and action plans shall be developed on the basis of these pillars between 2016 and the year 2050.

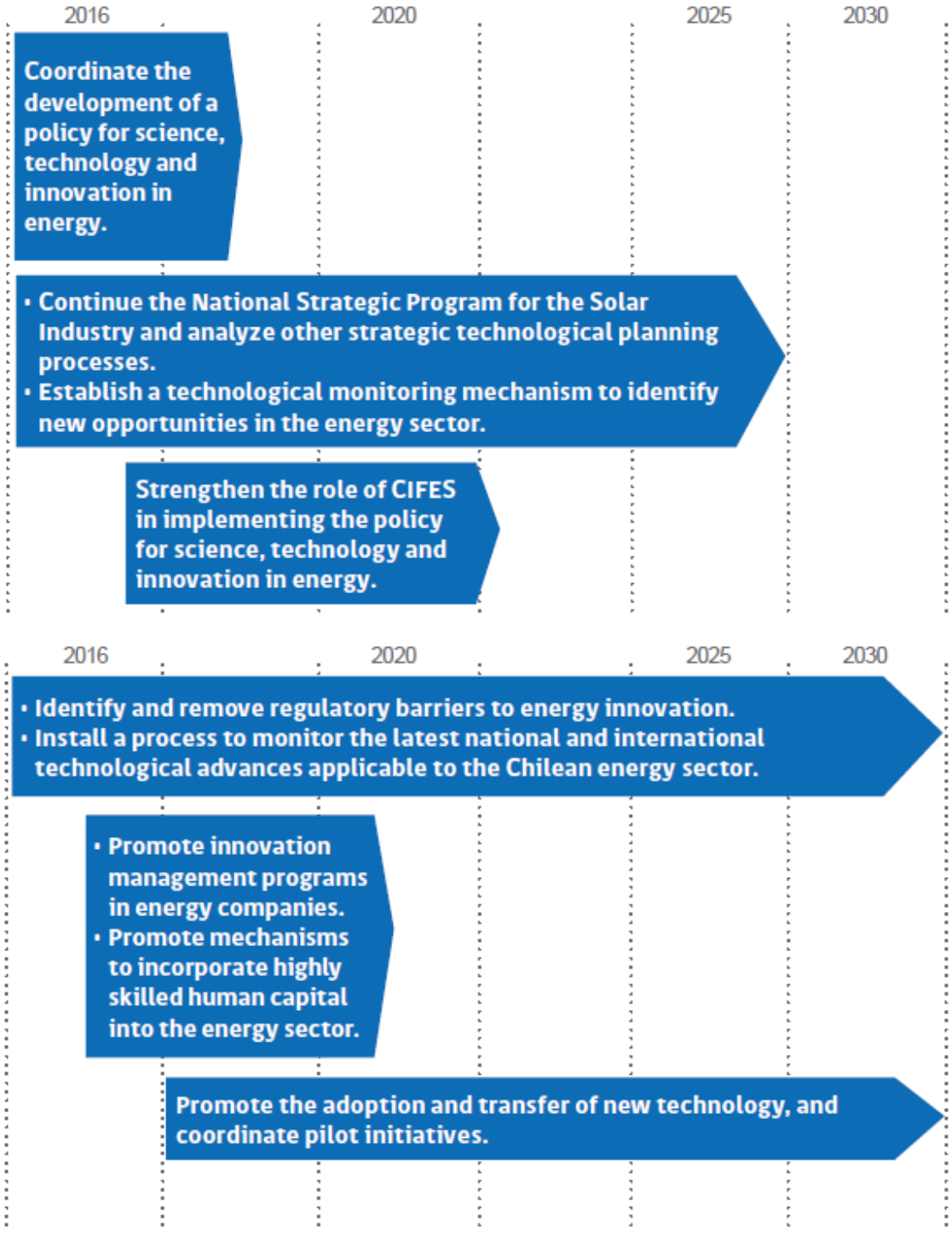
Main Goals of the Energy Policy – 2035

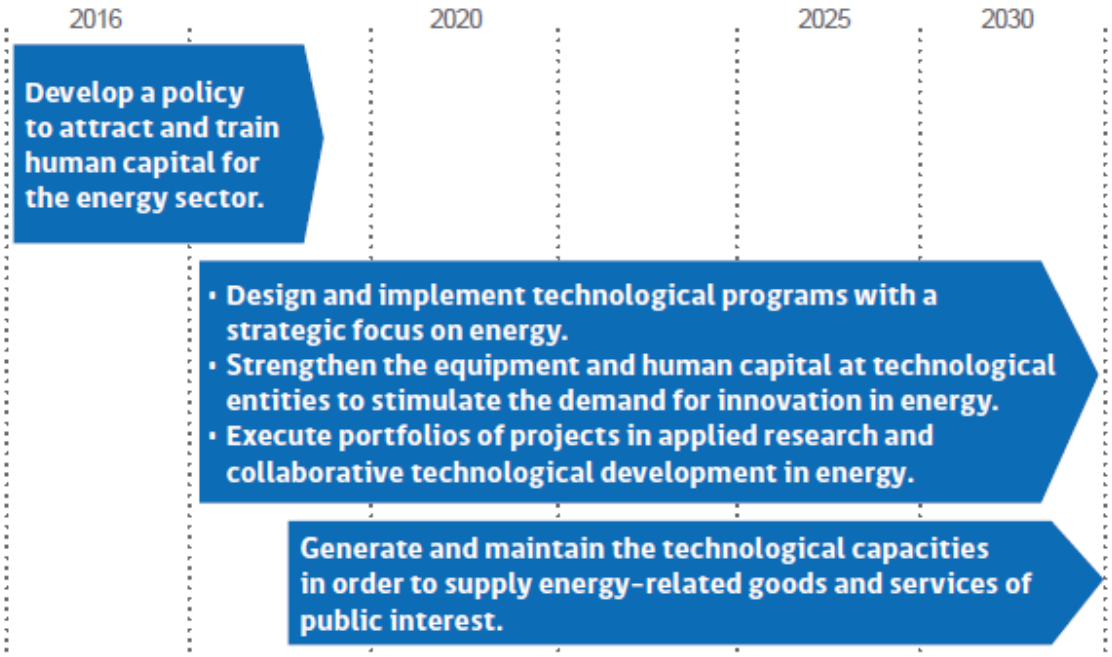


Main Goals of the Energy Policy - 2050

The Chilean target for doubling governmental investment in clean energy innovation as part of Mission Innovation is USD 9 MM by the year 2020. However, we expected that this target will be surpassed.

Innovation initiatives for next years





General remarks

Currently Chile is pushing a science, technology and innovation strategy, identifying the next research and development focus, beyond solar energy, as was already defined and agreed upon. According to the Long Term Energy Policy, the goal for innovation by 2035 is “Chile has become an exporter of technology and services for the solar industry”, and by 2050 are “Chile has become an exporter of technology and services for specific energy innovations” and “Innovation policies in the energy industry contribute to achieving a reduction in energy consumption.”

Baseline and Funding Plans

- Country-Determined Baseline Year(s): FY 2015
- Baseline Funding Amount: USD $4.1856 million
- Doubling Target-Year: 2020
- Doubling Target Amount: USD $9 million

Country Definition of Clean Energy R&D Investment

For Chile, energy is a driving force for the country's development, but not just any type of development: Chile's development must be respectful of people, of the environment and of productivity, and must ensure continuous improvement of living conditions. So according to this statement, and considering that there is no official definition of this concept, clean energy will be understood as all kinds of energy based on low emissions levels that contribute to reaching this multidimensional development.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	
Vehicles & other transportation	
Bio-based fuels & energy	
Solar, wind & other renewables	
Nuclear energy	
Hydrogen & fuel cells	
Cleaner fossil energy	
CO_2 capture, utilization & storage	
Electricity grid	
Energy storage	
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Public energy innovation budget

	FY 2015[2] MI Baseline (thousand USD)	FY 2016 MI Budget (thousand USD)
Renewable Energy	**3,551.7**	**4,611.2**
Solar Energy	1,246.2	3,929.6
Marine Energy	-	681.6
Biofuels	1,890.5	-
Clean Energy Access	415.1	681.6
Energy Efficiency	**633.8**	**582.3**
Mining Technologies	633.8	-
Industry Technologies	-	582.3
Total	**4,185.6**	**5,193.5**

The Chilean target for doubling governmental investment in clean energy innovation as part of Mission Innovation is USD 9 MM by the year 2020. However, we expected that this target will be surpassed.

Related websites:

Government of Chile

Ministry of Energy

[2] These figures correspond to an updated calculation of Chile's governmental investment in clean energy innovation in the year 2015.

CHINA

Narrative

In support of economic growth, energy access and security, and an urgent and lasting global response to climate change, China jointly announced the "Mission Innovation", to accelerate the pace of clean energy innovation to achieve performance breakthroughs and cost reductions to provide affordable and reliable clean energy solutions that will revolutionize energy systems throughout the world over the next two decades and beyond.

I. Baseline and Target

The R&D input of China in clean energy totaled 25 billion RMB (roughly 3.8 billion US dollars) in 2015, which was set as the baseline and baseline year of China on "Mission Innovation".

China's Doubling Plan target on "Mission Innovation" seeks to double the governmental and/or state-directed investment in clean energy research and development over five years, which means increasing in the input to 50 billion RMB (roughly 7.6 billion dollars) by 2020.

II. Priority Fields Input

The Chinese Government is promoting the revolution of energy production and consumption. China is dedicated to clean and efficient utilization of coal resources, and the development of non-coal energy, oil, gas, so as to form an energy supply system driven by balanced development of coal, nuclear and new energy and renewable energy, simultaneously consolidating the power transmission and distribution net, as well as the construction of storage facilities.

Resources' saving is explicitly emphasized in the strategy of "Comprehensively promoting the development of an ecological civilization". The Chinese Government is dedicated to economic and concentrated utilization of resources, to promote fundamental change of energy utilization, and strengthen the whole process management to sharply reduce the density of energy consumption, including energy, water, land, and enhance the efficiency and effectiveness of energy utilization, to facilitate the revolution of energy production and consumption, support the development of energy-efficient and low-carbon industries, new energy and renewable energy industries.

In the context of the national strategies and the energy mix, China hereby proposes that "clean energy" on "Mission Innovation" covers **safe, clean and efficient development and utilization of coal and new energy-saving, renewable energy and hydrogen energy technology, advanced nuclear energy and nuclear safety, smart grid, energy conservation in buildings, clean smart car**, etc.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2015
- Baseline Funding Amount: RMB 25 billion (USD $3.8 billion)
- Doubling Target-Year: 2020
- Doubling Target Amount: RMB 50 billion (USD $7.6 billion)

Country-Definition of Clean Energy R&D Investment

In the context of the national strategies and the energy mix, China hereby proposes that “clean energy” on “Mission Innovation” covers the clean utilization of coal (including carbon capture and storage) , renewable energy(including solar and solar-thermal), smart grid, bio-energy, hydro power, nuclear fission and fusion, energy storage and deployment of clean energy vehicles (electric vehicles), etc.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Biofuels	
Solar, wind & other renewables	●
Nuclear energy	●
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country’s full R&D portfolio.

Additional Information

Related websites:

The State Council of the People's Republic of China

Ministry of Science and Technology

National Development and Reform Commission

DENMARK

Narrative

Denmark has chosen to strengthen our dedicated public investment in clean energy research, development and demonstration focusing on reduction of technology costs and CO2 emissions and with an emphasis on innovative projects that can be replicated and scaled up with the involvement of private investors. We will seek to double these efforts departing from a baseline of the average funding to the Danish Energy Technology Development and Demonstration Programme (EUDP) of the years 2015-2016 and until 2020.

Energy Technology and Demonstration Programme

The Danish energy research programme, *Energy Technology and Demonstration Programme (EUDP),* is institutionally part of the Danish Ministry of Energy, Utilities and Climate, and embedded in the Ministry's energy agency, the Danish Energy Agency. EUDP funds energy related R&D projects based on the following provisions and strategies:

- The Act on EUDP of 22 December 2010, being the legal provision for the programme
- EUDP Strategies providing direction on areas and principles of support. The Strategies are reviewed and revised on a four-year basis
- Calls from the EUDP Secretariat providing detailed guidance for applicants
- Earmarked funding for politically designated areas.

Act on EUDP

The Act on EUDP is relatively broad in its scope as it aims at supporting the policy objectives of security of supply, considerations for the global climate and for a cleaner environment, as well increased cost-effectiveness. Specifically, it aims at making Denmark independent of fossil fuels. At the same time, the objective is to promote exploitation and development of business potentials and to foster growth and employment.

EUDP is tasked to:

- Provide funding primarily for development and demonstration projects;
- Actively promote public-private collaboration, and
- Strengthen involvement in international activities and programs within energy technology.

EUDP is a quasi-independent institution and is managed by an independent board comprising a chairperson and six members. The board members are appointed by the Minister for Energy, Utilities and Climate for a period of four years.

In terms of scope the vast majority of EUDP grants are allocated to the projects within the following fields of technology: biomass technologies, systems for transport and energy, wind power and other renewable energy technologies, hydrogen and fuel cell technologies, low energy buildings, energy efficient solutions energy system technologies (integration of technologies), energy efficiency measure

for oil and gas, and more efficient and environmentally friendly production in general (heat and power), including CCS.

4-year rolling strategies

The EUDP board is responsible for drafting a four-year strategy, which outlines key areas and principles for supporting and funding projects over the coming period. The strategy normally takes its point of departure in the strengths and needs of the Danish and the global energy systems. A key feature of the strategy is technology neutrality. Instead, more generic criteria such as *cost-effectiveness* and *unique value-proposition* are used as core principles when devising strategies. Another key feature is that the EUDP programme is evaluated after each four-year period in order to gauge its impact and efficiency. Currently, the acting board is drafting a new strategy for the period 2016-2019.

Open calls

The EUDP Secretariat publishes calls for proposals twice a year (spring and autumn), although the frequency depends on the amount of funding to be leveraged. Each call specifies in detail what is required of applicants. The calls are open calls where applicants are encouraged to display their own ideas and project proposals based on new technology and related business plans. Foreign companies, research institutions and universities are allowed to participate in EUDP-projects and to receive funding on an equal footing with Danish participants as long as the lead partner in the project is based in Denmark.

Earmarked funding

In exceptional cases where there is a political aspiration to provide direct stimulus to a specific field of technology in a national context, earmarked funding is provided through the annual Financial Act. Such funds are outlined in dedicated calls. However, these funds are administered in the same way as other EUDP funds and it is the board of EUDP that decides which projects will receive funding.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): FY 2015-16
- Baseline Funding Amount: DKK 292 million (USD $45 million)
- Doubling Target-Year: FY 2020
- Doubling Target Amount: DKK 580 million (USD $90 million)

Methodology for Determining Baseline

The Danish efforts to strengthen our dedicated public investment in clean energy research stems from a baseline that is based on the average public funding to the Danish Energy Technology Development and Demonstration Programme (EUDP) of the fiscal years 2015-2016.

Country-Definition of Clean Energy R&D Investment

The Danish definition of *Clean Energy* for Mission Innovation purposes is based on the approach of the Energy Technology Development and Demonstration Programme, which primarily supports the following technologies: Biomass technologies, systems for transport and energy, wind power and other renewable energy technologies, hydrogen and fuel cell technologies, low energy buildings, energy efficient solutions, energy system technologies (integration of technologies), energy efficiency measures for oil and gas, and more efficient and environmentally friendly production in general (heat and power), including CCS.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Related websites:

State Ministry

Danish Ministry of Energy, Utilities and Climate

Danish Energy Technology Development and Demonstration Program (EUDP)

EUROPEAN UNION

Narrative

The European Union (EU) is a strong advocate in the fight against climate change and the transition towards a cleaner, less polluting energy system. Having taken over the chairmanship of the Mission Innovation Steering Committee in February 2017, the EU is a fully committed partner to the global endeavour of Mission Innovation, representing a key vehicle towards accelerating global clean energy innovation and achieving a clean energy which is widely affordable.

The EU's Energy Union strategy – the reference frame for the EU's energy and climate policy – is a pillar of this commitment, made up of five closely related and mutually reinforcing dimensions:

- Security, solidarity and trust: Diversifying Europe's sources of energy and making better, more efficient use of energy produced within the EU;
- A fully-integrated internal energy market: Enabling energy to flow freely across the EU without any technical or regulatory barriers;
- Energy efficiency: Energy efficiency first – it will reduce our dependence on energy imports, whilst reducing emissions;
- Climate action – decarbonising the economy: Supporting ambitious climate policy as an integral part of the energy policy and fostering EU global leadership in renewables;
- Research, innovation and competitiveness: Supporting breakthroughs in low-carbon technologies by prioritising research and innovation to drive the transition of the energy system and improve competitiveness.

"The global clean energy transition is ongoing and irreversible. The Paris agreement is an unprecedented success of multilateral partnership between countries across the world. Mission Innovation and the Clean Energy Ministerial are key to reach the goals of Paris and reap the benefits of the clean energy transition. This also represents a tremendous global economic and industrial opportunity. The world can count on Europe to maintain its leadership in providing a global response to climate change and accelerating the pace of clean energy innovation worldwide".

Maroš Šefčovič

Vice-President responsible for the Energy Union

'Mission Innovation is a perfect complement to the initiatives we have launched at EU level, as part of our Energy Union policy. It is a very clear expression of our view that the global challenges of climate change and the need to move to a low-carbon economy will only work through international cooperation. These are challenges that we cannot tackle alone. We need to be open to learn from each other. Open to cooperate with each other. Open to find solutions together.'

Carlos Moedas

Commissioner for Research, Science and Innovation

Preparatory meeting for the 2nd Mission Innovation Ministerial in Beijing (MI-2), Brussels, 1 March 2017

The shift to a low-carbon energy system, and the even broader decarbonisation agenda inherent in the agreement reached at COP21 in Paris, is perhaps the biggest transformative project of the twenty-first century. It is fitting therefore that research and innovation plays a key role in the Energy Union strategy, as one of its five core dimensions and contributing to the other four.

By the end of 2016, the European Commission presented its 'Clean Energy for all Europeans' package containing a set of legislative proposals and a set of actions to Accelerate Clean Energy Innovation, targeting three overarching goals: (i) energy efficiency first, (ii) Europe as a leader in renewables, and (iii) a fair deal to consumers.

'The European Commission is stepping up efforts to implement the 2030 energy and climate targets; targeting investments to meet our goals and developing new, affordable clean energy solutions. Mission Innovation is instrumental in this respect. And it is more than an instrument; it is also an opportunity for us to engage with our international partners and provide urgent, collective solutions.'

Miguel Arias Cañete

Commissioner for Climate Action and Energy

Brussels, 22 May 2017

The 20 actions to accelerate clean energy innovation are addressing economic incentives, regulatory bottlenecks, private investment, European funding in key priority sectors, as well as reinforcement of international cooperation. On the later, the engagement of the European Commission to play a leading role within the global Mission Innovation initiative on behalf of the European Union is among the key actions. This engagement will represent the major input of the European clean energy research and innovation to the Paris Agreement and will have a specific focus on leveraging private investments.

Innovation Challenges

The European Union (EU) is deeply engaged in the Mission Innovation Challenges, where it has expressed its commitment to engage in all challenges and co-leads two of them: the Converting Sunlight into Storable Solar Fuels Innovation Challenge, and the Affordable Heating and Cooling of Buildings Innovation Challenge. These will be key areas of interest for the EU, where it seeks to identify gaps and opportunities for researchers, innovators and investors, and to foster international collaborations that will lead to the development of new innovative clean energy technologies and solutions.

Converting Sunlight into Storable Solar Fuels Innovation Challenge

The EU is fully committed to developing breakthrough energy innovation in the framework of the Converting Sunlight Innovation Challenge, which the European Commission (EC) co-leads alongside Germany. The objective of the Converting Sunlight Innovation Challenge (IC5) is to stimulate international cooperation and exchange in this area, with the ultimate goal of discovering affordable ways to convert sunlight into storable solar fuels.

The current energy demand is primarily met through burning fossil fuels such as coal, crude oil and natural gas. Not only is this situation currently unsustainable, but as energy demand is foreseen to increase to meet global needs, the continuous use of fossil fuels to satisfy this demand is simply untenable given our common goal to keep global warming well below 2 degrees Celsius, as set out in the Paris Agreement. Producing carbon-neutral clean fuels and developing breakthrough energy storage chemicals will not only contribute to mitigating climate change, they will also serve to enhance energy security and will provide opportunities for economic development across the globe.

By co-leading this challenge, the EC is fully committed to the development of new technologies that can deliver sustainable 'solar' alternatives to fossil fuels and meet the current energetic demand. In this context, Artificial Photosynthesis (AP) is amongst the most promising new technologies and is often considered as a potential 'game changer' technology in the fields of energy conversion and energy production, becoming thus a key area of interest for the EU energy research and innovation programmes. Europe occupies a frontline position in AP research, with 60% of the estimated 150 leading global research groups located in Europe. Moreover, over €30 million have been spent in the field of AP under the EU's research and innovation framework programme between 2002-2013, with 20 projects almost all related to the topics of photoelectrocatalysis (55%) and synthetic biology & hybrid systems (44%)[3]. The EC is also committed to other alternative means to convert sunlight into storable solar fuels, such as through high temperature thermochemical pathways, where Europe is also a key player.

Within this Innovation Challenge, it is intended to stimulate international cooperation in the following six focus areas:

1. Catalyst development for water splitting and CO2 reduction (oxygen evolution reaction - hydrogen evolution reaction - and CO2 reduction reaction);
2. Improved light-harvesting and efficient charge separation in photocatalytic systems;
3. Cyanobacteria or micro-algae that excrete fuels into a surrounding medium;
4. Photoelectrochemical cells;
5. Thermochemical pathways to energy rich chemicals (using concentrated solar light); and
6. Design and engineering of devices for the production of energy rich chemicals.

Affordable Heating & Cooling of Buildings Innovation Challenge

The European Commission also co-leads the Affordable Heating and Cooling (H&C) of Buildings Innovation Challenge, along with the United Kingdom and the United Arab Emirates. The ultimate goal of this Innovation Challenge is to make low-carbon H&C affordable for everyone, through the development of systems and measures to provide affordable solutions for the decarbonisation of the H&C sector and through the promotion of increased cooperation among the Members within the Challenge.

Heating and cooling is a standing policy priority for the EU, making this Challenge coherent with one of the EU's top energy concerns. H&C represents 50% of the final energy consumption in the EU and is the largest energy end-use sector, ahead of transport and electricity. 75% of Europe’s H&C needs are supplied by fossil fuel (gas represents 67% and most of it is imported), whereas renewable energy sources supply less than 20% of H&C needs (18%). H&C affects each and everyone’s daily comfort and represents a key element for Europe’s competitiveness.

Decarbonising the EU H&C sector contributes to the three core objectives of the EU energy policy: (i) to make the EU economy energy-secure, by reducing the reliance on gas and oil imports; (ii) to make it more sustainable, by reducing GHG emissions and the environmental and societal costs of coal and heating oil; (iii) to contribute to EU's economic growth, by creating new economic and business opportunities in the EU.

[3] EU Bookshop

The European Commission is addressing the challenge of making the H&C sector more efficient, sustainable and smart through its action at regulatory level and through other enabling actions, in particular research and innovation.

In relation to the policy and regulatory framework, following the adoption of the H&C Strategy in 2016, the Commission presented the Clean Energy for all Europeans legislative package highlighting the synergies between energy efficiency and renewable energy. Addressing the potential of renewable energy in the H&C sector is one of the objectives of the review of the Renewable Energy Directive. With the proposals on energy efficiency on the other hand we outline that integrated planning and long term vision are needed to act on the inefficient and old systems and appliances and significantly increase the renovation rate of EU buildings stock; we therefore facilitate refurbishment since it represents an opportunity to modernize the systems and increase the penetration of innovative and renewable technologies in the H&C sector as well.

In terms of research and innovation, H&C is part of the European Strategic Energy Technology Plan (SET Plan) priority on energy-efficient systems, with a focus on buildings. Linking electricity and heat sectors or linking industry and buildings allowing the recovery of waste heat are examples of the vision that we have for the H&C sector. H&C is among the selected research and innovation priority for European funding related to the decarbonisation of EU building block by 2050 to Accelerate Clean Energy Innovation and it will benefit from the more supportive policy and financial framework envisaged.

Mission Innovation is expected to help building collaborations and partnerships with established key stakeholders, business, investors and innovators in order to increase the industrial exploitation and commercial opportunities for clean H&C technologies.

Funding Programme

'Horizon 2020' is the EU's funding programme for research and innovation in the period 2014-2020 with an overall budget of almost EUR 80 billion. Clean energy R&D is supported through a dedicated programme part (Societal Challenge 'Secure, clean and efficient energy'), but also significantly in other parts across the programme.

The energy research and innovation priorities within Horizon 2020 are mainly defined by the European Strategic Energy Technology Plan (SET Plan) which represents the research and innovation implementing pillar of the EU's Energy Union strategy.

Industry & Buildings

The energy consumption by industry and buildings accounts for a substantial share of the total energy consumption. The EU, in partnership with industry, is investing in R&D for Energy-efficient Buildings, Factories of the Future, and Sustainable Process Industries. The aim is to increase the competitiveness and energy efficiency of the construction sector, to increase sustainability of production processes and make the process industry more resource and energy efficient. More information is available here

Vehicles & other transportation

The decarbonisation of transportation, especially road transport, is crucial for reducing greenhouse gas emissions. The EU supports activities targeting cleaner technologies as well as more efficient management and manufacturing processes for different transport modes. More information is available here.

Bio-based fuels & energy

Europe's energy and climate goals require the development of new fuels and mobile energy sources, particularly in the field of transport. The EU supports different bioenergy pathways at different scales while minimising negative environmental and social impacts linked to land use. More information is available here.

Solar, wind & other renewables

Fostering the development of renewable energy technologies has been one of the EU's key priorities in R&D, particularly with regards to photovoltaics, concentrated solar power, bioenergy, biofuels and renewable alternative fuels, wind, ocean energy, geothermal, hydropower and renewable heating and cooling. More information is available here

Hydrogen & fuel cells

The EU supports activities on fuel cells and hydrogen (FCH) through the Fuel Cells and Hydrogen Joint Undertaking (a public-private partnership) which covers mobile and stationary FCH applications for use in the energy and transport area. More information is available here.

CO2 capture, utilisation & storage

In its strive to achieve the decarbonised power generation challenge by 2050, developing technologies for safe and secure Carbon Capture and Storage (CCS) has become a key area of interest in energy research. The EU supports the full CCS chain for a representative portfolio of different capture, transport, storage and re-use technology options. More information is available here.

Electricity grid

The upgrade and development of energy networks across the EU is one of the key challenges to securing a sustainable and competitive energy future in the EU. In order to transform electricity networks into 'smarter' grids, the EU seeks to develop new components, technologies, and procedures which can respond to the particularities of both the transmission and distribution side of the grid. In this context, Smart Cities and Communities which foster a holistic approach for sustainable and innovative energy solutions are also a key area of interest to the EU. More information is available here.

Energy storage

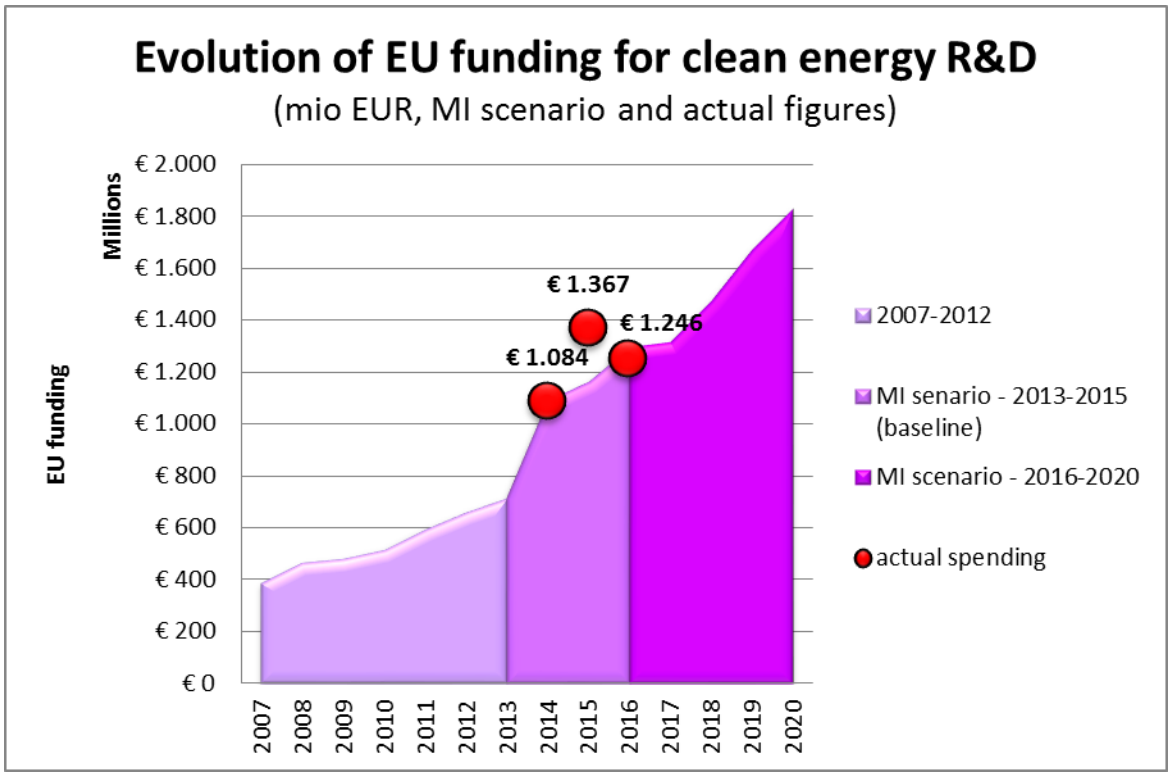
Energy storage is highly strategic for a more efficient use of renewable energy and its higher level of integration into the energy system. Storage can help deal with fluctuations in demand and generation in the electricity system by allowing excess electricity to be 'saved' for periods of higher electricity demand. In addition, storage via batteries or other carriers (e.g. hydrogen) allows for the introduction of renewable energy in transport besides biofuels. Finally, storage allows for a more flexible energy system. All forms of storage are supported by the EU. More information is available here

Basic energy research

Achieving more efficient and cost-competitive, as well as cleaner, safer and more sustainable energy technologies will be essential to confront future challenges and long term solutions. The EU supports multi-disciplinary research to achieve scientific breakthroughs in energy-related concepts and enabling technologies. More information is available here and here.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2013-2015
- Baseline Funding Amount: EUR 989 million (USD 1.1 billion)
- Doubling Target-Year: 2020
- Doubling Target Amount: EUR 1.974 billion (USD 2.2 billion)



** For 2016: since not all projects have been signed, the actual spending might still increase.*

Methodology for Determining Baseline

Average of the period 2013-2014-2015 as a Baseline reference for the doubling.

Member-Definition of Clean Energy R&D Investment

Sectors of clean energy R&D covered are renewable energy technologies, energy efficiency, energy system (smart grids, energy storage), carbon capture storage and use, and fuel cells and hydrogen. The Technology Readiness Levels covered are between 1 to 8 (i.e. these funds do not include deployment).

Overview of Clean Energy R&D Focus areas Emphasized in Mission Innovation Portfolio

	Focus areas	Share of overall funding (%) Period 2014-2016
Energy efficiency in Industry & buildings	●	30%
Energy efficiency in vehicles & other transportation	●	
Biofuels	●	27%
Solar, wind & other renewables	●	
Nuclear energy		
Hydrogen & fuel cells	●	7%
Cleaner fossil energy		5%
CO_2 capture & storage	●	
Electricity grid (incl. smart cities)	●	23%
Energy storage	●	
Basic energy research & Other	●	8%

The key focus areas of Mission Innovation R&D investment do not represent the entire EU's clean R&D portfolio. All EU clean R&D investment referred to in Mission Innovation relate to research, development and demonstration and not to deployment (i.e. The Technology Readiness Levels covered are between 1 to 8).

Additional Information

Budget Planning

The EU budget is decided jointly by the EU Council and the European Parliament. It is multi-annual, and since 2007 it covers a period of seven years. Experience for more than 20 years shows that there is almost no difference between the R&D budget as planned and as finally executed.

Framework programmes	Year	*Baseline scenario* (EUR Million)	*Mission Innovation scenario* (EUR Million)	
FP7 & IEE (2007-2013)	2007	€ 385	€ 385	
	2008	€ 464	€ 464	
	2009	€ 480	€ 480	
	2010	€ 516	€ 516	
	2011	€ 596	€ 596	
	2012	€ 659	€ 659	
Reference period	2013	***€ 713***	***€ 713***	**EUR 989 million**
	2014	***€ 1.091***	***€ 1.091***	per year
	2015	***€ 1.164***	***€ 1.164***	
Horizon 2020 (2014-2020)	2016	€ 1.182	€ 1.297	
	2017	€ 1.200	€ 1.316	
	2018	€ 1.202	€ 1.589	
	2019	€ 1.363	€ 1.802	
Year of doubling	2020	***€ 1.493***	***€ 1.974***	

Budget figures:

- Figures are based on the budgetary decision already taken by the EU Council and the Parliament. They are in current prices and only relate to operational budgets (i.e. administrative budget are excluded).
- Figures for the period 2007-2013 include FP7 (Seventh Framework Programme) and IEE (Intelligent Energy Europe). They are based on actual budget outturn.
- Figures for Horizon 2020 (2014-2020) are based on latest financing programming (not on actual outturn) and match the budget stated in the legal base.

The EU clean energy R&D budget will be more than doubled over the two financial periods (i.e. between 2007-2013 and 2014-2020 with Mission Innovation scenario) ⇒ total EU clean energy R&D budget of EUR 3 813 million and EUR 10 233 million (programmed budget) respectively for each period (i.e. a factor of more than 2.5).

In line with the Agreement reached at the UN Climate Change Conference 2015 (COP21) in Paris, the European Commission will step up its efforts towards the transition of Europe to a low carbon economy. This will be visible in the Mission Innovation Scenario related to clean energy R&D investment, where additional funds will be mobilised from Horizon 2020.

Within a period of five years, the EU clean energy R&D budget will double. From the EUR 989 million on average that the EU had granted from the annual budget to the period 2013-2015, the budget programmed for 2020 under the Mission Innovation Scenario will increase to EUR 1 974 million.

FINLAND

Narrative

Finland has a long history in developing innovative energy solutions. Cold climate and energy intensive industry have made us invest in energy efficiency. Combined heat and power production (CHP) has been important for both industry and big cities. Innovations have always been part of Finnish energy policy. R&D investments in Finland were even 4 % of the GDP in 2010. It is still one of the highest comparing to other countries although it has come down slightly from the highest values.

Bioenergy has been the main renewable energy source in Finland already many years based on the remarkable forest industry in Finland. Renewable energy production is getting closer to 40% of the total energy production in Finland. Bioenergy's role is significant but also wind power is growing fast in coming years. Finland puts much effort on biofuels development and demonstration for transportation and heating purposes.

Mission Innovation, the Government of Finland will seek doubling the financing of R&D&D investments for clean energy at the following areas:

1) Renewable energy
2) Energy systems
3) Energy storages
4) Electricity transmission and distribution.

Funding Programme

Academy of Finland is financing basic research. Their **New Energy** programme harnesses scientific methods to resolve complex issues related to the great energy transition. Smart technology will rapidly change the energy market, creating new infrastructures and new service models based on the energy choices consumers make. The programme will approach these complex issues from a scientific perspective. The energy solutions of the future will serve society's aims of achieving greater wellbeing, while taking due note of the values of, and appraisal by, society and individuals.

Under Academy of Finland there is **Strategic Research Council** which funds high-quality research that has great societal impact. The research should seek to find concrete solutions to grand challenges that require multidisciplinary approaches. An important element of such research is active collaboration between those who produce new knowledge and those who use it. Each year, the SRC prepares a proposal on key strategic research themes and priorities to be approved by the Finnish Government. The Government determines the research needs and decides the final themes, which the SRC then formulates into research programmes and funding calls. SRC programmes run for 3–6 years. The SRC's annual funding budget is some 55 million euros. In the energy sector there is one theme, a climate-neutral and resource-scarce society and under that the programme A Climate-Neutral and Resource-Scarce Finland.

The Tekes, Finnish Funding Agency for Innovation programmes and initiatives are topical entities targeted at financial and expert service areas. Within the programmes and initiatives, businesses and public research units can develop new know-how, build networks and have an impact on the development of their field. Tekes energy related programmes are:

BioNets (2016-) - The BioNets programme is being implemented in cooperation with Team Finland. Goal of the programme is to generate for Finland's bio and circular economy

- innovative and international business ecosystems
- new business development platforms
- new bioeconomy actors via digitalisation and the circular economy and
- pilot and demo projects

The goal is to pilot solutions at an early stage together with customers.

CleanWeb (2016-) - Green growth has become a focus for the whole of Finland. The objective of CleanWeb is to create rapidly scalable cleantech businesses and accelerate their access to the markets.This involves leveraging digitalisation and new innovations and practices to transform the Cleantech sector into a reformed, competitive growth industry.

Witty City (2013-17) - The aim of the Witty City programme is to provide people with better living and working environments and companies with opportunities to bring new products and services on the market. Cities will play a key role in the programme as they are central players in such areas as planning, procurement and the choice of energy sources.

The other Tekes programme which supports the energy sector is the **Industrial Internet-Business Revolution (2014-2019)** The programme aims to renew the business operations of companies through the Industrial Internet and encourage companies from different fields to engage in new kinds of cooperation.

Tekes will seek the increase of funding for MI areas under R&D programmes for clean energy, several already running and some new at planning phase. Tekes is planning new energy and climate related R&D&I programme which could take the coordinating role in MI action.

Highlights

Public private partnership and international cooperation is very important in a small country like Finland. Participation in international projects provides opportunities for building up professional expertise and operating networks. In the energy sector, Finland is involved in cooperation in the EU, the International Energy Agency (IEA) and strongly at Nordic level. Finland has also number of bilateral (the US, Japan, China, India, Brasil) cooperation.

The Government of Finland has already decided to use 100 million euro during 2016 -2018 for demonstrations of new technology investments in clean energy. This subsidy scheme will be included in the doubling plan and it will increase our funding for clean energy innovations with 20 million euro in 2016 and 40 million euro both in 2017 and 2018. Tekes will seek the increase of funding for those five MI areas under R&D programmes for clean energy, several already running and some new at planning phase.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): average of 2013-2015
- Baseline Funding Amount: EUR 54,9 million
- Doubling Target-Year: 2020
- Doubling Target Amount: EUR 109,8 million
- First-Year Mission Innovation Funding Amount: Under planning phase
- First-Year Mission Innovation Funding Increment: Under planning phase

	2013 Million €	2014 Million €	2015 Million €	MI Baseline Average Million € (2013–15)
Energy R&D (Tekes: Finnish Funding Agency for Innovation)	**41.6**	**34.7**	**42.4**	**39.6**
Renewable Energy	28.9	22.5	27	
Energy Systems	1.5	6.0	9.3	
Energy Storage	1.9	0.4	1.3	
Electricity Transmission and Distribution	9.3	5.8	3.8	
Clean Energy Demonstrations (2013–15)				**15.3**
Total				**54.9**

Renewable Energy

Renewable energy account for a substantial share of the total R&D efforts in Finland. The R&D programmes of Tekes have supported the development of bioenergy, biofuels, wind, photovoltaics, solar thermal, fuel cells, ocean energy, geothermal, hydropower, renewable heating and cooling and renewable alternative fuels. Finland will create new support programmes for renewable energy. Aid will be based on technology neutrality and ranking of economic priorities.

Energy Systems

Energy systems are probably in the biggest transition seen in their history, leading to major changes in energy production and energy transmission as well as energy use. The main R&D&I focus is in the new flexible energy system which is smartly controlled and uses digitalization and IoT effectively. The sustainable future energy system will utilize flexible power generation and the flexibility offered by demand response and energy storages to compensate for the intermittency of renewables. It will also take into account the human behavioral factors and user-experience as well as consider different geographical areas having centralized or distributed market models.

Energy Storage

The R&D&I programmes in Finland support energy storage technologies from small to large scale. The main focus is in the Power to X technologies as well as integration of storage to smart grids and renewable production.

Electricity Transmission and Distribution

Finland is already forerunner in smart grids and meters. In the coming years more R&D&I support is put on the smartly controlled micro grids both off grid solutions and when synchronized with the main grid.

FRANCE

Context

To face climate change challenges and be collectively able to limit global warming under 2°C, innovation will be key. It will enable us to act simultaneously towards three major goals: reduction of greenhouse gas emissions, economic development and job creation, and energy security. These goals are at the heart of French energy transition for green growth act[4], which was passed in August 2015, a few months before COP 21 and the Paris Agreement. They are also developed in the national low carbon strategy[5] published in November 2015.

The main issue for emerging technologies and solutions is to go from the prototype stage to the market at a large scale. When new technologies manage to cross the "valley of death", they are too often restricted to niche markets, usually because of high costs or risks. Although significant progress has been achieved in recent years, for instance in the field of renewable energy, which costs have fallen dramatically, investments are still short what is needed.

Mission innovation is about giving these new technologies and solutions the possibility to play a decisive role in the fight against climate change. The conjunction of public and private efforts at an unprecedented level must enable these revolutionary technologies to overcome barriers, accelerate their development and reach the mass market, to provide every country with reliable and affordable clean energy.

In that context, France committed on November 30th 2015, at the launch event of Mission Innovation, to doubling its state-directed public investments in research and development for clean energy over five years, compared to its average investment level during the 2012-2014 period (440 M€).

A new round of the French programme of investments for the future was launched by the end of 2016, with a total amount of funding of 10 billion euros over 2017-2025. Around two thirds of this sum will be dedicated to the ecology and energy transition in general, including clean energy innovation in particular.

France also published its national energy research strategy[6] in December 2016, focusing on key transformational themes for energy transition (energy efficiency and integration of renewable sources, increased flexibility, digitization and decentralization of systems). It also emphasizes the need to support cross disciplinary research, to foster innovation in relation to territories and the industrial network, in particular small businesses, and to develop skills and knowledge for and through R&D.

More information can be found at National Energy Research Strategy, December 2016.

[4] For more detail on French energy transition for green growth act, please refer to : http://www.developpement-durable.gouv.fr/sites/default/files/Energy Transition for Green Growth Act in action - Regions, citizens, business (32 pages - juillet 2016 - Version anglaise).pdf

[5] For more detail on French national low carbon strategy, please refer to http://www.developpement-durable.gouv.fr/sites/default/files/Brochure sur la stratégie nationale bas carbone (version anglaise).pdf
http://www.developpement-durable.gouv.fr/sites/default/files/SNBC_SPM_Eng_Final v4.pdf

[6] For more detail on French national energy research strategy, please refer to http://www.developpement-durable.gouv.fr/recherche-et-developpement-lenergie

Narrative

The energy issue is part of a complex framework that must address several major challenges: guaranteeing and securing access to energy for populations and organizations at an affordable and competitive cost, avoiding fuel poverty, tackling climate change mitigation and adaptation, preserving human health and the environment, and providing a sustainable energy mix. Through the Energy Transition Law for Green Growth and the ratification of the Paris Agreement, France is resolutely committed both to orienting technological and societal choices and to supporting a research and development (R&D) effort required for continuous improvement of existing energy sectors and the emergence of new solutions to meet these major challenges.

Baseline

French investments related to Mission Innovation will focus on renewable energy, energy storage, carbon capture storage and use, and innovations aiming at improving energy efficiency (including in industry, buildings, transports, circular economy, and smart grids). They will cover the whole chain of innovation, from basic research to demonstration (Technology Readiness Levels between 1 to 8 i.e. do not include deployment).

Over the 2012-2014, the average state-directed[7] public investments in these areas, both through research funding agencies programmes and public research organisations budget allocations, amounted to 440 M€ per year in France, as was reported to the International Energy Agency. This constitutes the baseline for France to be doubled by 2020.

Beyond direct funding to R&D and innovation projects, France has also set up complementary instruments, such as a tax credit ("Crédit impôt recherche"), with 5.4 billion euros in 2016 to support companies' efforts in R&D in all sectors, including in clean energy. France also contributes significantly[8] to the European programme Horizon 2020 on clean energy, that amounts to 9.8 billion euros for the 2014-2020 seven-year period.

Funding programmes

The doubling effort in France will, for a large part, go through the "*Programme d'Investissements d'Avenir*" (PIA)[9] or "*Investments for the future programme*". A first round of this programme was launched in 2010, a second round in 2014 and a third round in 2017.

French agency of environment and energy management (ADEME) operates in this framework a programme[10] with about 4 billion euros funding on the 2010-2020 period (for subsidies, refundable grants, and also private equity in startups and SPVs for first-of-a-kind projects) and has launched a series of calls for projects of demonstration in the field of clean energy.

[7] Local authorities funding is not included
[8] France provided around 16 % of EU budget in 2015
[9] http://www.gouvernement.fr/investissements-d-avenir-cgi
[10] http://www.ademe.fr/entreprises-monde-agricole/innover-developper/programme-investissements-avenir-pia

So far, more than 620 projects have been supported with 2.1 bn€ from ADEME and a leverage effect (ratio of total cost to public funding) close to 3. The annual average spending by Ademe on this programme was around 125 M€ in 2015-2016, up 94% from the average annual level of 65 M€ during the 2012-2014 period.

Several calls are opened at the beginning of June 2017 on various topics covering French perimeter for Mission Innovation and will help accelerating the funding of innovation in the coming months and years. Some calls are dedicated to small businesses, with a fast track and a simplified process.

French agency of research (ANR) operates another PIA programme called "*Instituts de la transition énergétique*" (ITE) or "*energy transition institutes*", with 1 billion euros funding on the 2010-2020 period. ITE gather private industries and public laboratories for the creation of new high standard companies dedicated to R&D and innovation in the field of clean energy: for instance, institute SUPERGRID[11] is focused on future electric transmission grids, VEDECOM[12] is specialized on sustainable mobility and connected vehicles, INES2[13] and IPVF[14] are dedicated to solar energy, PIVERT[15] and IFMAS[16] are focused on bio energy, EFFICACITY[17] is about smart cities, etc.

In addition to the PIA programme, ANR also runs a basic research funding programme based on annual calls for projects focused on the priorities defined by the national research strategy[18], which identified a "clean, secure and efficient energy" challenge similarly to the European SET Plan, with five areas of action:

- Dynamic management of energy systems ;
- Multi-scale governance of new energy systems ;
- Energy efficiency in all fields of the economy ;
- Reduced need for strategic materials ;
- Decarbonisation of energy and chemistry sectors.

Main French energy research organisms (CEA, IFPEN, CNRS, universities, etc., that are grouped in a research alliance dedicated to energy, called ANCRE[19]) also follow these priorities, through their objectives and performance contracts with the French State.

[11] http://www.supergrid-institute.com/en/home
[12] http://vedecom.fr/en/
[13] http://www.ines-solaire.org/
[14] http://www.ipvf.fr/en/
[15] http://www.institut-pivert.com/?lang=en
[16] http://www.ifmas.eu/
[17] http://www.efficacity.com/en/
[18] http://www.enseignementsup-recherche.gouv.fr/pid24538/strategie-nationale-de-recherche-s.n.r.html
[19] http://www.allianceenergie.fr/

Innovation Challenges

France is engaged in all 7 innovation challenges. Some highlights:

- IC 1 on smart grids:
  - France is at the forefront in Europe on smart grids development. 40 demonstration projects have been funded since 2011 by Ademe, with a total of 120 millions euros state aids. French players have created a dedicated association to promote their solutions and technologies : Think SmartGrids[20]
  - First lessons learnt from demonstration projects have been shared[21] and now is the time to scale up. Some pilot territories have been selected in 2016 to showcase the value of smart grids solutions and to experiment new technologies: project "Smile" in regions Britany and Pays de Loire, project "Flexgrid" in region PACA.
- IC 2 on off grid access to electricity
  - Access to affordable fossil-free electricity for rural and urban households is a major challenge at the global level and is identified as one of the UN sustainable development goals.
  - France is proud to co-lead this challenge with India and will host an international workshop in Paris in July 2017 in collaboration with the IEA, gathering researchers, companies, development banks, international institutions and NGOs, to help identify needs for innovation in this field.
- IC 4 on sustainable biofuels
  - French players are active in the development of advanced biofuels, with several major demonstration projects ongoing for various categories of biofuels (bioethanol, biodiesel, algae biofuels…)[22]. These projects, associating research organizations and companies, will promote the development of industrial and commercial synergies between the advanced biofuels sector and the bioproducts sectors such as bio-alcohols, bio-olefins, bio-aromatics.
- IC 6 on new materials for clean energy
  - Discovering new materials for clean energy is vital to enable a faster implementation of the energy transition. French research players are fully mobilized towards this goal and the French energy research alliance ANCRE has launched a multi-disciplinary dedicated work group on this topic at the beginning of 2017, in application of the French energy research strategy.

[20] https://www.thinksmartgrids.fr/en/
[21] http://www.ademe.fr/sites/default/files/assets/documents/smart-grids_summary_en-010120.pdf
[22] http://www.ademe.fr/expertises/energies-renouvelables-enr-production-reseaux-stockage/passer-a-laction/produire-biocarburants/produire-biocarburants-avances

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2012-2014
- Baseline Funding Amount: EUR €440 million
- Doubling Target-Year: 2020
- Doubling Target Amount: EUR €880 million

Methodology for Determining Baseline

Over 2012-2014, the average state-directed[23] public investments in these areas, both through research funding agencies programmes and public research organisations budget allocations, amounted to 440 M€ per year in France, as was reported to the International Energy Agency. This constitutes the baseline for France to be doubled by 2020. Beyond direct funding to R&D and innovation projects, France has also set up complementary instruments, such as a tax credit ("Crédit impôt recherche"), with 5.4 billion euros in 2016 to support companies' efforts in R&D in all sectors, including in clean energy. France also contributes significantly[24] to the European programme Horizon 2020 on clean energy, that amounts to 9.8 billion euros for the 2014-2020 seven-year period.

Country-Definition of Clean Energy R&D Investment

These investments will focus on renewable energy, energy storage, carbon capture storage and use, and innovations aiming at improving energy efficiency (including in industry, buildings, transports, circular economy, and smart grids). They will cover the whole chain of innovation, from basic research to demonstration (Technology Readiness Levels between 1 to 8 i.e. do not include deployment).

Overview of Clean Energy R&D Focus areas Emphasized in Mission Innovation Portfolio

	Focus areas for France in MI	Share of overall baseline funding (%)
Energy efficiency (buildings, industry, transports, circular economy, etc.)	●	38%
Biofuels, solar, wind & other renewables	●	35%
Hydrogen & fuel cells	●	8%
Electricity grids and energy storage	●	7%
Nuclear energy		-
Cleaner fossil energy		-
CO_2 capture storage & use	●	7%
Basic energy research	●	Included in all other fields + 5% cross-cutting

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

[23] Local authorities funding is not included
[24] France provided around 16 % of EU budget in 2015

Additional Information

Webinar:

Supporting Innovation to Reduce Time to Market: The French Policy, October 2016

Remarks at Launch Event:

President François Hollande

Related sites:

President's website
Ministry of Environment, Energy and the Sea

GERMANY

Narrative

In November 2015 at the COP 21 meeting in Paris chancellor Angela Merkel joined Mission Innovation. Within Mission Innovation 23 countries (incl. EU) share the commitment of doubling their investments in research, development and innovation for clean energy technologies. This is a huge step forward for the promotion of clean energy worldwide.

The transformation of our energy systems towards reliable and cost effective clean energy is a fundamental part of an effective, long-term global response to our shared climate challenge. A step-change, global effort is required to accelerate the pace of technological advance and cost reduction for clean energy. Research and development are an indispensable prerequisite to achieve these goals with our knowledge, creativity and inventive spirit being our most important resources. We need to work together with all interested countries and bundle our competencies to make a difference. Therefore, the Federal Government welcomes and supports this important international initiative Mission Innovation.

The Federal Government gained a pioneering role by orienting its energy policy towards an energy system based on high efficiency and renewable energy sources. We were thus able to cut the output of harmful greenhouse gases by about 25% between 1990 and 2012. After the earthquake disaster in Japan in March 2011 and the resulting flooding of the Fukushima Nuclear Power Plant, the Federal Government re-assessed the role of nuclear power and set the cornerstones for an energy turnaround: nuclear phase-out and a focus on higher efficiency and renewable energy sources. This turnaround in energy policy, known as the “Energiewende”, has attracted attention worldwide. Central goals are a 50 percent reduction of primary energy consumption, the expansion of renewable energies to 60 percent of gross final energy consumption and reductions of greenhouse gases by 80 – 95 % until 2050. At present, a third of German electricity comes from wind, solar and other renewable sources. In addition energy is used more economically. The energy transition has furthermore opened up important new fields of business. New global markets have arisen in the wake of the expansion of renewable energy sources and efficient use of energy.

Nevertheless, the currently available energy technologies might not be sufficient to eventually realize these ambitious goals while preserving security of supply and a high level of prosperity. The Federal Government therefore resolutely focused its funding for research and development on technologies for the energy transition. At the core of this are intelligent solutions in the areas of energy efficiency, energy conservation, renewable energy and supply systems (including storage, grids and ancillary system services through renewable energy).

But the energy transition is not a matter of technological and economic feasibility alone. It is a national task involving every citizen and affecting all levels of policy-making. The energy transition can only be achieved if related technological advances are backed by our citizens. This requires thematically comprehensive and system-oriented research approaches. Within the framework of project funding, questions of implementation and social acceptance need to be taken into account in setting priorities for energy research.

Funding Programme

Three Federal Ministries work in close collaboration under one comprehensive energy research programme (6th Energy Research Programme). Thereby, the competencies of the different ministries complement each other to promote and support research for the “Energiewende” along the whole innovation chain.

The Federal Government will further increase its already high efforts for clean energy research and development to support the process of the energy transition. Funding programmes will be focused on the main pillars of the 6th Energy Research Programme: energy efficiency and renewable energy technologies.

At the core of the 6th Energy Research Programme are the following topics and measures.
In the area of renewable energy:

- Photovoltaics: increasing efficiency, reducing cost, increasing lifetime and reliability of all components and the whole system, reducing materials use.
- Wind power: R&D for onshore and offshore application, reducing cost, increasing availability and environmental compatibility.
- Current funding measures address for example: Smart electricity grids, energy storage, materials research for the energy transition.

In the area of energy efficiency:

- Industry, trade and services: R&D for innovative components, new processes and methods for decreasing energy demand, enhancing demonstration for an accelerated transfer of R&D results.
- Building sector: Leveraging opportunities for increased efficiency and integration of renewable energy in the heating sector. A new funding initiative “Solar Buildings/Energy Efficient Cities” has been initiated.

Baseline

In accordance with our commitment to Mission Innovation the Federal Government intends to double its federal budget for research, development, demonstration and innovation for clean energy within five years. By 2020 the Federal Government is aiming to provide more than 900 Mio. € for funding programmes which qualify under the objectives of Mission Innovation.

Highlights

Recently, the funding initiative “Kopernikus Projects for the Energy Transition” has been started. Its eponym, the famous mathematician and astronomer Nikolaus Kopernikus, stands for scientific excellence, courage, and a new conception of the world. The planned Kopernikus Projects form a comprehensive R&D initiative for the energy transition, so far dealing with the four topics: Future Grid Structures, Power-to-X, Industry Processes, and Energy Systems Integration. In these projects large consortia consisting of scientific institutions and universities, private companies, and organisations of the civil society work together for up to ten years to develop technological solutions for the transformation of the energy system. High-level representatives from over 90 institutions and organisations contributed their views and opinions to identify the four most important topics for a successful energy transition.

In addition to the previously described measures within the 6th Energy Research Programme the Federal Government will initiate new programmes which will complement existing R&D activities. An example is the SINTEG initiative, standing for “Smart Energy Showcases - Digital Agenda for the Energy Transition". It aims to develop and demonstrate in large model regions exemplary solutions for a climate-friendly, secure and efficient energy supply with high proportions of intermittent power generation on the basis of wind and solar energy. Another example is the recently started technology introduction measure for new and innovative household fuel cell systems.

Baseline and Funding Plans

In accordance with our commitment to Mission Innovation the Federal Government intends to double its federal budget for research, development, demonstration and innovation for clean energy within five years. By 2020 the Federal Government is aiming to provide more than 900 Mio. € for funding programmes which qualify under the objectives of Mission Innovation.

- Country-Determined Baseline Years: average of 2012-2015
- Baseline Funding Amount: EUR €450 million (USD $490 million)
- Doubling Target-Year: 2020
- Doubling Target Amount: EUR €900 million (USD $980 million)
- 2016 Mission Innovation Funding Amount: EUR €522 million (USD $568 million)
- 2016 Mission Innovation Funding Increment: EUR €72 million (USD $78 million)

Methodology for Determining Baseline

The baseline is calculated by averaging the budget for project funding within the 6th Federal Energy Research Programme on renewable energy and energy efficiency technologies for Fiscal years 2012 to 2015. On average 450 Mio. € were spent in respective research areas within this period.

Country-Definition of Clean Energy R&D Investment

The funds available within the individual ministries are primarily aimed at particularly innovative energy technologies that promise to be successful in the long term and are important for Germany's transition to a sustainable energy supply. Energy policy will therefore focus on renewable energy, energy efficiency, energy storage technologies and grid technology, the integration of renewable energy into the energy supply and the ways in which these technologies interact with one another. Clean Energy under this definition does not include nuclear energy.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio

Additional Information

Related websites:

Federal Government's website

Research for Sustainable Development (FONA) - Transformation of the Energy System

Federal Ministry of Education and Research (BMBF)

Federal Ministry for Economic Affairs and Energy (BMWI)

Federal Ministry of Food and Agriculture

Links to Supporting Country Documents:

The 6th Energy Research Programme of the Federal Government

Report of the Federal Government on Energy Research 2015

Joint Research Activities:

- Technological developments must increasingly be assessed from a global perspective. The Federal Government therefore actively promotes research cooperations with other interested countries on the EU-level and internationally.
- At the European level, the Federal Government particularly supports research cooperations within the EU framework as well as through additional bilateral commitments. With regards to energy research the Federal Ministry of Economic Affairs and Energy supports applicants in their participation in and successful implementation of the Strategic Energy Technology Plan (SET Plan). For the implementation of the SET-Plan, Germany has proposed the "Berlin Model." The core element of this funding model is an as unbureaucratic and efficient multinational funding for research projects as possible in close cooperation with the respective national funding programs or organisations. The first bilateral collaborative projects using this model were successfully started as part of a joint call for proposals with Finland on the topic of energy efficiency in 2013. Other cooperations exist with Austria and Switzerland in research areas which focus on energy efficient cities and hydrogen and fuel cell technology. The Federal Ministry of Research and Education successfully established bilateral research cooperations with many European countries with energy research being one important topic (https://www.bmbf.de/de/zusammenarbeit-in-wissenschaft-und-forschung-mit-europaeischen-laendern-283.html).
- At the international level, a very successful instrument for the implementation and coordination of international cooperations are agreements for Science and Technology Cooperation (STC). These agreements are international treaties that provide framework conditions for bilateral research cooperations with non-EU countries. In particular they regulate issues relating to the financing of research staff and student exchanges and the easing of customs and visa requirements for the purpose of such cooperations. The STC treaties thereby facilitate and promote international cooperations. The Federal Ministry of Research and Education has STC treaties with 40 countries including 12 Mission Innovation members (http://www.kooperation-international.de/detail/info/verzeichnis-der-wtz-abkommen.html).
- In addition, the Federal Government supports international energy research cooperations within Energy Technology Network of the IEA.

INDIA

Narrative

Minister's Quote

"I would like to reaffirm India's commitment to pursue green path to growth through Research Innovation and Joint Collaboration."

— Dr. Harsh Vardhan, Minister for Science & Technology & Earth Sciences and Environment, Forest & Climate Change

India recognizes the serious nature and significant scale of the energy-related challenges facing the country and globe. Energy security, reduced pollution, access to electricity for our people who currently lack it, and reduced emissions are some of issues which Indian government considers necessary for reducing the worst impacts of climate change. Meeting these challenges on a global scale will require significantly increased and innovative effort to develop clean energy technologies and reduce their costs so that they can become widely accessible and affordable. For this Government of India considers international cooperation essential and thus was one of the first few countries to join Mission Innovation.

India along with other member countries has agreed to double its investments in span of 5 years on development of clean energy technologies over the base investments of 2015. The additional resources will be deployed to develop our country specific clean energy technologies in chosen priority areas so as to provide affordable clean and sustainable energy to its citizen. This will see a fundamental change on the energy utilization, reducing the density of energy consumption, developing and deploying alternate energy sources and supporting low carbon technologies.

The Government has announced an ambitious plan to deploy 175 GW of renewable energy capacity by 2022, which includes 100 GW of solar, 60 GW of wind, 10 GW from biomass, and 5 GW of small hydropower. The Government has also embarked on a major mission for construction of 100 Smart Cities that will use both renewables and energy efficient technologies. The government also has a target of 20% blending of biofuels in the transport fuels.

The Government is making a concerted effort to enhance the pace of innovation and scale of transformation in support of a clean energy revolution to meet the requirements and goals for India's economic and energy security in a timely manner. This will be achieved by:

- Strengthening and scaling up research in existing programs
- Enhancing international cooperation in priority areas
- Utilizing public-private partnerships and private sector investment
- Strengthening capacity building for specific skill requirements

Major Funding & Implementing agencies

There are several key government departments and research agencies engaged in research, development, and demonstration of clean energy and the major contributors are:

- Ministry of Science & Technology (specifically Department of Biotechnology, Department of Science and Technology, Council of Scientific and Industrial Research)

- Universities and technical institutes like IIT's through Ministry of Human resource Development
- Ministry of New and Renewable Energy
- Research institutes funded by Public Sector companies like Oil , Power, automotive sectors
- Private sector research institutes

To meet the ambitious national target for a green path to growth, R&D and demonstration projects are supported through grants and in some case for setting up specialized centres in high technology areas. These special centres develop linkages between the organizations/agencies undertaking technology development and the user organizations and transfer of know-how is thus facilitated to industry. With a view to achieve global competitiveness, participation by industry in R&D and technology development is encouraged with increased investment by industry.

International scientific and technical cooperation in the area of clean energy is established in accordance with national priorities and socio-economic development strategies and goals. Modalities of such cooperation include joint research and technology development, field studies, pilot-scale plants, and demonstration projects with active involvement of research institutions and industry on either side. Technology induction and transfer is facilitated, wherever necessary, with time-bound goals for indigenization and local manufacturing. Appropriate bilateral and multilateral cooperation programs for sharing of technologies and funding are developed. Participation in international partnerships and exchange of scientists, wherever necessary, is also explored.

Specific plans to double clean energy R&D investment involve intensifying research efforts on:

- Promoting India-centric innovation for clean energy proliferation
- National, bilateral, and multilateral joint virtual centres on clean energy themes (see Department of Biotechnology and Department of Science and Technology)
- Setting up of technology platforms led by industry for clean energy technologies
- Scaled-up funding to academic and R&D institutions as well as R&D units in industry for research on identified topics relevant to clean energy
- National, bilateral, and multilateral capacity building programs in clean energy
- Demand-oriented mission programs on clean energy technologies
- Developing models for last mile connectivity for technology leads obtained through R&D
- Setting up demonstration models/pilot plants for developed technologies (see Department of Biotechnology, Ministry of New and Renewable Technologies, and Department of Science and Technology)
- Working with all stakeholders to translate research outputs for end-use deployment

Research Areas of Interest & Baseline

Areas of emphasis for Mission Innovation clean energy R&D include the following: energy efficiency (industry; residential and commercial buildings, appliances and equipment; transport); renewable energy sources (solar energy, on-shore wind energy, off-shore wind energy, ocean energy, biofuels, geothermal energy, hydroelectricity, other renewable energy sources); Hydrogen and fuel cells; other power and storage technologies (electric power generation including advanced but non-renewable; electricity transmission and distribution; energy storage; non-transport applications; smart grids); and other cross-cutting technologies in Carbon Capture, Utilisation and Storage or research (energy system analysis, basic energy research that cannot be allocated to a specific category).

Industry and buildings

Following the launch of Mission Innovation, the Department of Science and Technology (DST) announced a new Initiative to Promote Habitat Energy Efficiency (I-PHEE). I-PHEE is focused on promoting R&D activities to improve energy performance of buildings and cities and support enhancement of knowledge and practice to save energy in design, construction, and operation of human habitats. The program will support specific outcome-based research in the areas of energy efficient building envelope technologies, low energy cooling systems, day-lighting and electric lighting, building automation and controls for energy savings and research.

Research Priorities include

- Building envelop: Building materials and / or construction technology for walls, roofs, windows which will help reduce operational energy, increase thermal comfort, or reduce embodied energy of building.
- Low energy cooling: Novel systems that help achieve thermal comfort, direct / indirect evaporative cooling, ground couple cooling, geothermal, passive down draft systems.
- Buildings and cities automation and controls: Cost effective sensors, controllers, automation system hardware, and / or software to help save operational energy of buildings and cities.
- Development of test protocols, methods, data acquisition tools and methods for building energy benchmarking or development of any scientific procedure to help derive policy, codes and standards.

Vehicles and other transportation

India has most ambitious programme of transport fuel quality upgradation for reducing the emissions both by using better fuels and modern technology vehicles. Whole country is now supplies BS-IV (Euro-IV) fuel quality which saw an investment of Rs 60,000 crores (approx US$ 9.1 b). In a major shift Govt. has decided to jump to BS VI (Euro VI) fuel quality by 2020 which will see additional investment of Rs 28,000 crores (US$ 4.4 b) in refineries upgradation (www.mopng.gov.in). Alongside the vehicles are also been upgraded with most vehicles having catalytic convertors and meeting at-least BS IV emission norms.

The government has introduced bioethanol and biodiesel in transport fuels and also use of CNG in diesel vehicles for reducing emissions. The government also mounted a National Mission on Electric Mobility which envisages R&D programme on setting up Technology Platform on Electric Mobility (TPEM). DST initiated steps to keep a close watch on the innovations in the field of “Electric Mobility” in support of the manufacture of vehicles under the “Faster Adoption and Manufacturing of (hybrid) Electric Vehicles (FAME)” scheme of the Department of Heavy Industry (DHI).

Bio-based fuels and energy

The National Policy on Biofuels mandates a blending of biofuels of approximately 20% of biofuels in transport fuels. This is an ambitious target and several steps have been undertaken to broad-base the feedstock for biofuel production and R&D for new technology and feedstock is being supported to achieve this. The Ministry of Science and Technology and the Ministry of New and Renewable Energy have placed a special focus on algal biofuel as an area of interest in Mission Innovation. Department of Biotechnology (DBT) has established four Bioenergy Research Centres in the country that integrate basic and translational science capabilities for biofuel development and scale up. The major focus has been on cellulosic ethanol and algal biofuel. Early results of these centres are encouraging and demo scale

technologies for cellulosic ethanol have been established in country. Based upon this success, Government of India has decided to set up several large commercial scale cellulosic ethanol plants using waste agricultural resides as the feedstock. Six of these, about 400 ton feed per day, plants are approved by major oil marketing companies based upon indigenous technology and are likely to be operational by Q2 of 2019.

The four centres of excellence each specializing in their own areas are:

1. **DBT-ICT Centre for Energy Biosciences, Mumbai** is a unique centre that integrates basic and translational science capabilities for bioprocess development and scale up. The 10 ton/day biomass demonstration facility based on the novel DBT-ICT Lignocellulosic Ethanol Technology, the development of novel 'Hybrid Technology' for the treatment of municipal solid waste (MSW) and municipal liquid waste (MLW) and the commissioning of 1000L modular photobioreactors designed for autotrophy as well as mixotrophy growth of algae are some of the salient achievements for the Centre. More information on DBT-ICT can be found (www.dbt-ceb.org).
2. **DBT IOC Centre for Advanced Bioenergy Research, Faridabad** is a finest example of collaboration of DBT with an industry. The Centre has established protocols for Life Cycle Assessment and GHG emission evaluation of all grades of biofuels. Unique process for CO_2 fermentation and conversion to lipids has been carried out and a pilot is under installation. Development of enzymes needed for cellulosic ethanol is a major programme of the centre. More information on DBT IOC can be found (www.dbtiocberc.org).
3. **DBT-ICGEB Centre for Advanced Bioenergy Research** has been successful in developing key technologies for 'potent enzyme composition for biomass hydrolysis', 'engineered bacteria for C5 fermentation to ethanol' and 'engineered algae with enhanced CO_2 sequestration'. Deep synthetic biology intervention led to discovery of new pathway for fatty alcohol production and CRISPR/Cas9 based genome engineering led enhanced fungal enzyme production. More information on DBT-ICGEB can be found (www.icgeb-bioenergy.org).
4. **PAN IIT Bio-energy Centre** constitutes a network of 32 investigators from 5 Indian Institute of Technology (IITs) working on various thematic areas related to Bioenergy (www.dbtindia.nic.in).

Capacity Building in Bioenergy

- **Ten post-doctoral fellows attracted back to country under the Energy Bioscience Overseas Fellowships** – They are now placed in some of the centres of excellences on bio-energy in the country.
- **Launching the Bioenergy Awards for Cutting Edge Research** – India and United States have joined hands to support a fellowship that will allow a group of fellows and interns to pursue cutting edge research in various areas of bio-energy in US institutes of repute. This will help build capacity in clean and environmentally safe energy.

DBT established network of more than 100 scientists working to realize the goals of National Biofuel Policy with high quality research publication and patents for generated knowledge and developed technologies.

The Bioenergy program also includes establishing a major network of programs on algal biofuels. There are three repositories with more than 2,000 cultures that may be available for the algal biofuel program. This has been identified as an area for both bilateral and multilateral cooperation. Details on the Bioenergy Roadmap Vision 2020 can be found (www.dbtindia.nic.in).

Various projects under clean energy are provided to industries through Biotechnology Industry Research Assistance Council an interface agency of DBT to strengthen and empower the emerging Biotech enterprise (www.birac.dbt.nic.in).

Solar, wind, and other renewables

The Ministry of New and Renewable Energy is working on a solar wind hybrid policy, in which wind and solar can be co-located to maximize the utilization of transmission systems, reducing cost and increasing efficiency. They are also working to develop solar floaters indigenously. More information about the wind power program can be found (http://niwe.res.in) and more information about the solar mission can be found (http://nise.res.in).

Hydrogen and fuel cells

The Ministry of New and Renewable Energy Hydrogen Energy Program is embarking upon the National Hydrogen Energy Road Map. This program supports research, development, and demonstration projects on various aspects of hydrogen energy including its production, storage and use as a fuel for generation for mechanical, thermal and electrical energy. More information about the Hydrogen Energy Program can be found (www.mnre.gov.in). The Department of Science and Technology is also embarking upon a national mission to utilize methanol and di-methyl ether as cleaner fuels in automobiles and fuel for fuel-cell based vehicles. Indianoil R&D centre has established a Hyrogen dispensing station and vehicles on Hydrogen are tested for endurance. This centre has also patented a technology to produce mixture of Hydrogen and methane by partial catalytic reforming of natural gas for fueling vehicles to reduce emissions (www.iocl.com).

Cleaner fossil energy

With Mission Innovation, the Department of Science and Technology has developed plans to set up demand-oriented mission programs on clean coal technologies and has launched a national mission with plans to set up material research centres on advanced ultra-supercritical technologies. National programme on fuel quality upgradation for transport fuels, as detailed above, has helped greatly in reducing vehicular emissions. Biomass pyrolysis in combination with coal and petcoke and subsequent hydrotreating of the oil has been taken up by several institutes to produce clean sulphur free drop in fuels (www.iocl.com).
A consortium has been formed among NTPC, BHEL and IGCAR –Kalpakkam for the indigenous development of Advanced Ultra Super Critical technology for high efficiency thermal power plants in India.

Carbon Dioxide capture, utilization and storage

- Carbon capture
- Carbon storage and
- Carbon utilization for value addition

Out of these three components, India has not much experience or large projects on carbon dioxide storage. However, Indian companies in power and oil sectors would like to collaborate in this area.

Carbon capture technologies either by growing algae or by capture in solvents / adsorbents have been studied by several institutes.

A large number of basic research projects have been undertaken in carbon dioxide value addition. Some of the priority areas are:

- CO2 to organic products with organo-catalysis
- Hydrogenation and reduction of CO2 with molecular catalysts
- Reforming of CO2 to Syn gas
- Production of polycarbonates
- Catalytic hydrogenation of CO2 to MeOH / DME
- CO2 to alkyl carbamates as fuel components

Electricity grid

The Department of Science and Technology is setting up a clean energy centre for integration of intermittent renewables with suitable energy storage in on grid or off grid situations (www.dst.gov.in).

Research Priorities in off grid electricity system:

- Off grid electricity systems utilizing polygeneration and also solar, wind, micro-hydel, biogas, and various other forms individually or hybridised for heating/cooling/thermal applications
- Augment the existing fossil with renewable sources including roof top solar as an off grid solution
- Frequency and voltage stability of off grid system and developing robust control algorithm
- Development and demonstration of affordable and sustainable solution/devices for wide application spectrum
- Village Distributed Energy resource (DER) Grid
- Hybrid distribution system (AC and DC grid)
- Development of efficient DC appliances and smart centralized distribution control to ensure disciplined and efficient end use of energy

Energy storage

The Ministry of Power is working on flow batteries, which have larger potential for energy storage and are more efficient. A large programme focused on development of materials for hydrogen storage has also been initiated by DST(www.dst.gov.in) and MNRE (www.mnre.gov.in).

Basic energy research

Science & Engineering Research Board (SERB) under the aegis of DST is mandated to promote basic research in all domains. Besides several individual-centric projects, SERB has funded advanced research centres in the area of improved combustion and battery technologies. Department of Biotechnology has been supporting fundamental research on innovative approaches that lead to intensification of biofuel. Emphasis has been on feedstock improvement (microalgae) and biochemical processes for conversion of biomass to biofuels and production of biofuel molecules/hydrocarbons using synthetic biology and genetic engineering, hydrogen production from autotrophic and heterotrophic microorganisms. Similar projects of basic research are also funded by CSIR. However all basic research projects funded in clean energy area are focused and linked to eventual development of corresponding technologies and projects are closely monitored and reviewed.

International Cooperation in Clean Energy

- Government of India has major international collaboration with countries for a large number of programmes such as UK, USA, Europe, Australia, Canada, Korea, etc. The Indo-US Joint Clean Energy Research and Development Centre is a public-private partnership in which Government of India and the US Department of Energy jointly supported three consortia on energy efficiency, solar, biofuels and the 4th consortia on Smart Grids and Energy Storage is currently under consideration. More information can be found (www.iusstf.org).
- Specifically created centres on clean energy are encouraged for international cooperation and these centres have established research links and projects with appropriate international agencies.
- Government of India's Ministry of New and Renewable Energy (MNRE), Department of Biotechnology (DBT), and Department of Science and Technology (DST) currently has several centres of excellence dedicated to solar, wind, bioenergy and biofuel. As part of Mission Innovation, the Government has developed proposals for upgrading existing centres of excellence while also looking to create a centre for clean energy. Through Mission Innovation, the Government hopes to expand on current collaborations, both international and between the public and private sectors, to ensure that the centres of excellence are not limited to just the Indian public sector, but bringing in the private sector and other countries.
- As part of Mission Innovation, the Department of Science and Technology is also setting up technical research centres on energy and has plans to set up two virtual centres on energy material research at the Indian Institute of Science and International Advanced Centre of Research (ARCI), a DST institute at Hyderabad. Department of Biotechnology has planned to start a mission program on Algal Biofuel and Waste to Energy.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2014-2015
- Baseline Funding Amount: INR 470 crore (USD $72 million)
- Doubling Target-Year: 2019-2020
- Doubling Target Amount: INR 967 crore (USD $145 million)
- First-Year Mission Innovation Funding Amount: INR 475 crore (USD $72 million)
- First-Year Mission Innovation Funding Increment: INR 5 crore (USD $1 million)
- First-Year Funding Percent Increase: 1.37%

Methodology for Determining Baseline

Baseline has been worked out on the data available for each of the priorities sector identified under Mission Innovation for fiscal year 2014-15 (base year) this includes all Government funding by different Department/Ministries for research, development demonstration activities.

Country-Definition of Clean Energy RD&D Investment

Research, Development and Demonstration in environmentally friendly, clean energy technologies including renewable energy, energy efficiency, Clean fossil technologies, electric grid technologies and advanced transportation systems and fuels and other crosscutting technologies. Investments are made through various models of joint collaboration involving Public Private Sector, National Laboratories, Universities and International Partners.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

	Focus areas for MI	Share of overall funding (%)
Industry & buildings	●	5%
Vehicles & other transportation	●	15%
Bio-based fuels & energy	●	5%
Solar, wind & other renewables	●	40 %
Nuclear energy		
Hydrogen & fuel cells	●	5%
Cleaner fossil energy	●	10%
CO_2 capture, utilization & storage	●	
Electricity grid	●	10%
Energy storage	●	5%
Basic energy research	●	5%

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Webinar:

Accelerating Clean Energy Innovation in India, September 2016

Remarks at Launch Event:

Prime Minister Narendra Modi (text) (video)

Related websites:

Prime Minister's website

Ministry of Power

Ministry of New and Renewable Energy

Ministry of Science and Technology

Report on India's Renewable Electricity Roadmap 2030

Strategic Plan for New and Renewable Energy Sector for the Period 2011-17

National Biofuel Policy

The Bioenergy Road Map 'Vision 2020'

INDONESIA

Narrative

Indonesia is the largest archipelago in the world covering an area of 7.7 million km^2, which includes 1.9 million km^2 of land, 3.1 million km^2 oceans, and 2.7 million km^2 of marine waters. There are more than 13,000 islands which make up the estimated 47 distinct ecosystems and, while covering only an area of 1.32% of the world, Indonesia is home to some of the largest concentrations of flora and fauna.

The country is a strong and stable democracy that aspires to generate prosperity for all its citizens. A country with a diverse population and complex landscape, Indonesia is the world's fourth most populous nation with people inhabiting over 6,000 islands. Indonesia's constitution embraces democracy and pluralism and is home to 300 distinct native ethnic groups and other populations, speaking over 700 languages and dialects.

Divided administratively into 34 provinces with more than 514 districts, Indonesia has an estimated[25] population of 267 million people and 72 million households which make up the 82,190 thousand villages. The average population density is 140/km[26] although, the island of Java which constitutes only 7% of the total land area, and home to 57% of the population, has a population density of 1,160/km^2.

Indonesia is one of the largest emerging economies in the world - with an expected USD900 billion GDP in 2015, making Indonesia the largest economy in Southeast Asia and the 16th largest economy in the world. Due to its reliance on natural resources and domestic markets, however, Indonesia has been less integrated into global supply chains.

Like many emerging economies, Indonesia's economic focus on natural resources has delayed its development and expansion of the service sector which, in turn, has curtailed capacity development of the estimated 170 million work forces. The current administration, however, in its first budget in 2015, allocated more than double capital expenditure for infrastructure development aiming to reverse the country's reliance on domestic markets, increase investment, and expand its foreign trade potential[2].

Energy Resilience

In addition to infrastructure spending, a key priority for the Indonesia's medium-term development plan (RPJMN 2015-19) is to increase the country's capacity to generate energy and ensure equitable access and affordable supply of energy for social and economic development[27].There are an estimated 11,157,701 (4%) people without electricity in Indonesia and 8,596,620 (3%) rely on combustion fuels for local energy supply. Furthermore, for the government to maintain its economic growth target of up to 6-

[25] These statistics are calculated from the national 2014 census data. While figures for population were not published in the 2014 statistics, household totals were provided for each of the 80,190 villages (72,195,696). The population count in this document is calculated based on the ratio of people-households (at village level) from the 2011 census data which published figures for population. See: *Pendataan Potensi Desa/Kelurahan 2011, 2014*, Badan Pusat Statistik.

[26] Despite its reliance on domestic markets, Indonesia's trade to GDP reached 45% in 2014 with an estimated USD199.8 billion in exports and USD212.5 billion in imports.

[27] "Energy Resilience" refers to a situation where the supply and public access to energy is guaranteed - at an affordable cost over the long term, while continuing to protect the environment (PP 79/2014).

7%, which it has achieved over the past decade, an estimated 35GW will need to be generated over the next 5 years to avert an embedded slowdown of it recent economic achievements.

Indonesia is adopting wide ranging policy reform to resolve these challenges and ambitious targets, focusing particularly on energy supply diversification. These reforms cover: i) increased private-sector investment and more effective public-sector investment; ii) greater reliance on domestic gas, renewable energy (RE), and energy-efficiency; and iii) expansion of energy supply and access to all Indonesians.

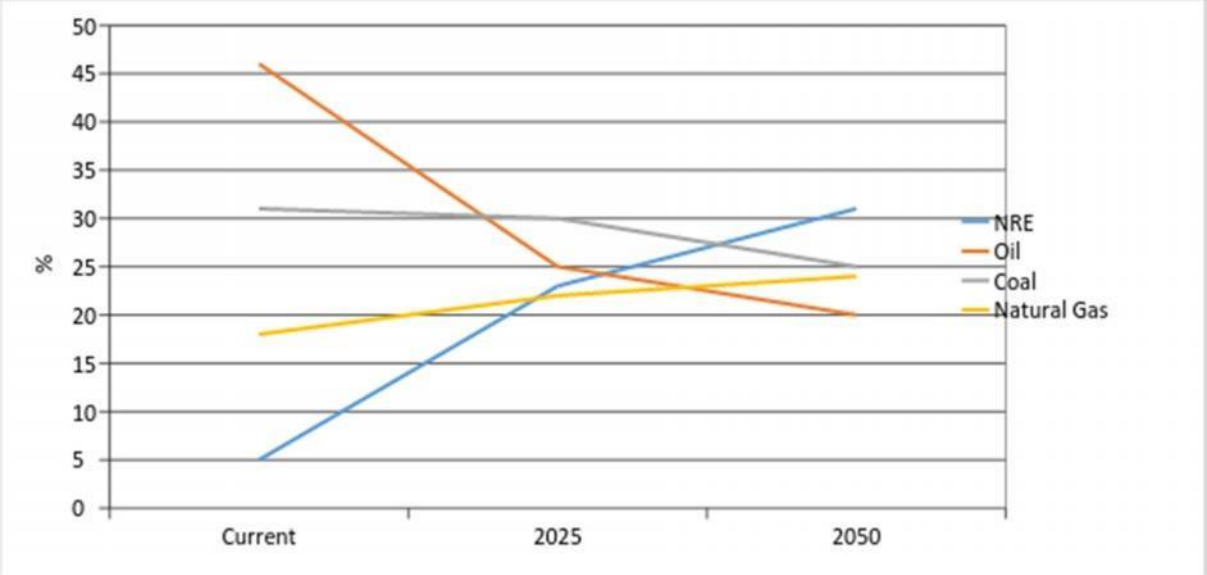


Figure 1: Diversification of Electricity Generation[28]

Meeting demand growth and ensuring environmental sustainability of energy supplies are key considerations for Indonesia's economic and investment policies and strategies. With exhausted oil and gas reserves, a lack of exploration and production, and ageing refineries, the cost of meeting the energy demand through combustion fuels continues to escalate, and is clearly not sustainable[29].

Indonesia has prioritized reducing GHG emissions by 41% by 2020 (with international assistance) and codified this into a Presidential Decree and National Action Plan for Reducing GHGs (RAN-GRK). With environmental sustainability and climate change a national and international priority, the prospect for developing the infrastructure and managing social and environmental safeguards, for increased domestic use of coal is increasingly not tenable[30].

Indonesia's diversification of energy will focus primarily on the research and development, deployment and investment, of clean energy and related technologies, given these constraints, and the global trend

[28] Adapted from Government Regulation 79/2014 concerning the National Energy Policy (*Kebijakan Energi Nasional*, KEN), Article 8, 9.
[29] Currently, Indonesia imports over 800,000 barrels of oil per day and continues to finance subsidised end-consumer prices, which are a legacy from pre 2004 when Indonesia was a net oil exporter. These energy subsidies in 2014 reached IDR315 trillion while in 2015 were reduced to IDR131 trillion.
[30] Indonesian is the largest exporter of coal globally and the largest exporter of gas and liquid biofuels regionally. See IEA, Indonesia 2015, p. 9.

towards renewable energy deployment[31]. This includes the goal of reaching a 23% renewable energy share, from its current 7%, in the national energy mix by 2025.

Clean Energy

In order to bridge the energy demand gap and ensure environmental sustainability, Indonesia is moving towards adopting modern, clean and highly efficient energy technologies. These technologies will be deployed to "leapfrog" the emission-intensive development paths that developed countries have taken and move towards sustainable energy sources that are renewed or replenished rather than exhausted. Given the country's past and present reliance on non-renewable energy, this move is challenging, and cannot be achieved without a major restructuring of, and paradigm shift within, the energy and related sectors.

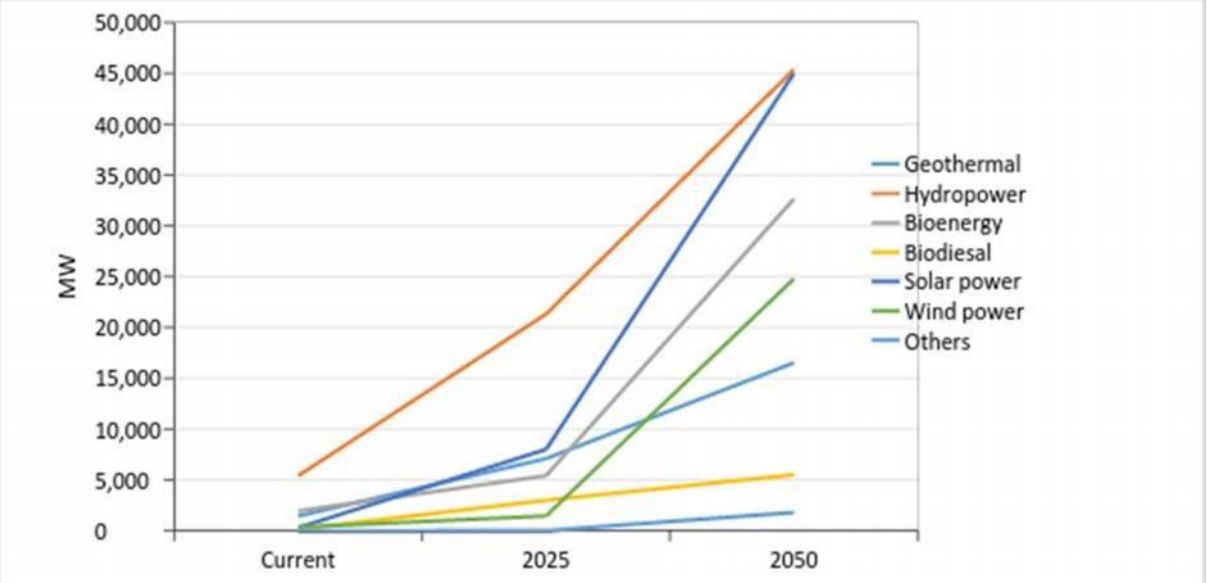


Figure 2: NRE Electricity Generation Targets[32]

The technology and capacity to harvest RE sources remains under developed in Indonesia as it does in most emerging economies, despite the country's abundance of almost every RE source, including solar, wind, biomass, ocean and an estimated 40% of the world's geothermal reserves. Unlike traditional sources of energy, the deployment of RE is not about the energy itself, which is free, but rather the technologies that capture it. Furthermore, unlike previous energy transitions from wood to coal, or coal to oil, the transition to RE represents a major shift from conventional energy systems and infrastructure.

The Government of Indonesia, private sectors, research institutions and communities are already equipped with baseline understanding on what and which clean technology that has worked or could work in Indonesia. This is evident in Indonesia's various electrification programs. The remaining task is developing a solid coordination among stakeholders to share data and information which could be used

[31] Renewable energy will soon become the main source of energy worldwide. IEA estimates that RE will account for 60% (USD5 trillion) of global investments over the next 10 years. In 2014, RE electricity generation reached 1,828 GW compared to 1,500 GW gas and 1,880 GW coal, and the labour force for RE increased by 18% with an estimated 200,000 employees coming from the oil and gas sector.

[32] Adopted from *Draft National Energy General Plan 2015-2050*, Part 3: Annex, Ministry of Energy and Mineral Resources, 10 December 2015, p. 60.

as lessons learned for future planning. This would demonstrate Indonesia's resolve and commitment to develop its clean energy to the world, potential partners and investors.

To enable this diversification to RE and to accelerate Energy Efficiency (EE) implementation, Indonesia's regulatory and market environment will require a major transformation, and the trade or transfer barriers that prohibit countries from modern clean energy technologies will need to be reformed. In addition, environment policies and incentives for the adoption of RE technologies will require further development along with capacity building. This not only addresses the energy supply side but also from the demand side. Incentives for technology owner and user would need to be addressed to trigger technology transfer and usage.

The development of quality data and information regarding RE sources will need to be accelerated in Indonesia in order to facilitate decision support mechanisms, feasibility assessments, and least-cost electrification analysis. For Indonesia to "leapfrog" emission intensive development through clean energy and related technologies, improved coordination and greater market orientation is required to ensure that the sector's institutional environment is coherent with clearer definitions of responsibilities that enable the rapid transformation required to support the national development targets.

To encourage the patient investment required to finance a national transformation to RE, national and international partnerships will need to be forged in an effort to participate globally, and apply locally, the advancements in modern clean energy technologies and the knowledge required to develop a capacity both locally and nationally.

Through the Mission Innovation initiative, Indonesia aims to address these challenges and engage in collaborations to build capacity for clean energy innovation worldwide and to facilitate exchanges, discussion, and linkages between government-funded research and development programs and the private sector investors and companies.

Baseline and Pledge Priorities

Indonesia's participation in the Mission Innovation initiative is a part of its global commitment to address the challenges of energy security and climate change. Given Indonesia's current and growing dependency on importing oil and gas, and its vulnerability to climate change, solutions for the former and mitigation or adaptation of the latter need to be acted upon urgently. An obvious strategy is to address these challenges simultaneously through the use of sustainable energy sources which can displace emissions of greenhouse gases from the combustion of fossil fuels and thereby mitigate climate change.

If developed and deployed correctly, sustainable energy sources can contribute to social and economic development, to energy access, to a secure and sustainable energy supply, and to a reduction of the negative impacts of energy provision on the environment and human health. While there are range of government institutions equipped with the capability to develop (or acquire) clean energy technology, through Research and Development (R&D), the challenge now facing Indonesia's clean energy revolution is not limited to the lack of government-funded research and development programs. Rather, as a vast archipelagic nation with varying levels of economic and social development, Indonesia's challenge lies in its ability to effectively deploy clean energy technologies.

It is Indonesia's contention that a broader objective of the Mission Innovation initiative is to facilitate deployment of clean energy technology through innovative approaches that accommodate diverse social and environmental circumstances.

Baseline

The baseline year that is 2016, comprising R&D budget for clean energy across various government institutions with total amount of USD16,7 million. At the moment, the majority of R&D budget is allocated to develop cleaner fossil energy, and will remain favorite in 2017 along with growing interest in new and renewable energy, electricity grid and basic energy research.

The proliferation of clean energy in Indonesia as a prominent emerging economy with population of 267 million people is significant, particularly within the context of climate change mitigation. To increase new and renewable energy portion in the national energy mix and gradually integrate clean energy as part of social life and one of the drivers of economic growth, Indonesia is committed to enhance its research and development budget from USD16,7 million in 2016 to USD 150 million by 2020.

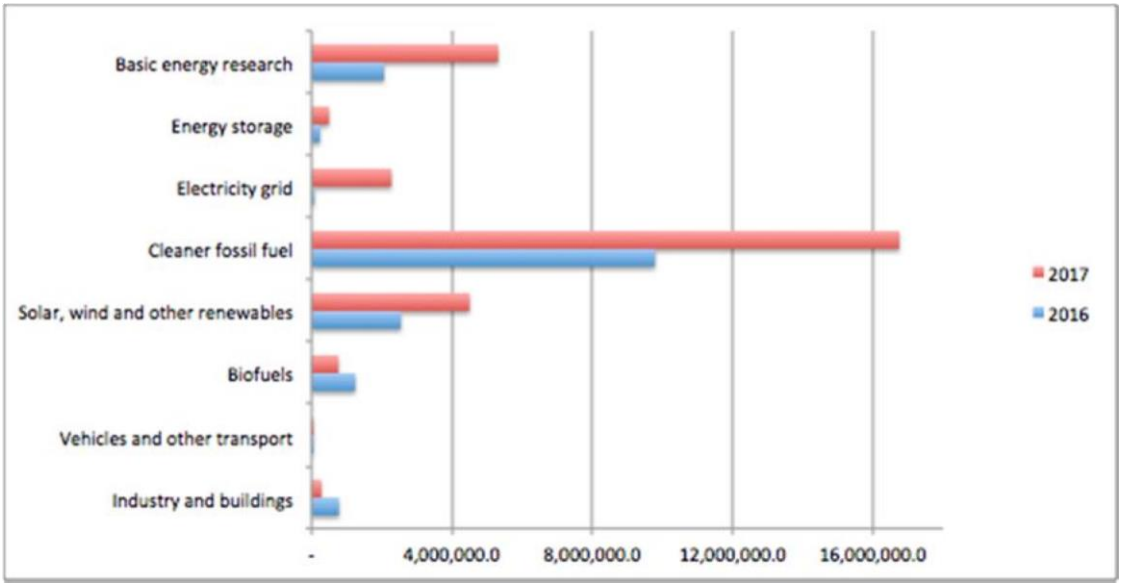


Figure 3: Clean Energy R&D Focus Areas (USD)

Table 1: Clean Energy R&D Appropriations in Support of Mission Innovation Pledge in FY 2017

	Clean Energy	2016	2017
1	**R&D** Energy Efficiency	776,771	272,727
	Energy efficiency and Conservation	776.771	272,727
2	Vehicles and other transportation	12,545	16,309
	Transport	12,545	16,309
3	Biofuels	1,239,381	759,645
	Biofuels (Incl. Liquid biofuels, solid biofuels and biogases)	1,239,381	759,645
4	Solar, wind and other renewables	2,543,278	4,503,436
	Ocean Energy	328,228	115,967
	Geothermal Energy	1,806,997	4,240,121
	Other renewable energy resources	75,455	147,349
	Unallocated renewable energy sources	332,599	-
5	Cleaner fossil energy	9,778,510	16,735,995
	Oil and gas	3,829,381	9,604,995
	Coal	5,548,739	7,149,000
	Unallocated fossil fuels	400,390	-
6	Electricity grid	72,930	2,271,719
	Electric power generation	63,839	2,259,900
	Electricity transmission and distribution	9,091	11,818
7	Energy storage	235,386	490,973
	Energy storage (non-transport application)	235,386	490,973
8	Basic energy research	2,067,067	5,320,091
	Energy system analysis	149,616	-
	Basic energy research that cannot be allocated to a specific category	1,099,269	4,501,909
	Unallocated	818,182	818,182
TOTAL BUDGET		**16,725,869**	**30,388,895**

Pledge Priorities

Realizing the importance of promoting clean energy, Indonesia has almost doubled its R&D budget in this sector from its baseline year from USD16.7 million in 2016 to USD30.3 million in 2017 and ambitiously aiming to reach USD 150 million in 2020.

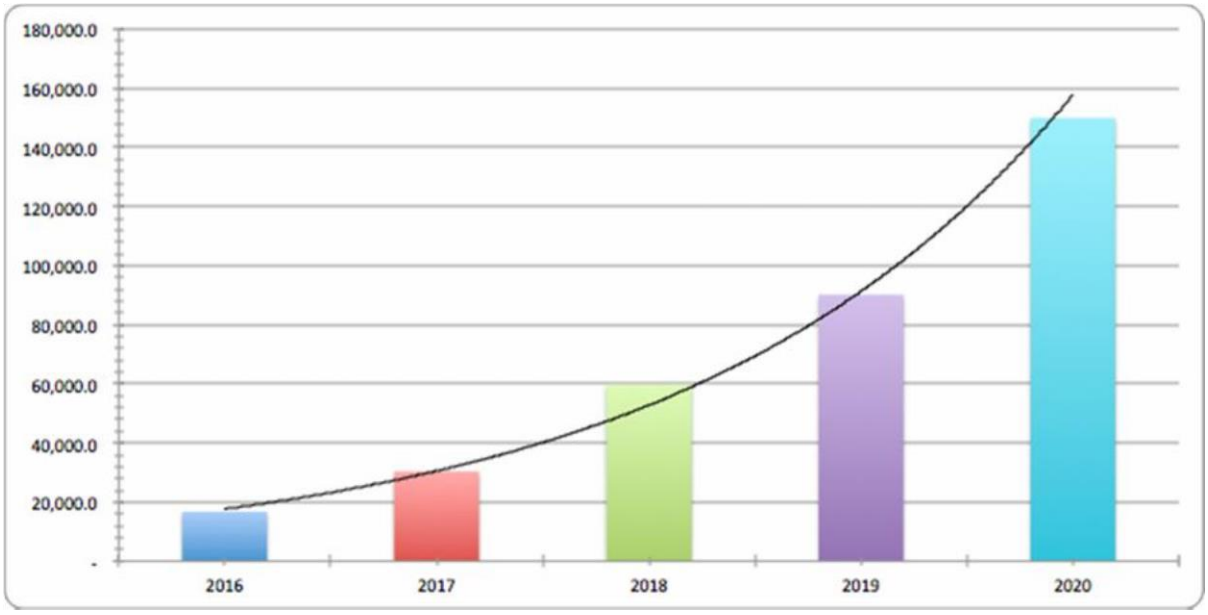


Figure 4: Indonesia R&D budget allocation projection from 2016-2020 (Thousand USD)

Currently Indonesia's priority in research and development of energy is threefold: i) mitigating the impact of climate change; ii) reducing dependency on fossil fuels and iii) promoting clean energy in social and economic development.

Indonesia also has a number of priority programs concerning clean energy in the pipeline, namely:

1. The establishment of **Indonesia's Centre of Excellence (CoE) for Clean Energy** is a collective endeavor led by the Ministry of Energy and Mineral Resources. CoE aims to holistically address research, deployment, investment and project development as interlinked aspects that are required for the acceleration of clean energy technology diffusion.

CoE envisions to enhance access to reliable and affordable supply of clean energy to achieve sustainable social and economic development through three approaches:

- Consolidating information and high quality data analysis to stimulate synergy and innovation;
- Supporting higher certainty of financial viability through providing data and analysis that can assist, among others, constraint mapping and environmental impact analysis. Moreover, CoE aims to reduce administrative and regulatory barriers through synchronizing and coordinating government supervision over clean energy project; and
- Enhancing quality of basic science and technical support synchronized standards and certifications that are conducive for sustainable development of clean energy and, ultimately, locally appropriate technology innovation ready for deployment.

2. **Bali National Clean Energy Area** or *Kawasan Nasional Energi Bersih (KNEB)* is a pioneer initiative where clean energy deployment applied at territorial scale which in this case is at provincial level. The main goal of the initiative is for Bali to use 100% of its energy use from clean energy. KNEB is using a 3 (three) tier approach which encompasses: 1) Tier 1: conversion of fossil-fuel based energy to clean energy mainly targeting large power plants; 2) Tier 2: clean energy utilization by businesses, communities and households; 3) Tier 3: operationalization of Center of Excellence as the center for applied research, investment facilitation and decision making support. In 2017, ERF will allocate around USD740,740 through a competitive call for proposal targeting innovations in clean energy initiatives in Bali Province.
3. ***Program Indonesia Terang (PIT)*** is a national electrification program that sets to provide electricity to people living in remote, underdeveloped, and outermost villages in Indonesia--people who are currently living without electricity, using clean energy. The goals of PIT are to enhance the current electrification ratio, which currently stand at 86 per cent to 97 per cent by 2020, as well as increasing new and renewable energy portion up to 23% by 2025. Through the application of geospatial analysis, PIT is focused on areas that can not be accesed by conventional electricity grid. Therefore, PIT utilizes off-grid approach which include mini/micro grid option for clustered residentials and solar home system for scattered households. The foundation of the programme are: 1) inclusive: involvement of all relevant stakeholders in entire stages; 2) affordable: considering the community's ability to pay; 3) progressive: starting from Eastern Indonesia and gradually reach Western Indonesia, and 4) synergistic: integrating government budget and corporate funding mechanism.
4. As an effort to reduce dependency on fossil fuel as electricity source, **the government is developing new and renewable energy power plants with capacity of 8,800MW**. The 8,800MW new and renewable energy power plant is part of the government's 35,000MW electricity programe where 25% of this capacity will be generated from clean energy. Moreover, the 8,800MW power plant will be derived from solar (4,000MW), bioenergy (1,000MW), geothermal (1,500MW), hydro (1,800MW) and wind (500MW). In general, the development of new and renewable energy to complement the 35.000MW electricity program is built through three specific approaches: 1) acceleration the diversification of energy towards achieving 23 per cent of the energy mix of new renewable energy in 2025, 2) the conversion of diesel power plants into renewable energy, and 3) improving existing power plants, including the development of power plants in remote and border areas.
5. Aside from accelerating the development of new and renewable energy, the Government of Indonesia is also promoting **energy efficiency and conservation** effort. This concern is reflected on General Plan of National Energy which emphasizes the importance of energy conservation's role in achieving energy resilience, along with energy supply and generation. One of the manifestations of this effort is through an initiative called "Reduce 10%". This movement encourages all elements including government, business and industry, civil society organizations, up to the individual to conserve 10 per cent energy consumption from their daily life--equal the cost to develop a 3,5GW power plant (USD4million).
6. The establishment and operation of Indonesia's **Center of Excellence (CoE) for Carbon Capture and Storage (CCS)** led by the Ministry of Energy and Mineral Resources. The CoE CCS main objectives are to establish policy, regulatory, technical, financial and public acceptance of CCS in Indonesia. CCS is a chain of various alternative industrial steps and systems with a potential to reduce emissions from large point of CO2 sources, for instance from coal-fired power plants and gas processing plants in Indonesia. This technology is generally compatible with other climate change technologies and may be tailored to suit the scope, objectives, regulatory framework and GHG source/sink profile of a given mitigation project. CCS research has been started in Indonesia since 2003 such as capture, transport, injection, storage and monitoring technology.

In addition, the Government also plans to funnel R&D funds through the Energy Resilience Fund and the Indonesian Science Fund:

1. Energy Resilience Fund (ERF) is a pool of fund that is proposed by the Government of Indonesia through the Ministry of Energy and Mineral Resources focusing on incentives in accelerating new and renewable energy deployment in Indonesia towards energy resiliency. Amongst the funding windows under the ERF, namely: 1) off grid and on grid electrification project; 2) biofuel; 3) energy efficiency; 4) R&D. Under the R&D window, a competitive call for proposal will be conducted to invite innovations in the clean energy sector. Recipients may come from community organizations, start-up companies, corporations and even individuals. In 2017, the ERF is planned to allocate USD1,481,481 for research proposals along the innovation chain from laboratory research, demonstration activities to precommercial development. Furthermore, ERF will fund research for setting solar panel standard and certification for USD 3.7 million.
2. On March 30 2016, Indonesia launched its first research funding institution, named the Indonesian Science Fund (ISF), supported by the Government of Indonesia, United States, Australia, and United Kingdom. ISF provides multi-year grants for fundamental and frontier research. ISF aims to elevate the current state of science by providing sustainable funding for Indonesian scientists to conduct world-class research. ISF focus areas encompass: 1) Identity, Diversity and Culture, 2) Archipelago, Marine, and Bio-Resources, 3) Life, Health and Nutrition, 4) Water, Food and Energy, 5) Earth, Climate and the Universe, 6) Natural Disasters and Community Resilience, 7) Materials and Computational Science, 8) Economy, Society and Governance. In 2016, ISF opened its first call for proposal for Identity, Diversity and Culture and Life, Health and Nutrition for up to 3 years of research at a maximum amount of IDR 1.5 billion (USD 100,000) a year. Although the call for proposal for energy area is not yet commenced, the ISF's has shown its commitment in removing barriers to science funding.

Abbreviations and Acronyms

Bappenas	State Ministry of National Development Planning
BKPM	Indonesia Investment Coordinating Board
DG EBTKE	Directorate General of New and Renewable Energy and Energy Conservation (MEMR)
DG Migas	Directorate General of Oil and Gas (MEMR)
DG Minerba	Directorate General of Minerals and Coal (MEMR)
GDP	Gross Domestic Product
KEN	National Energy Policy
MEMR	Ministry of Energy and Mineral Resources
MOEF	Ministry of Environment and Forestry
MOF	Ministry of Finance
NRE	New and Renewable Energy
PGN	State Gas Company
PLN	State Electricity Company
RE	Renewable Energy
RUEN	National Energy Plan
R&D	Research and Development
RD&D	Research, Development and Demonstration
RDD&D	Research, Development, Demonstration and Deployment
PUSDATIN	Centre of Data and Information (MEMR)
Ristekdikti	Ministry of Research, Technology and Higher Education

References

DOE 2015	*Quadrennial Technology Review an Assessment of Energy Technologies and Research Opportunities*, DOE, USA, September 2015
Frascati Manual 2015	*Frascati Manual 2015, Guidelines for Collecting and Reporting Data on Research and Experimental Development*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris: 2015.
IEA 2011a	*Technology Roadmap: Smart Grid*, International Energy Agency, OECD/IEA, 2011.
IEA 2011b	*IEA Guide to Reporting Energy RD&D Budget/Expenditure Statistics*, International Energy Agency, June 2011 Edition, OECD/IEA, 2011.
OECD 2014	"Expenditure on R&D", in OECD Factbook 2014: Economic, Environmental and Social Statistics, OECD Publishing, Paris (http://dx.doi.org/10.1787/factbook-2014-61-en, retrieved 27 Apr 2016).
Oslo Manual 2005	*Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, Organisation for Economic Co-Operation and Development Statistical Office of the European Communities, Third Edition, 2005.
RUEN 2015	Rancangan *Rancangan Rencana Umum Energi Nasional 2015-2050*, Draft Dokumen, Ministry of Energy and Mineral Resources, 10 December 2015.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2016
- Baseline Funding Amount: USD $16.7 million
- Doubling Target-Year: 2020
- Doubling Target Amount: USD $150 million
- First-Year of Mission Innovation Funding Increment: 2017
- First-Year Mission Innovation Funding Amount: USD $30.4 million
- First-Year Mission Innovation Funding Increment: USD $13.7 million

Methodology for Determining Baseline

The baseline year that is 2016, comprising R&D budget for clean energy across various government institutions with total amount of USD16.7 million. At the moment, the majority of R&D budget is allocated to develop cleaner fossil energy, and will remain favorite in 2017 along with growing interest in new and renewable energy, electricity grid and basic energy research.

Country-Definition of Clean Energy R&D Investment

At the moment, the majority of R&D budget is allocated to develop cleaner fossil energy, and will remain favorite in 2017 along with growing interest in new and renewable energy, electricity grid and basic energy research.

Overview of Clean Energy R&D Focus Areas Emphasized in MI Portfolio

Industry & buildings	
Vehicles & other transportation	
Bio-based fuels & energy	
Solar, wind & other renewables	
Nuclear energy	
Hydrogen & fuel cells	
Cleaner fossil energy	
CO_2 capture, utilization & storage	
Electricity grid	
Energy storage	
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Related websites:

National portal

Ministry of Energy and Mineral Resources

ITALY

Narrative

The National Energy Strategy (NES) issued in 2013 recognizes that the energy sector has a fundamental role to play in the growth of the economy. Developing a more competitive and sustainable energy is therefore one of the most significant challenges for Italy's future. Accordingly, the NES aims being to pave the way for wider and more effective participation of industry and the country's public and private research centers in future R&D programmes. Smarter investment in energy-related research activities will contribute to further improving the energy and resource efficiency of the economy and to creating new sources of growth.

As envisaged, currently the NES is under review in the light of 2015 Paris Agreement and the related new European Union 2030 climate and energy targets. In this regard, it is important to underline that a new 2030-2050 NES – which will be issued for a prior public consultation and finally launched in the next months – foresees a strong commitment in R&D activities including a key role of Mission Innovation in the future revised Italian R&D governance.

Furthermore, it is important to point out that the Central Government has the review of governance of public research through the 2015-2020 National Research Plan (PNR), that also includes the activities of energy and clean tech R&D. In fact, the high level of fragmentation of actors and areas of research together with a lack of a unified coordination actor/"control room" can be addressed by the new PNR. The PNR was approved by CIPE (Comitato Interministeriale per la Programmazione Economica) in 2016 for an overall amount of public funding of EUR 2.5 billion.

Accordingly, one of the aims of the new NES is to pave the way for wider and more effective participation of industry and the country's public and private research centers in future R&D programmes. On this basis, the NES proposes a series of new measures:

- Greater support for R&D promoted by private stakeholders: Tax reliefs were recently introduced as a first step.
- These measures will be complemented with two other instruments: the Fund for System Research in the Electricity Sector (financed from electricity tariff revenues), and the Fund for Sustainable Growth.
- Increase the amount of resources available under competitive access conditions to create partnerships between both universities and research establishments and private-sector companies.

Italy's technological innovation activities are closely coordinated with the European Union Strategic Energy Technology (SET) Plan in the perspective of the full implementation of the Energy Union at European level. In coming years in fact, EU R&D resources will increasingly be allocated to the priority projects identified under the SET Plan, as already happened for the Horizon 2020 Programme for Research and Innovation.

Moreover, also considering UE efforts and commitment in Mission Innovation, the new NES will establish an integrated approach for both MI and the SET Plan to be implemented by the Italian government in designing the clean tech R&D governance framework.

Within this context, Italy considers the launch of Mission Innovation an opportunity to accelerate public and private investments in clean energy research and innovation. The Italian participation can offer a significant contribution in facing problems such as the low private sector participation in R&D investment in the energy sector and the high degree of fragmentation among the R&D actors.

Highlights

The Ministry of Economic Development (MISE) has been appointed by the Italian Prime Minister's Office, as lead Administration of the Italian participation in Mission Innovation and, thus, has implemented two levels of governance. One with the main Ministries involved: the Ministry of Foreign Affairs and International Cooperation (MAECI), the Ministry of Economy and Finance (MEF), the Ministry of Education, Universities and Research (MIUR) and the Ministry of Environment and Protection of Land and Sea (MATTM).

The other level is with the public R&D institutions which carry out energy-related research such as the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), the National Research Council (CNR) and Research on Energy Systems (RSE) which are committed in the context of Programme Agreements with MISE. An important role will be also played by the regional governments and the scientific community (universities, R&D labs).

Funding Programme

Research and development investments in low carbon technologies are implemented through a number of mechanisms including cost-shared projects with the private sector, research and development activities at the R&D National Agencies, grants to universities and Cohesion Funds at regional level. Further resources have been budgeted to fund R&D through tax breaks through 2015-2020 to the benefit of the private sector and of public- private research projects.

The main contribution to Mission Innovation investments will come from public institutions both at national and regional level. Following a period of decline in the first half of the 2000s, public funding for energy-related R&D increased, reflecting the renewed priority attached to this sector. Funding declined again at the end of the decade, however, as a result of an overall cut in public spending. The government energy R&D budget allocated to energy efficiency and renewable technologies grew steadily during the decade, with the exception of the last few years. In 2011, public energy RD&D funding amounted to around EUR 400 million. The budget structure has changed in recent years, with a marked shift towards energy efficiency and renewable (24% and 17% of the total budget respectively), while nuclear R&D has lost ground (23% in 2011 compared to 40% in 2000). Transport research is also funded through the general research framework and through programmes dedicated to transport.

Innovation Challenges

Italy is engaged in all the 7 Innovation Challenges with different levels of interest and involvement.

1. Smart Grids IC

Co-Lead with China and India and it is extremely active in engaging other partners, stakeholders and related international institutions.

Italy is founder of ISGAN and relies on notable expertise in deploy smart solutions and on research and economic actors with relevant international profile along the whole value chain as TSOs, DSOs, technology component manufactures (batteries, electrical and electronic devices).

2. Off-Grid Access to Electricity IC

Endorsement of IC and sharing of relevant national information and perspectives also in the light of a high national interest both at research and industrial level.

Italy has a specific target regarding the deep decarbonisation of small non connected communities.

3. Carbon Capture IC

Endorsement of IC and current position of observer in order to better match Challenge plans with national related R&D activities

4. Sustainable Biofuels IC

Endorsement of IC and great expectation of the work programme's development, forasmuch as several research and deployment activities are ongoing in Italy along the entire innovation value chain; moreover according to national plan biofuels are among key tools for transport sector decarbonisation. In fact Italy works on the analysis of biomasses availability, the designing of sustainable bioenergy scenarios, the development of biomass-in-biofuel conversion technologies and the efficient utilization of biofuels in engines. Biofuels are

5. Converting Sunlight IC
Endorsement of IC and involvement in work plan strategic planning, in the light of a national interest which is reflected in activities all along the research chain (modeling, design, prototypes production). Italy shares the perspective of a conspicuous engagement of the industrial sector in the IC activities.

6. Clean Energy Materials
Endorsement of IC and active involvement in planning further developments.

Italy has strong competence in new material synthesis engineering and industrialization, with particular interest in topics as energy conversion, low energy application and materials with peculiar properties and emerging class of 2D materials (graphene). It is envisaged as a complementary activity a national "roadmap for new materials for energy".

7. Affordable Heating and Cooling of Buildings IC
Endorsement of IC and active participation in the activities.

Based on the significant energy demand for H&C applications, Italy can rely on important research efforts in topics related to the development of integrated and efficient energy urban districts and in the integration of heating and cooling systems in the building sector.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): Fiscal Year 2013
- Baseline Funding Amount: EUR 222.6 million
- Doubling Target-Year: Fiscal Year 2021
- Doubling Target Amount: EUR 445 million
- First-Year of MI Increment: Fiscal Year 2017
- First-Year MI Funding Amount: EUR 267 million
- First-Year MI Funding Increment: EUR 44.5 million
- First Year Funding Percent Increase: 20%

Baseline is composed of the Mission Innovation related parts of enacted appropriations for Fiscal Year 2013 (base year), as identified among selected line-items of clean energy RD&D, across the Ministry of Economic Development, and like-budget tables of other Governmental Agencies and public R&D Institutions.

Country-Definition of Clean Energy R&D Investment

Research and development in low carbon technologies, including end use energy efficiency, renewable energy, electric grid technologies, carbon capture, storage and utilization, and smart cities integrated technologies. Investments are implemented through a number of mechanisms including cost-shared projects with the private sector, research and development activities at the R&D National Agencies, grants to universities and Cohesion Funds at regional level.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

	Focus areas for MI	Share of overall funding increment 2017(%)
Energy efficiency in Industry & buildings	●	16
Energy efficiency in vehicles & other transportation		
Biofuels	●	4
Solar, wind & other renewables	●	24
Nuclear energy		
Hydrogen & fuel cells		
Cleaner fossil energy		
CO_2 capture & storage		
Electricity grid (incl. smart cities)	●	40
Energy storage	●	9
Basic energy research	●	7

Additional Information

Related websites:

Government of Italy

Prime Minister's website

Ministry of Economic Development

Ministry of Foreign Affairs

National Strategy for Competitiveness

Three Year Plan 2015-2017 for National Research of the Electricity System

JAPAN

Narrative

We have been positively working on R&Ds on energy and environmental fields. The amount of public investments on the R&Ds in our country are the second largest following US, and the first among the major developed countries as a share of GDP

For instance, since the mid-1970s, Japan has been promoting R&Ds of technologies in the field of energy and environment including photovoltaic cells, heat pumps and fuel cells, under the national strategies such as the “Sunshine Project” and the “Moonlight Project”. Based on such long-term strategies, Japan has realized breakthrough innovations including widely diffusion of solar energy generation and the commercialization of fuel-cell vehicles, ahead of the rest of the world.

In order to accelerate R&Ds of innovative technologies for drastically reducing GHG emissions in the long-term, Japan has established a new national strategy, the “National Energy and Environment Innovation Strategy towards 2050 (NESTI2050)”, in this April. Under this strategy, Japan will identify such promising technologies as next-generation batteries and technologies related to hydrogen and will focus to conducting R&Ds on these technologies. This effort is in line with that of MI.

We propose the registration of the FY 2016 as its base year and 45 billion yen for its baseline amount. Further, we will try to allocate as much budget as possible to the fields of innovative technologies looking ahead to the year of 2050 in NESTI2050. Even if there are financial constraints, we will aim at doubling the budget in five years.

In addition, we compiled a report called the Long-term Energy Supply and Demand Outlook for FY2030 (the” Energy Mix”). Tackling climate change issues requires finding a balance between mitigation measures and economic growth. To achieve this, Japan is committed to:

1) promoting energy-saving measures,
2) expanding the use of renewable energy sources, and
3) increasing investments aimed at establishing a new energy system to improve the efficiency of energy use.

In particular, the total share of renewable energy is set to double from 12% in 2013 to 22-24% (Solar 7.0%, Wind 1.7%, Biomass 3.7-4.6%, Geothermal 1.0-1.1%, Hydropower 8.8-9.2%) in 2030.

Besides, we started R&D programs such as R&D on supercritical geothermal resources and R&D on quantum dot photovoltaic cells as promising technological fields specified in NESTI2050.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2016
- Baseline Funding Amount: JPY 45 billion (USD $410 million)
- Doubling Target-Year: 2021
- Doubling Target Amount: JPY 90 billion (USD $820 million)

Country-Definition of Clean Energy RD&D Investment

We have defined “clean energy” targeted in MI as the energy through innovative technologies that are expected to drastically reduce GHG emissions by 2050, which is decided in “National Energy and Environment Innovation Strategy towards 2050 (NESTI2050)” published in this spring.

Specifically, the following eight fields are the decided targets:

1. Innovative production process
2. Ultra-lightweight and heat-resistant structural materials
3. Next-generation batteries
4. Production, storage and utilization of hydrogen, etc.
5. Next-generation photovoltaics
6. Next-generation geothermal power generation
7. Fixing and utilizing CO2
8. System infrastructure technologies: energy system integration technologies (AI, Big Data and IoT) and core technologies (next generation power electronics, innovative sensors and superconductivity) constituting the system

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	●
Cleaner fossil energy	
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country’s full R&D portfolio.

Additional Information

Prepared Remarks for Launch Event:

H.E. Shinzō Abe, Prime Minister of Japan

Related websites:

Prime Minister of Japan and His Cabinet

Ministry of Economy, Trade, and Industry

KINGDOM OF SAUDI ARABIA

Narrative

Saudi Arabia believes that Technology provides the most viable solution to address climate challenge. This is why we joined Mission Innovation at its launch during the 21st Conference Of the Parties (COP21) in November 2015. Technology has done so for mankind throughout history and it requires greater innovation, collaboration and investments to address climate change. We trust that Mission Innovation provides the right platform to advance international collaboration on science and technologies that could enable significant emissions reduction in all residential and industrial sectors.

Saudi Arabia clean energy innovation focuses on greenhouse gas management, energy efficiency and renewable energy. The Kingdom's Carbon Capture, Utilization and Storage (CCUS) research portfolio encompass the following five areas: (i) carbon dioxide capture from fixed sources, (ii) carbon dioxide reduction from mobile sources such as cars, marine, trains, (iii) industrial use of carbon dioxide for polymers, carbon fiber, construction materials, and chemicals, (iv) carbon dioxide use for enhanced oil-recovery, (v) carbon dioxide sequestration in geological formation. In addition, the Kingdom is investing in developing and implementing a renewable energy program as well as energy efficiency technologies in residential and industrial applications.

The Kingdom, through its leading companies, universities, and science cities as well as the private sector, has been playing a leadership role in basic research, clean energy deployment at scale, venturing, and international collaborations to advance innovation in clean energy technology.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2015
- Baseline Funding Amount: SR 281.3 million (USD $75 million)
- Doubling Target-Year: 2021
- Doubling Target Amount: SR 562.5 million (USD $150 million)
- First-Year of Mission Innovation Funding Increment: 2017
- First-Year Mission Innovation Funding Amount: SR 337.5 million (USD $90 million)
- First-Year Mission Innovation Funding Increment: SR 56.3 million (USD $15 million)
- First-Year Funding Percent Increase: 20%

Methodology for Determining Baseline

Saudi Arabia baseline is based on contributions from academia and state owned companies for the fiscal year of 2015.

Country-Definition of Clean Energy R&D Investment

Our efforts will focus on research, development and demonstration (R&DD) of technologies such as greenhouse management, energy efficiency (buildings, transport, and industry), renewable energy, and carbon capture utilization and storage (CCUS).

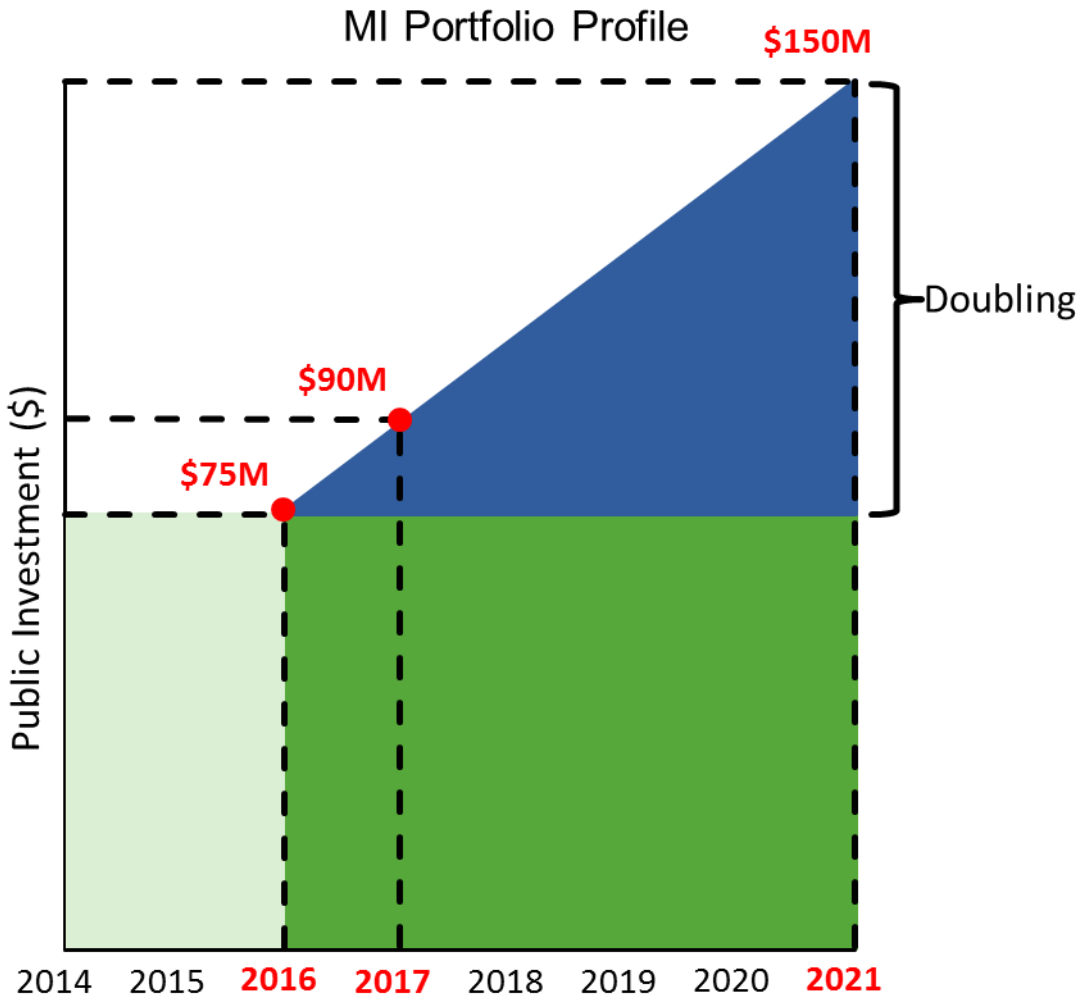
Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture, utilization & storage	●
Electricity grid	
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Materials

Investment Chart:



Prepared Remarks for Launch Event:

H.E. Ali Al-Naimi, Minister of Petroleum and Mineral Resources

Related websites:

National portal

King Abdullah City for Atomic and Renewable Energy

Ministry of Environment, Water and Agriculture

Ministry of Energy, Industry and Mineral Resources

King Abdulaziz City for Science and Technology (KACST)

King Abdullah University of Science and Technology (KAUST)

MEXICO

Narrative

Accelerating widespread clean energy innovation is an indispensable part of an effective, long-term global response to our shared climate challenge; necessary to provide affordable and reliable energy for everyone and to promote economic growth; and critical for energy security. While important progress has been made in cost reduction and deployment of clean energy technologies, the pace of innovation and the scale of transformation and dissemination remains significantly short of what is needed.

For these reasons, participating countries have come together to launch Mission Innovation to reinvigorate and accelerate public and private global clean energy innovation with the objective to make clean energy widely affordable.

Context

To promote clean energy innovation in Mexico, the Mexican Government established the Energy R&D Funds in 2008. These Funds are designed to be the engines that promote a level of research and technology development that allows Mexico to address the great challenges of its energy sector, including an increased demand for energy resources, pollution and climate change.

These Energy R&D Funds are jointly led by the Ministry of Energy (SENER) and the National Science and Technology Council. The Energy R&D Funds receive annual contributions from the Federal Income Budget Law, which stipulates that 0.65% of oil revenues shall be divided among the Energy R&D Funds and the Mexican Institute of Petroleum.

As a member of Mission Innovation, Mexico pledged to double its investment in research and development of clean energy technologies. Mexico hereby reaffirms its commitment adopted in Paris on November 30th, 2015 and in this document, details its plans to more than double its R&D investment in clean energy technologies over the next five years.

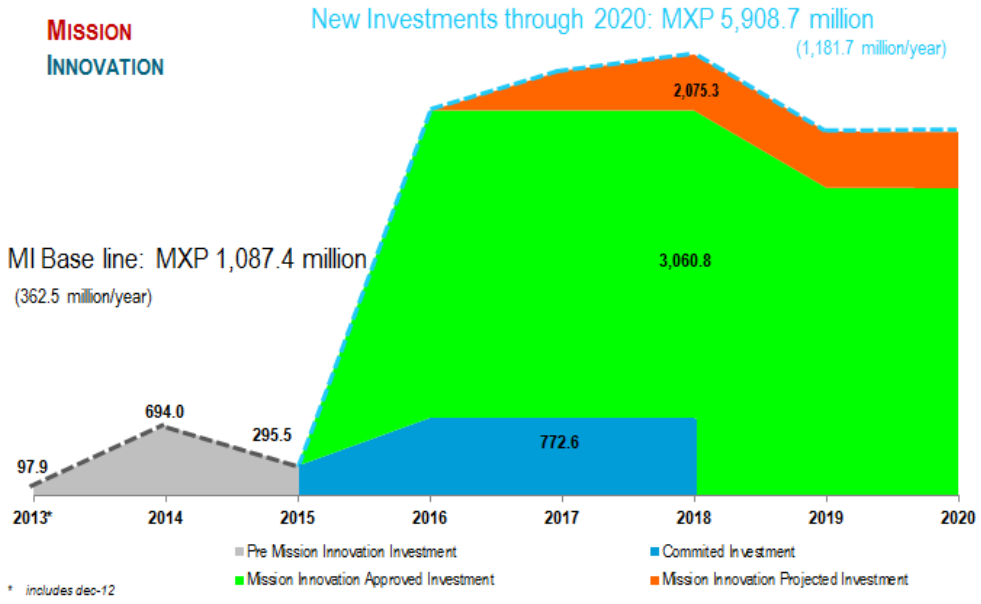
Funding Programme

The objective of the Energy R&D Funds, the Hydrocarbons Fund (FH) and the Energy Sustainability Fund (FSE) is to fund and support scientific research, technology development, innovation, human capital development, promotion and technology deployment in energy. Both Funds focus on expanding Mexico's energy matrix. The FSE focuses on clean energy and sustainability, while the FH focuses on improving, optimizing and expanding the hydrocarbons sector to meet the country's growing energy needs in a responsible and sustainable way.

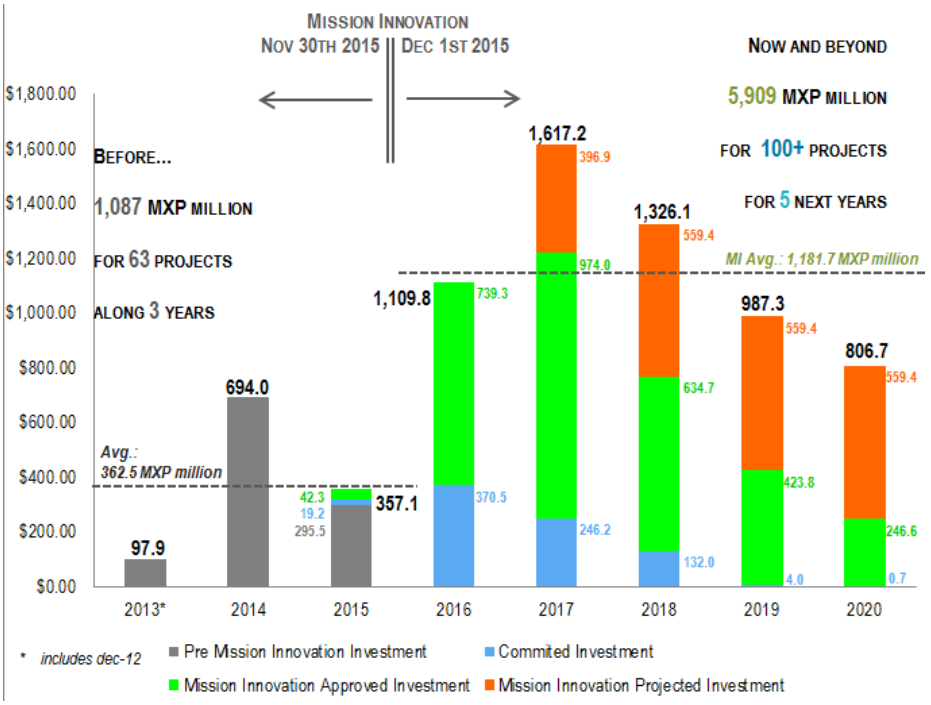
The FSE allocates its resources through calls for proposals. This Fund has published 27 calls for proposals since its creation in 2008. As a result, the FSE has approved 131 projects, with many more projects currently in the evaluation process.

Baseline

- Country-Determined Baseline Year(s): average investment per year from Dec 2012 to Nov 2015
- Baseline Funding Amount: MXP$362.5 million per year (USD $20.7 million)[33]
- Five Year Target Amount: MXP $1,181.7 million average investment per year from Dec 2015 to Dec 2020, corresponding to MXP$1,187.7 million per year.
- Resources invested since joining Mission Innovation, in December 2015, to October 2016 are MXP $894.4 million (USD $51.1 million).



[33] Exchange rate will remain fixed to $17.51 MXP/USD. All the investments made by the Energy Sustainability Fund are made in Mexican Pesos.



Project Classification	Total Funding 2016-2020 (in million MXP)	Investment Allocated as of Sept 2016 [MXP million]	%
Wind, Solar and Ocean	$ 867.6	$ 215.9	24.9%
Geothermal	$ 627.3	$ 173.7	27.7%
CCUS	$ 998.8	$ 29.4	2.9%
Bioenergy	$ 870.1	$ 213.9	24.6%
Energy Sustainability Capacity Strengthening	$ 626.7	$ 204.6	32.6%
Smartgrids and electric efficiency	$ 488.7	$ 2.7	0.6%
Energy Efficiency in Buildings, industry, transport and rural areas	$ 167.6	$ 28.2	16.9%
Nuclear	$ 21.4	$ 6.5	30.5%
Hydrogen and Non-conventional	$ 47.5	$ 9.8	20.7%
Other (Modelling, Statistics, waste and pollution management)	$ 55.5	$ 9.6	17.4%
TBD	$ 1,137.5	$ -	0.0%
Total general	$ 5,908.7	$ 894.4	15.1%

Wind, Solar and Ocean

Efforts in this area focus on three Mexican Energy Innovation Centers that work on research and technology development for its respective renewable energy. There are also several independent projects, many of which are researching on solar PV panel materials.

Geothermal

The geothermal effort also focuses on the support given to de Mexican Geothermal Energy Innovation Center, although a new collaborative project between Mexico and the European Union, which will develop on Enhanced and Super Hot Geothermal Systems, will begin in December 2016.

CCUS

The Energy Sustainability Fund is currently supporting three small CCUS projects. In addition, SENER has an initiative for research and technology development as well as a CCUS pilot plant, that will be built with the support of the World Bank ($25 million dollars); the call for proposals for this project will launch in 2017.

Bioenergy

The Energy Sustainability Fund has begun the operations of five research clusters on biogas, bioalcohol, solid biofuels, bio jetfuel and biodiesel. In addition, there are several projects on biological waste to fuel using agave and other endogenic plants.

Energy Sustainability Capacity Strengthening

SENER is funding several projects designed to build institutional capacities, including laboratories enhancements, graduate program, technical training and research groups creation. These kinds of projects focus on renewable energies, clean technologies, energy matrix diversification, energy efficiency, and sustainability.

Smartgrids and Energy Efficiency

Large projects in smart grids and energy efficiency will begin in 2017, including a Mexican Energy Innovation Center for research and technology development in Smartgrids. These kinds of projects will be essential to maximize the potential of distributed energy generation, a new area of opportunity that has opened up as a result of Mexico's Energy Reform.

Highlights

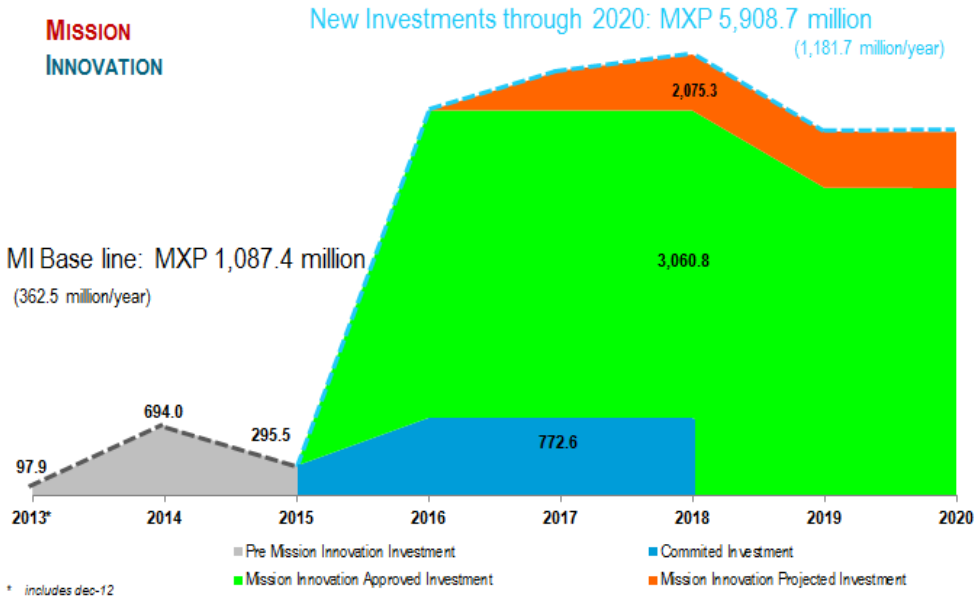
Over the last several years, the FSE has been actively engaging and working with international partners as part of its strategy to promote stronger interaction and collaboration with leading international institutions. This year, the FSE launched Mexico's first Energy Frontier Research Center, involving 5 Mexican research institutions, led by Mexico's National Autonomous University (UNAM), that are collaborating with a number of research institutions in the United States. This EFRC is focused on synthesis and characterization of clean energy materials. Other examples include a 20 million Euro project on Enhanced (EGS) and Super-hot (SHGS) Geothermal Systems in a collaboration with the European Commission.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2012-2015
- Baseline Funding Amount: USD $20.71 million
- Doubling Target-Year: 2020
- Doubling Target Amount: USD $62.02 million
- First-Year of Mission Innovation Funding Increment: 2016
- First-Year Mission Innovation Funding Amount: USD $70.39 million
- First-Year Mission Innovation Funding Increment: USD $49.68 million

Methodology for Determining Baseline

Mexico´s baseline with respect to the Mission Innovation commitment is defined by the investments made through the Energy Sustainability Fund (FSE) over the three-year period prior to Mexico's integration to Mission Innovation, from the 1st of December 2012 to the 30th of November 2015.



Country-Definition of Clean Energy R&D Investment

The establishment of Mexican Energy Innovation Centres (CEMIES) represent the largest projects that are currently being developed on clean energy R&D in Mexico.

The CEMIES are expected to provide a platform to launch and grow an unprecedented portfolio of low carbon activities, through a guaranteed 4 years funding scheme to deliver low carbon innovation.

- CEMIE Geothermal ($23.6 million)
- CEMIE Wind ($6.6 million)
- CEMIE Solar ($9.9 million)
- CEMIE Ocean ($19.8 million)
- CEMIE Bioenergy ($40.1 million)
- CEMIE CCSUS ($28.6 million)
- CEMIE Smart Grids ($25.7 million)

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	
Vehicles & other transportation	
Bio-based fuels & energy	
Solar, wind & other renewables	
Nuclear energy	
Hydrogen & fuel cells	
Cleaner fossil energy	
CO_2 capture, utilization & storage	
Electricity grid	
Energy storage	
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Related websites:

President's website

Ministry of Energy

NETHERLANDS

Narrative

The Netherlands is convinced that research, development and demonstration of clean energy technologies will help achieve the long-term goal of a sustainable low-carbon energy system.

With a view to joining Mission Innovation, the Netherlands reaffirms its commitment to stepping up its efforts on clean energy research and development by 2020. In the 2013 Energy Agreement for Sustainable Growth, concluded with major stakeholders from the private sector, research organisations, local governments and NGOs, the Dutch government committed to an ambitious level of public investment on clean energy RD&D, most notably in the demonstration phase of clean energy technologies, giving a strong boost to investments in this field. The Netherlands therefore proposes taking the fiscal years from 2013 to 2015 as its baseline. The following ambitions of the National Energy Agreement for Sustainable Growth form the core of the Dutch government's public funding commitments up to 2020:

- In 2014 the Dutch government introduced a grant program for demonstration projects in the area of energy innovation, which have considerable export potential. Under this program, Dutch companies may receive up to 6 million euros per project to demonstrate new sustainable energy technologies and energy efficiency innovations. The program has an average budget of 50 million euros per year from 2016 to 2020, a marked increase compared to the average budget of 20 million euros per year from 2013 to 2015 (+30 million euros per year). The grant enables businesses to demonstrate innovative technologies with global market potential. Funded projects may therefore have major innovation spillover effects for other Mission Innovation members.
- The Netherlands will also invest in offshore wind energy projects demonstrating innovative techniques and aimed at achieving a cost reduction of 40% (through process innovation). The innovation component of this public financing concerns an average increase of +4 million euros per year from 2016 to 2020.
- From 2016 to 2019 the Netherlands will provide 50 million euros per year (from the Stimulation of Sustainable Energy Production (SDE+) operating fund) for energy innovation aimed at making renewable energy production more costeffective. Negotiations on the Energy Agreement for Sustainable Growth resulted in additional spending of, on average, +40 million euros per year from 2016 to 2020.
- More public funding is available for innovative energy-efficiency projects in the built environment, with a view to accelerating the cost-effective adoption of energy efficiency technologies. Funding is available for projects in the social housing sector, e.g. zero-energy buildings, and in the owner-occupied sector, through a joint approach by municipalities, businesses and other parties offering innovative product-market combinations. This will result in an average increase of public funding by +40 million euros per year from 2016 to 2020.
- The Energy Agreement also announced a demonstration project for Carbon Capture and Storage (CCS), the 'Rotterdam Opslag en Afvang Demonstratieproject' (ROAD). The Netherlands has pledged 135 million euros to this project, on top of commitments from the European Commission, other EU Member States and the businesses involved. A final investment decision will be made by the end of 2016. This will involve an average spending increase of +27 million euros per year from 2016 to 2020.

- The Netherlands' baseline also includes ongoing research and innovation activities specifically targeting clean energy. From 2016 to 2020 funding will be maintained at more or less current levels for activities in the following areas:
    - Fundamental research on clean energy technologies: ongoing funding for fundamental research will be around 21 million euros per year from 2016 to 2020, a slight increase of +2 million euros per year compared to the baseline of 19 million euros per year.
    - Public funding for clean energy technologies in collaboration with the private sector and knowledge institutions, within the Top Sector for Energy: this concerns an average of 34 million euros per year from 2016 to 2020, compared to the baseline of 38 million euros per year, or a projected decrease of -4 million euros.
    - Applied research into energy innovation: around 20 million euros government funding per year. Compared to the budget of 23 million euros in the baseline, a slight decrease of -2 million euros per year is projected for 2016 to 2020.

The abovementioned measures add up to average spending in this area of 237 million euros per year from 2016 to 2020, compared to average spending of 100 million euros per year in the baseline years 2013 to 2015 – a doubling of investment by the Netherlands on the basis of existing commitments from the Energy Agreement for Sustainable Growth.

Baseline and Funding Plan

- Country-Determined Baseline Year(s): 2013, 2014, 2015
- Baseline Funding Amount (million EUR): 100
- Baseline Funding Amount (million USD): 113[34]
- Doubling Target-Year: 2020
- Doubling Target Amount (million EUR): 237
- Doubling Target Amount (million USD): 269[35]

Methodology for Determining Baseline

The baseline is the average annual budget in the fiscal years 2013, 2014 and 2015. It includes the main programs for research, development and demonstration activities (RD&D) in the area of clean energy innovation currently funded by the Ministry of Economic Affairs and the Ministry of the Interior and Kingdom Relations.

Country-Definition of Clean Energy RD&D Investment

In the Netherlands the following clean energy technologies are eligible for funding from research, development and demonstration programs: renewable energy technologies (including offshore and onshore wind), energy efficiency technologies, carbon capture and storage, and other crosscutting technologies.

Overview of Clean Energy R&D Focus Areas Emphasized in MI Portfolio

Industry & buildings	●
Vehicles & other transportation	
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

[34]Based on the EUR-USD exchange rate as at 9 June 2016
[35]Based on the EUR-USD exchange rate as at 9 June 2016

Additional Information

The Netherlands has a long tradition of public-private partnerships. The Dutch government collaborates closely with the private sector, knowledge institutions and NGOs in the 'triple helix' to achieve its energy and climate objectives. This also involves establishing collaborative platforms for sharing knowledge and developing and implementing energy innovation policies.

This collaborative approach also underlies the Dutch government's Energy Agreement for Sustainable Growth, which was concluded with more than 40 parties, including industry, business associations, knowledge institutions, trade unions, NGOs, and regional and local governments, and which sets out the goals of national energy policy with a view to 2020.

The triple helix approach also informs the activities of the Top Sector for Energy, a public-private platform for energy research and innovation. Knowledge institutions, businesses and the government are represented on the platform and jointly set the priorities of Dutch policy on energy research and innovation. Joint innovative projects are carried out by Top Sector Alliances for Knowledge and Innovation. Communication in the top sector alliances is always two-way. The collaborative approach and the development of joint goals and roadmaps have multiple benefits:

1. The government can depend on businesses and knowledge institutions to cooperate in the implementation of energy innovation policies. By setting targets that are aligned with businesses activities and research priorities, the most critical innovation needs are addressed.
2. The Netherlands' institutionalized cooperation platforms are an efficient structure for information-sharing between knowledge institutions and businesses. Having a clear picture of planned business and research activities facilitates the identification of knowledge gaps and opportunities. By mapping existing knowledge, capabilities and resources, the most critical innovation needs can be identified.
3. Setting common goals further strengthens business and investor engagement in clean energy projects.

The Netherlands aims to extend this alliance-based, systemic and integral approach to the Mission Innovation initiative. Through its well-developed information-sharing structures joining government, knowledge institutions and businesses, the Netherlands can contribute to the identification of innovation needs at global level. Furthermore, the Netherlands has broad experience with engaging businesses and the general public in the development of clean energy priorities. Its methods include organizing workshops and exchanges.

Moreover, the Netherlands would bring its experience in several areas of energy innovation, such as in offshore wind energy on the North Sea, into the Mission Innovation initiative. The Netherlands is firmly committed to building several offshore windfarms by 2023 that will significantly boost cost-efficiency and innovation. The Netherlands is also focusing on integrated innovative solutions for urban environments, such as energy efficiency and greater flexibility on the grid.

The Netherlands, as a sustainable urban delta with a high population density, a well developed (ICT) infrastructure and a well-educated population, is eminently suited for social innovation labs and field testing, which are essential for learning. For example, innovative experiments are being carried out in electric mobility and 'smart energy cities'. Dutch universities and institutes like the Netherlands Organisation for Applied Scientific Research (TNO) and the Energy Research Centre of the Netherlands

(ECN) take the lead in research on clean energy technologies, and participate actively in European and international platforms and networks.

The Netherlands has a large energy-intensive industry which operates internationally. Our chemicals industry, for example, is the fourth largest in Europe in terms of turnover. Dutch industry needs to make significant progress in the coming years in the energy transition towards 2050. Both public and private investment in this sector may benefit from the spillover of innovation efforts in other industrialized countries.

The Netherlands is active in various international collaborative platforms on clean energy innovation, including the Strategic Energy Technology (SET) Plan, and the European Energy Research Alliance (EERA) at European level, and the Working Groups and Technology Collaboration Programmes within the International Energy Agency (IEA) at global level. Within these frameworks, the Netherlands shares its expertise and data on energy innovation, contributing to global innovation analysis and roadmapping.

The Netherlands is an active participant in a variety of bilateral and multilateral research partnerships and cooperative engagements to help enhance collective global capacity in energy innovation. For example, the Netherlands Organisation for Scientific Research (NWO) recently signed a Memorandum of Understanding with the University of California on challenges concerning energy and sustainability. The Netherlands is also participating in seven ERA-Net Cofunds – co-financing mechanisms between the European Commission and the EU Member states under the Horizon 2020 program – for clean energy technologies such as offshore wind, smart grids, solar power and carbon capture and storage. Finally, the Netherlands has signed bilateral Memorandums of Understanding on clean energy with 22 countries, including Brazil, China and India.

As a member of Mission Innovation, the Netherlands would be able to share its broad experience with multi-stakeholder collaboration, outlined above, and best practices in order to strengthen global cooperation frameworks between governments and with private sector parties and knowledge institutions. As a member of Mission Innovation, the Netherlands would be able to contribute in a positive way to global efforts and partnerships on clean energy innovation, and to the joint achievement of major steps towards a low-carbon economy.

NORWAY

Narrative

Norway acknowledges the need to accelerate clean energy innovation to respond to our shared climate challenge. What is needed is a massive push for research, development, dissemination and deployment of clean energy technologies, but also cooperation between governments as well as governments and private investors.

As a country rich in energy resources and with a history of developing and using innovative energy technologies and solutions Norway is pleased to play a part in Mission Innovation. By 2020, Norway will seek to double the already considerable public resources devoted to developing and demonstrating clean energy technologies and solutions. This means increased efforts on renewable energy technologies, energy efficiency and carbon capture and storage. Important stakeholders will be the Research Council of Norway (RCN) and our two state energy enterprises, Enova and Gassnova, as well as energy research institutions and the private sector.

Norway has always given high priority to the development, use and deployment of environmentally sound technologies. Mission Innovation will put the world on a faster route to the point where we can secure energy access for all, while at the same time curbing global emissions of greenhouse gases. Norway signed the launch statement for Mission Innovation in 2015 because we have a strong commitment to the ambitions in the statement.

In the two years since the launch in Paris our dedication to the ambitions in Mission Innovation has grown even stronger. We believe that innovations and technological breakthroughs will be vital to ensure that low carbon energy technologies will be viewed as the best choices when the energy demand grows in many parts of the world. But also in Norway, where we face big challenges concerning replacing old infrastructure and investments in new capacity, innovations and new technology are of great importance. We also believe that investments in the energy sector worldwide will represent some of the most interesting marked opportunities for Norwegian companies, and we want to be part of the global effort to find new and environmentally good solutions.

Innovation Challenges

Norway was an active participant when the seven Innovation Challenges were launched in 2016, and have chosen to support all of them. We believe that each topic represents important challenges, and we want to mobilize Norwegian scientists to participate in the international cooperation that strives to find new solutions to these challenges.

We have, however, selected the following three challenges that we want to follow more closely than the rest of the challenges:

Challenge nr. 1 – **Smart Grids Innovation Challenge**
Challenge nr. 3 – **Carbon Capture Innovation Challenge**
Challenge nr. 4 - **Sustainable Biofuels Innovation Challenge**

All three represent areas that have high priority in Norwegian R&D-strategies. Norway therefore wants to follow these challenges closely and contribute in the best way we can. In addition, Norway have taken a

big interest in Challenge nr. 6, **Clean Energy Materials Innovation Challenge**, and plan to participate in the planned activities for this challenge.

National R&D Strategy

Energi21:
Energi21 is the Norwegian strategy for research, development and commercialisation of new climate friendly energy technologies. Established in 2008 it focuses on how increased efforts in research and development and new technology can result in enhanced value creation and efficient use of energy resources in the sector.

Energi21 sets goals and advises on research and development of technology for renewables, energy efficiency, as well as carbon capture and storage (CCS). Commissioned by the Ministry of Petroleum and Energy (MPE), the strategy has been developed by the industry, research institutions and relevant government bodies. Energi21 aims at contributing to a coordinated, efficient and goal-oriented focus on research and technology, with a strong commitment by the energy sector at its centre.

The government-appointed board of Energi21 is responsible for the follow-up of the strategy and gives advice to the MPE on research funding allocations. The board's representation is dominated by the industry, but research institutes and authorities are also represented. The board's revised strategy from September 2014 recommends more public funding for research, development and demonstration within six priority areas:

- Hydropower
- Flexible energy systems
- Solar power
- Offshore wind power
- Energy efficiency
- Carbon capture and storage

In these areas Norway enjoys competitive advantages, thanks to its natural energy resources, a strong technology and knowledge base and industry experience. http://www.energi21.no/prognett-energi21/Home_page/1253955410599

SCHEMES COUNTED IN UNDER THE MI BASELINE

Energy R&D:
The Research Council of Norway:

- **ENERGIX**: The ENERGIX programme provides funding for research on renewable energy, efficient use of energy, energy systems and energy policy. This encompasses both natural science and engineering as well as social science-based research and development. ENERGIX has a wide range of funding instruments, and both industry, research institutes and universities can apply for funding. The programme is a key instrument in the implementation of Norway's national RD&D strategy, Energi21, as well as for achieving other energy policy objectives. http://www.forskningsradet.no/prognett-energix/Home_page/1253980140022
- **Centres for Environmentally-Friendly Energy Research**: The scheme of the Centres for Environment-friendly Energy Research (FME) seeks to develop expertise and promote innovation through long-term research in selected areas of environment-friendly energy. There are today 11

FME centres within renewable energy, energy efficiency, social sciences and CO2 management. The centres are hosted by either research institute or universities. The research activity is carried out in close cooperation between prominent research communities and industry partners. http://www.forskningsradet.no/prognett-energisenter

Energy and Climate Technology Demonstration

- **Enova**: Enova is a state-owned enterprise owned by the Norwegian Ministry of Petroleum and Energy. Enova's objective is to promote a shift to more environmentally friendly consumption and production, as well as development of energy and climate technology. Enova's tasks are set out in a four- year agreement between the Ministry of Petroleum and Energy and Enova. With regard to technology, the agreement requires that work on energy and climate technology must result in a reduction of greenhouse gas emissions and promote a long-term shift in energy consumption and production through the development and market introduction of new technologies and new solutions. Enova must focus its efforts on the development of new technology and support for technologies and solutions close to market introduction. https://www.enova.no/

CO2 Capture and Storage R&D

- **CLIMIT (RCN/Gassnova):** The CLIMIT Programme is Norway's national programme for research, development and demonstration of CO2 capture and storage technology (CCS). The programme is directed towards companies, research institutes and academia. Collaboration with international partners is encouraged.

  The programme consists of two support schemes; CLIMIT R&D and CLIMIT-Demo, run by the Research Council of Norway and Gassnova respectively. CLIMIT aims for a balanced project portfolio and supports technology projects spanning from basic research to demonstration in the final stage before commercial launch. http://www.climit.no/en
- **CO2 Capture and Storage Large-scale Demonstration**
  The Norwegian government's strategy for CCS, presented in October 2014, spans across a broad range of measures including research, development and demonstration, realising a full-scale CCS-facility, transport, storage and alternative use of CO2 and international cooperation for promoting CCS. A continued, strong support of CLIMIT, Centres for Environmentally-friendly Energy Research (FME) and international research activities is an important part of the strategy, c.f. above.
- **Technology Centre Mongstad (TCM):** TCM is a world-class test-facility that bridges a gap in the technology chain by enabling testing, verification and demonstration of CO2 capture technologies on an industrial scale. The main objective of the centre is to support test campaigns and identify actions leading to reduced costs and technical, environmental and financial risks associated with implementing CO2 capture technologies in full scale. The facility has been in operation since 2012, and has completed a large number of test campaigns for different vendors. http://www.tcmda.com/en/
- **Large-scale CCS Demonstration Facility**
  The government's ambition is to realise at least one full-scale demonstration facility for CCS by 2022. Realising such a facility in Norway is challenging as there are few large, suitable emissions sources. The government has since 2014 conducted studies on potential full scale projects in Norway. In the spring of 2017 three industry players were awarded financial support to conduct further concept studies. Before a final investment decision, a FEED-phase will also be needed. We are well on track to achieve our ambition.

- **International Cooperation**
  In the field of energy R&D, international cooperation is given high priority in Norway and it is an important supplement to national research efforts. Participation in international projects provides opportunities for building up professional expertise and gives scientific and financial support in solving important research tasks. International cooperation also provides a showcase for Norwegian technology and know-how suppliers.

In the energy field, Norway is primarily involved in cooperation under the EU system, the International Energy Agency (IEA) and at Nordic level. Norway is also involved in a number of bilateral (the US, Japan) and multilateral (CSLF, IPHE[36]) agreements.

[36] CSLF – Carbon Sequestration Leadership Forum
IPHE – International Partnership for the Hydrogen Economy

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2013-2015
- Baseline Funding Amount: NOK 1.132 billion (USD $140 million)
- Doubling Target-Year: 2020
- Doubling Target Amount: NOK 2.265 billion (USD $280 million)
- First-Year of Mission Innovation Funding Increment: 2016
- First-Year Mission Innovation Funding Amount: NOK 1.419 billion (USD $176 million)
- First-Year Mission Innovation Funding Increment: NOK 287 million (USD $36 million)
- First-Year Funding Percent Increase: 25%

Methodology for Determining Baseline

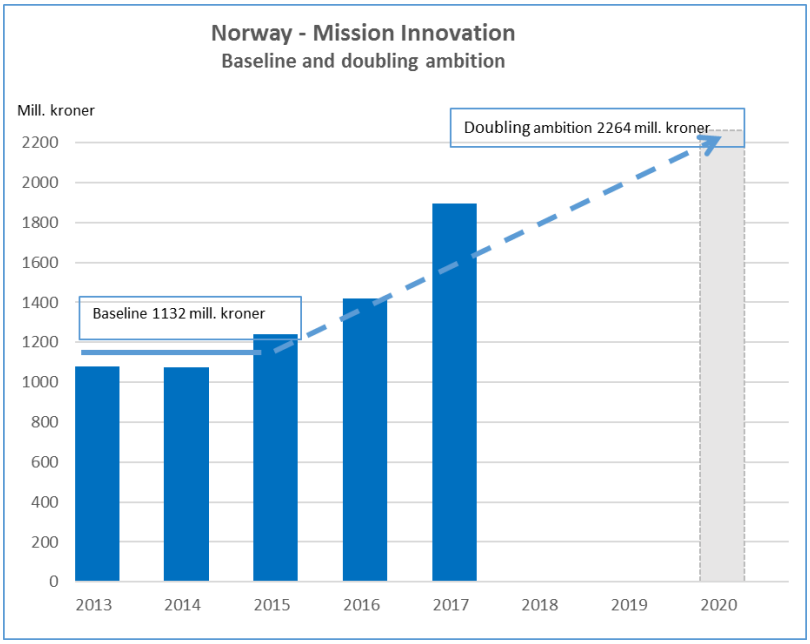
The baseline is composed of relevant budgetary allocations for the fiscal years of 2013-2015, as defined by the Norwegian definition of clean energy RD&D, of the Ministry of Petroleum and Energy.
Other Ministries may also have relevant budgetary allocations. These are not included in the MI baseline, nor will they be counted in as part of the target funding amount in 2020. The state budget is decided by the Norwegian parliament annually.

Country-Definition of Clean Energy R&D Investment

Research, development and demonstration in environmentally friendly technologies, including end-use energy efficiency, renewable energy, electric grid technologies, CO_2 capture and storage and low-carbon transportation systems and fuels.

Status per 2017

The Norwegian government have increased R&D-budgets for environmentally friendly energy solutions with more than 60 percent from the baseline-level. This means that Norway is well on track to fulfil the doubling ambition. One important reason for this is the strong support for technology within Carbon Capture and Storage – CCS, with the goal of realizing at least one full-scale demonstration project for carbon capture and storage by 2022. But also the regular budgets for energy R&DD have been increased by more than 60 per cent.



Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	●
Cleaner fossil energy	
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional information

Related websites:

Government of Norway

Ministry of Petroleum and Energy

Ministry of Education and Research

Energi 21

Centres for Environment-friendly Energy Research

ENERGIX

Enova

CLIMIT

Technology Centre Mongstad (TCM)

REPUBLIC OF KOREA

Narrative

Korea's Clean Energy Technology Roadmap marks the milestones for clean energy technology development in order to achieve a low-carbon society, and it helps to realize the energy policy directions of the Korean government. To refocus Korea's energy R&D on clean energy, 7 government ministries, including the Ministry of Trade, Industry, and Energy and the Ministry of Science, ICT and Future Planning, and approximately 200 experts from industry, academia and research institutes collaborated to established the Clean Energy Technology Development Strategy. The vision of the roadmap is to "convert the new climate regime crisis into an opportunity for economic growth through clean energy technology innovation." The goals of the roadmap are 1) responding to climate change by contributing to the reduction of greenhouse gas emissions 2) creating new energy business, and 3) leading global technological innovation.

Strategies

Four strategies are established for the roadmap as follows:

① Penetrate the new market through innovative technology and technological convergence

- We intend to transform the existing market by introducing disruptive technologies that enhance performance, reduce costs, and shorten commercialization time. In addition, through convergence with humanities and social science, we will increase social acceptability that will allow for energy R&D penetration into the market. The convergence of energy technology with other technology will overcome the "Valley of Death" and the "Darwinian Sea", i.e. market penetration failure.

② Implement new energy industry related government policy

- The Korean government is trying to activate the new energy industry. '2030 Strategy for boosting New Energy Industry' was established in November, 2015 in order to meet Korea's goal to cut back on greenhouse gas emissions and to create a future growth engine that is centered on energy prosumers, low-carbon generation, EV, and eco-friendly processes. KEPCO (Korea Electric Power Corporation) has also established an investment plan for the new energy industry with regards to smart meters, frequency regulation ESS, electric vehicle charging stations, and energy big data. The roadmap will be implemented to comply with these policies.

③ Shorten commercialization time with overseas demonstration

- To shorten the time for the new technologies to enter the market, certification standards and demonstration programs will be developed from the R&D stage. Overseas demonstration based on local and regional environments will be enhanced. For example, through smart-city demonstration which reflects the diverse urban characteristics of each different city, we will execute our specialized power system demonstration, which complies with local regulations, policies, markets, and power grids.

④ Create an eco-system for clean energy industry with participants from various fields

- We need an energy platform for distributed energy transactions that takes consumers, power capacity, and energy sources into consideration. The eco-system for the clean energy industry will be expanded through the participation of various industry players, including electronics manufacturers, solution companies, and IT companies. We will also make incumbent companies participate in materials technology for new energy industries.

Thirteen Key Technologies

The basic direction for investment in clean energy is to put priority on areas, in which technical competitiveness for commercialization can be achieved by 2025. The government (create new industries) and state-owned enterprises (provide stable supply of power) will each play a different role in this process to increase the investment effectiveness. The level of GHG emission reduction, market potential, competitiveness and government policy on clean energy technology were reviewed to select the 6 main areas and 13 technologies. For each focus area, the government established a Clean Energy Technology Roadmap with 67 strategic tasks and 283 core technologies to set milestones for the development process. In the technology development strategy for focus areas, the government defined the specific area of application that reflected market demand; the strategic agenda including the goal of the technology; and the core technology for which the government, SOEs and private sector should each respectively take the lead in development, in order to highlight the areas private-sector investment was needed.

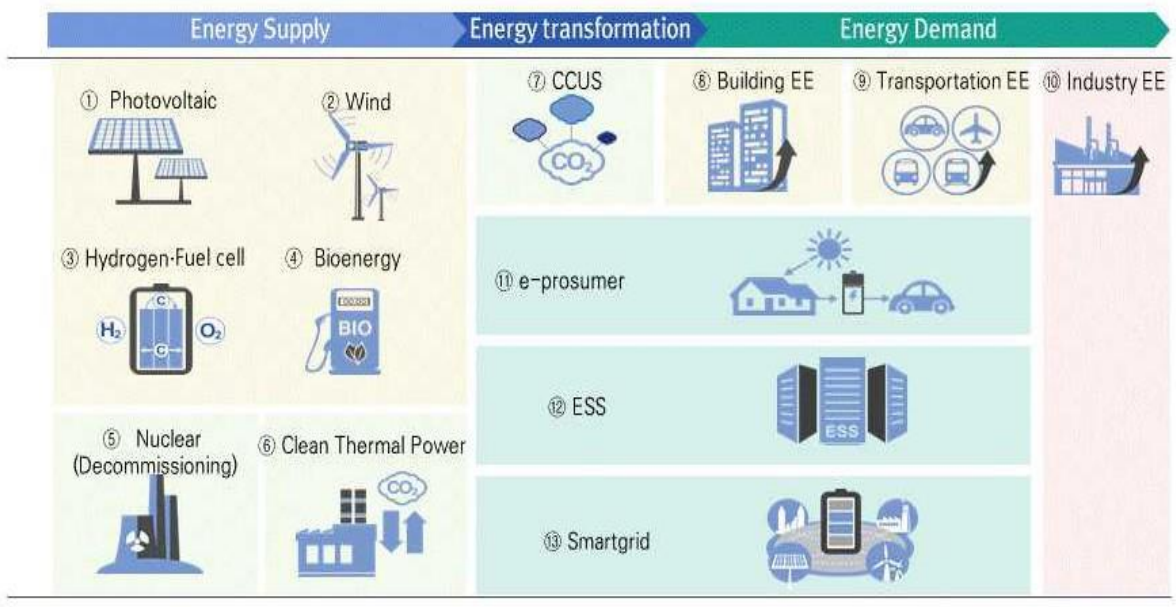


Figure 1. Thirteen Key Technologies

1. Renewable Energy

In renewables, the strategy for solar is to become more cost competitive, so that solar power can be deployed more widely, and to develop a wide variety of solar modules that can be used to encourage distributed energy generation. For wind, the strategy is to make the industry more competitive by developing the technology to optimize the overhaul and operation of wind farms and the technology to run 6-8 MW level large-scale wind capacity. For hydrogen cells and fuel cells, the focus will be to improve the efficiency of fuel cells used for buildings, power storage and transport; and to build the infrastructure necessary for the production, storage, transport of hydrogen, and build-out of hydrogen stations. In the bio area, the aim is to increase the competitiveness of bio energy by securing the technology needed to create carbon-neutral bio processes and bio power plants that will replace fossil fuel.

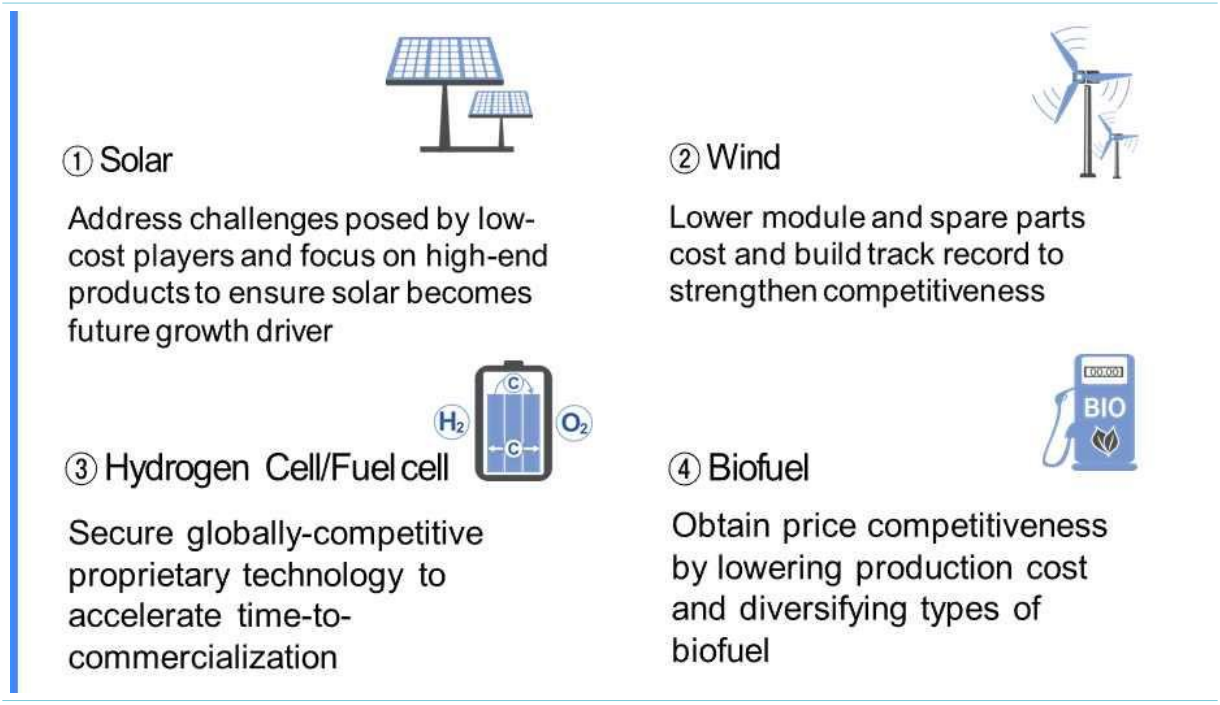


Figure 2. Renewables Technologies

2. Energy Efficiency/Demand Management

For the area of efficiency improvements, the strategy for industry is to integrate the management of energy, which is currently consumed dispersedly, and to develop high-efficiency process technologies that can be implemented in energy-intense industries. In the transport area, the government is planning to focus on improving the efficiency and functionality of next-generation EV, while also satisfying the requirements of stronger environment regulations in the global transport sector. For buildings, the strategy is to develop key parts or materials needed to build zero-energy buildings, and embark on future convergence technology, such as community network technology. In terms of demand management, for ESS, the strategy is to develop stable and longer-life, large-capacity energy storage systems, and to develop and demonstrate ESS services to gain market competitiveness. To encourage more E-prosumers,* i.e. those who can directly sell energy in the power exchange, the government plans to extend participation by ICT companies and start-ups, and to establish a market exchange regime and infrastructure fit for more distributed energy resources.

* a consumer who not only consumes electricity, but also produces power via distributed energy resources, like solar

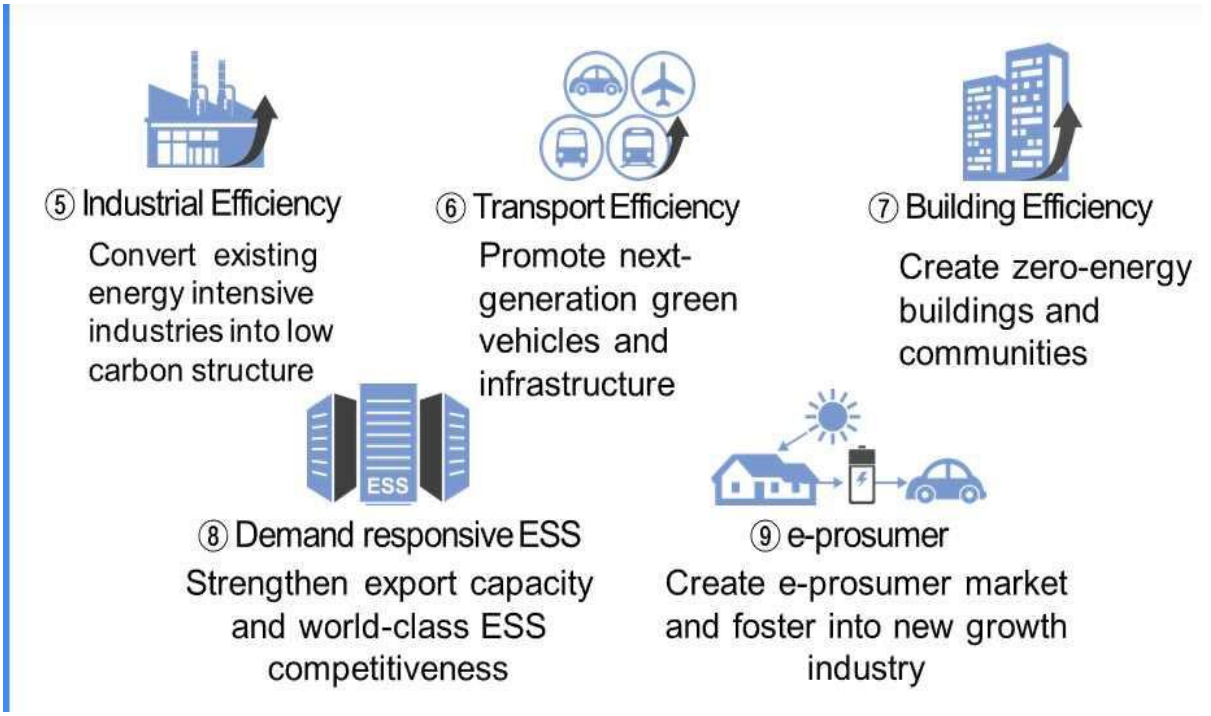


Figure 3. Energy Efficiency/Demand Management Technologies

3. Clean Power

In the area of thermal transmission and distribution, the government wants to build a smart grid which will improve power supply efficiency and capacity factors, and provide more system stability and social acceptability. Clean thermal will include acquiring next-generation technology to build high-efficient thermal power plants and localizing the key machinery needed to build gas-based combined cycle power plants. In the area of nuclear energy, the Korean government wants to secure decommissioning technology in order to use nuclear power in a safe and sustainable manner. Lastly, for CCUS the strategy is to create new industries utilizing CCU and then try to extend it one step further by demonstrating integrated CCS which includes carbon capture, transport and storage.

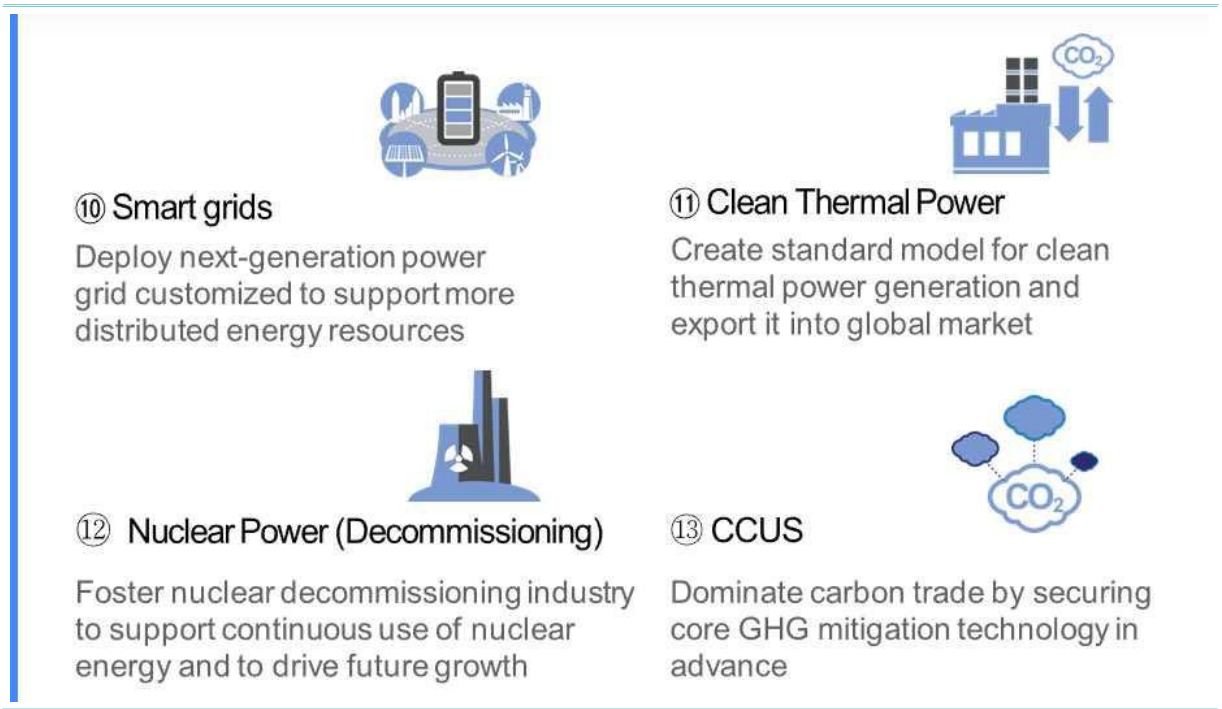


Figure 4. Clean Power Technologies

Future Plans

Going forward, the Korean government is committed to executing this investment expansion plan and technology development strategy for focused areas to improve existing technology, save costs and accelerate the time-to-market. In addition, we plan to update the Clean Energy Technology Roadmap every 2-3 years to reflect changes in market trends. Mission Innovation member countries emphasize international cooperation to facilitate information sharing and accelerate clean technology innovation. To this end, there are subgroup activities and innovations that have been identified. Korea has established a framework of cooperation with partner countries, with which it is either engaging in joint research or is preparing to do so. Through the Mission Innovation platform, the Korean government plans to develop joint R&D projects with countries that have similar needs and actively engage in cooperation.

Figure 5. Future Plans

Baseline and Funding Plans

- Country-Determined Baseline Year(s): FY 2016
- Baseline Funding Amount: USD $490 million
- Doubling Target-Year: FY 2021
- Doubling Target Amount: USD $980 million

The Republic of Korea will endeavor to double public clean energy R&D investment over five years from USD $490 million in fiscal year 2016 to USD $980 million in fiscal year 2021.

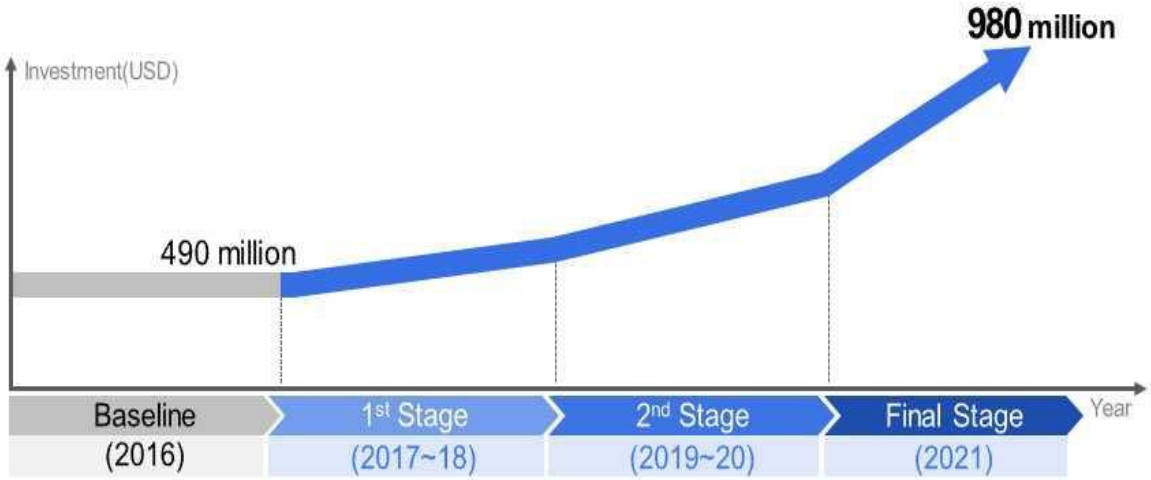


Figure 6. Baseline and Doubling Investment Plan of Korea

Country-Definition of Clean Energy R&D Investment

- The increased investment will be mainly used on clean energy technologies: renewables, energy efficiency improvement, clean thermal power, smart grids, carbon capture, utilization and storage (CCUS), energy storage systems (ESS), and nuclear power.
- The Korean government sees the clean energy technologies for a new growth engine, and is thus devoting efforts in clean energy industries to develop and demonstrate business models using clean energy technologies.
- Investment in clean energy technology will be shared by the government and public enterprises so as to enhance investment efficiency. In particular, the government will focus on CCUS, renewables, demand management, and energy efficiency improvement, while public enterprises will concentrate on clean thermal power, transmission and distribution, and nuclear power.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	●
Hydrogen & fuel cells	●
Cleaner fossil energy	●
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Prepared Remarks for Launch Event:

H.E. President Park Geun-hye

Related websites:

President's website

Ministry of Trade, Industry and Energy

Republic of Korea's International Joint Energy R&D Program:

Republic of Korea's International Joint Energy R&D Program was first launched in 2011 to provide financial aid for research projects jointly conducted by domestic and international research institutions with funding from the Ministry of Trade, Industry and Energy. The main goals of the Program are to promote the exchange of human resources and information between domestic and international research institutions, to carry out multifaceted cooperation on the governmental and private levels, and to achieve energy innovation through international joint R&D activities.

The Program strives to promote energy technology development, to further boost the global energy market, and to secure greater competitiveness through the convergence of different technologies from around the globe. Furthermore, it aims to improve clean energy technology competence and to contribute to the creation of new energy markets by promoting international cooperation, readily identifying and obtaining cutting-edge technologies and providing a platform to advance into the global market through an open innovation paradigm.

The Program provides multi-directional support. Bottom-up support is designed to effectively respond to demand in the field, such as the needs of SMEs for demonstrations and product commercialization and the needs of research institutions for energy innovation through joint research projects. Top-down support capitalizes on government-level cooperation in the form of MOUs between governments, etc. For the latter direction, energy technology issues are introduced and discussed by the countries concerned through events such as joint workshops to plan and design projects before they are publicly announced. Such projects are funded jointly by the government of the Republic of Korea and the government of the partner country. Since its inception in 2011, the Program has funded various projects jointly conducted with the US, UK, Canada, and Germany. The list of our partner countries is also expanding continually, with the Czech Republic and Mexico recently added.

SWEDEN

Narrative

Sweden has had a government funded Energy RD&D programme since 1975. It was created in response to the oil crisis and initially formed to address the great oil dependency of the Swedish energy system at the time.

The current Swedish Energy R&I programme is based on the approach of having a balanced portfolio of thematic programs, activities and funding instruments to support the development and deployment of clean energy solutions and technologies.

The flexibility to be able to adopt new ideas and new ways of tackling existing energy challenges is very important. So, besides having programs initiated as an answer to detailed and technically specified calls of proposals, the Swedish Energy R&I program today includes programmes that are open for new and unexpected ideas. A need for boosting these kinds of activities has been highlighted . Also, the need for transformative R&D has been mentioned in the writings leading up to the establishment of the Breakthrough Energy Coalition. Sweden's doubling pledge is just about these kinds of actions.

For the Mission Innovation, Sweden has therefore chosen to double the parts of our energy R&I that focus on funding for researchers and industry to work bottom-up with solutions to energy challenges and which at the same time supports long-term and transformative research and development. This is a part of the total Swedish Energy Research and Innovation funding that is closely related to the goals and the approach of the Mission Innovation initiative.

We will seek to double these efforts departing from a baseline based of average funding of the years 2013-2015 and until 2020. An average number is chosen because of variations in the funding over time. The baseline number of 134 million SEK relates to the activities of Basic Energy Research, Innovative and energy relevant research and development, and energy relevant Strategic Innovation Areas. These three programmes are characterized by not having a specific technology focus beyond being original and excellent and addressing the energy challenge within the overall focus of renewables, efficiency, electricity and energy transmission and distribution, and energy systems.

We will undertake to double these efforts to 2020, either as expanded continuation of the programmes mentioned above, or through other programmes of similar character.

The Focus of the Entire Programme of Energy Research and Innovation

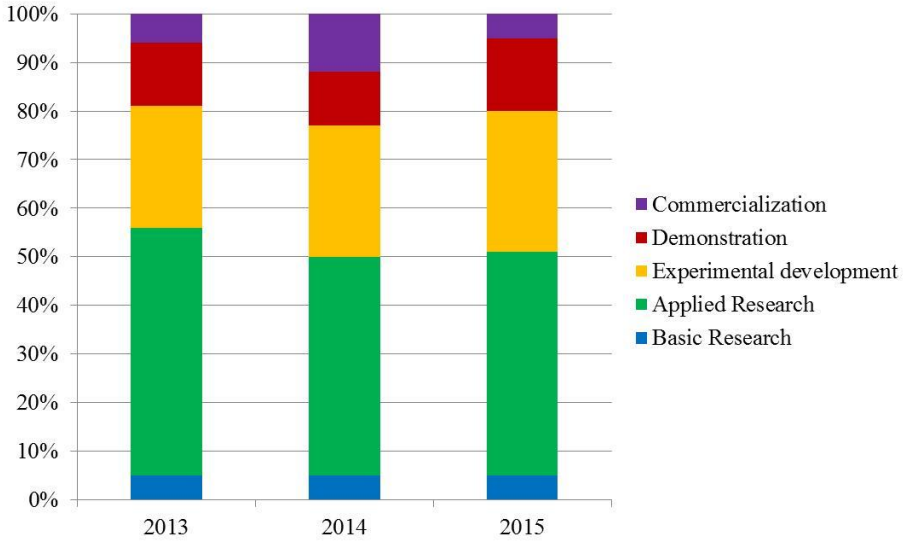
The Swedish programme of energy research and innovation is a part of the Swedish research policy, but also an integral part of the Swedish energy policy. Energy R&I is seen as an important measure to make it possible to reach climate and energy policy goal in a cost efficient manner.

Synergies with other policies and measures in the energy policy area are to be explored.

The entire programme is to be implemented as a cohesive effort spanning the entire innovation system and addressing complete value chains based on an energy systems perspective.

The responsibility for the strategic planning and the implementation rests with the Swedish Energy Agency, http://www.energimyndigheten.se/en/.

In the period 2013–2015, the type of support has been distributed as depicted in the graph below.



The picture shows that the bulk of the funding is allocated to applied research and experimental development, but that efforts were also made on more basic research as well as on demonstration and support for product development. Much of the funding is allocated through research programmes, research and development programmes co-funded by industry, and also Centres of Excellence and other centres run in collaboration between the research community and industry. Approximately half of the funding is allocated to researches at universities, and the other half to industrial actors, industrial research institutes and organisations, and for international collaboration.

During the period 2013 – 2015 the main focus areas for the programme funding were energy aspects of the transport system, including advance biofuels and electric vehicles, the power system, including renewable generation of electricity, transmission and distribution, and bioenergy; from forestry and agriculture through processing distribution and utilisation for heat and for Combined Heat and Power. Other important areas were energy efficiency in industry, energy in the built environment and energy systems studies, including economic, social and human science studies.

Future Developments of the Energy Research and Innovation Programme

In addition to the doubling of efforts on transformative bottom-up funding, Sweden is also on track to increasing the total programme on Energy R&I.

A baseline funding for the entire programme was established by a decision in 2007. This baseline was around 900 million SEK in the period 2007–2012. A baseline calculated as an average for the period 2013–2015 would be 1 139 million SEK. This value is calculated on the actual payment to all the projects in the programme, not the budget allocation.

An increase is to be expected from this baseline and forward. Decisions on general funding are taken in four year periods, and more in detail for each fiscal year. Proposals for coming years are currently being developed.

The total budget is expected to increase substantially by 2020, but a doubling in relation to the average for 2013–2015 cannot be guaranteed.

Other Efforts to Promote Clean Energy Innovation

Other funding agencies also contribute to energy relevant research and innovation outside the specific energy R&I programme. Among these are the Swedish Research Council (Vetenskapsrådet), the Swedish Innovation Agency (Vinnova), and the Swedish research council for sustainable development (Formas). In addition to the funding of research, development, demonstration and innovation, there are also a number of Swedish programmes or policies to promote the uptake of new, clean and efficient energy technology. Among these measures are the Climate Step, an investment programme for industry, local governments, regions and organisation to reduce climate impact. The budget is 1,9 billion SEK for the period 2015–2018. A special fund for public venture capital for energy and climate technology is being established. The total budget for the fund is expected to be 650 million SEK.

Swedish Energy Policy Agreement

The Government in 2016 concluded an agreement on Sweden's long-term energy policy signed by in total five of the eight political parties in the Swedish parliament. The agreement consists of a common road map for a controlled transition to an entirely renewable electricity system, with a target of 100 per cent renewable electricity production by 2040.

The Government and the parties agree that Sweden must have a robust electricity system with high security of supply and low environmental impact, and offer electricity at competitive prices. This creates a long-term perspective and clarity for actors in the market and helps generate new jobs and investment in Sweden.

By 2045, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions.

An energy-efficiency target for the period 2020 to 2030 will be produced and adopted no later than 2017.

In support of the goals and ambitions of the Agreement, research and innovation should focus on areas that contribute to achieving established climate and energy policy targets, and that have prospects for growth and for exports. Energy research and innovation must continue to focus on technological development and demonstration and pilot projects in all areas within energy.

Current Swedish Interest and Priorities

The European Union Strategic Energy Technology Plan has recently conducted a study of the priorities and interests of the member countries in the energy area.

The Swedish input to this exercise gave an indication of the priorities and interests of Swedish energy research and innovation at the time (2014). It must be noted that the description is not complete since it is made using general headings and descriptions agreed for the disposition of the SET-Plan activities, and thus does not necessarily capture all Swedish considerations. Also, it provides a snapshot of the situation at the time and priorities can be expected to evolve.

However, the government's guidelines and goals for the Energy Research and Innovation programme for the period up to and including 2020 is currently being developed and not yet available. Therefore, the Swedish response to the EU questionnaire can be taken as at least an approximate indication of current interest.

Sweden reported high interest in engaging and activating consumers through better understanding, information and market transformation, and with innovative technologies, products and services. Sweden also has a high interest in increasing energy efficiency in buildings, in the heating and cooling sector, and in industry and services.

Sweden also indicated a high interest in modernising the European electricity grid and establishing synergies between the various energy networks, including aspects such as energy storage and conversion of electricity to other energy carriers, and providing the energy system with flexibility, demand response, security and cost-effectiveness.

Sweden also showed interest in the development and demonstration of holistic system optimisation at local/urban level (Smart Cities and Communities), as well as in accelerating the development of renewable electricity and heating/cooling technologies.

Sustainable Advanced Biofuels, as well as other advanced alternative fuels are also among the areas of high interest in Sweden.

Sweden also showed high interest in socio-economic research in support of policymaking.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2013-2015
- Baseline Funding Amount: SEK 134 million (USD $17 million)
- Doubling Target-Year: 2020
- Doubling Target Amount: SEK 270 million (USD $33 million)

Methodology for Determining Baseline

A baseline funding for the entire programme was established by a decision in 2007. This baseline was around 900 million SEK in the period 2007–2012. A baseline calculated as an average for the period 2013–2015 would be 1 139 million SEK. This value is calculated on the actual payment to all the projects in the programme, not the budget allocation.

Country-Definition of Clean Energy R&D Investment

The six thematic areas are 1) Biobased Energy Systems, 2) Energy in the Built environment, 3) The Electricity System, 4) Energy in Transport, 5) Energy Intensive Industry, and 6) Energy System Studies. The thematic area 3) also includes non-fuel based electricity production, i.e. wind, solar, marine, etc. Fission, fusion or fossil fuel technologies are currently not included at all. Energy in transport focuses on renewable transport fuels as well as the electrification of road traffic etc.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	
Hydrogen & fuel cells	
Cleaner fossil energy	
CO_2 capture, utilization & storage	
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Materials

Webinar:

Energy Policy, Research and Innovation in Sweden, January 2017

Related websites:

Swedish Royal Court

Prime Minister's website

Ministry of the Environment and Energy

Ministry of Education and Research

UNITED ARAB EMIRATES

Narrative

UNITED ARAB EMIRATES
MINISTRY OF ENERGY

الإمارات العربية المتحدة
وزارة الطاقة

The UAE leadership has launched the UAE Vision 2021 strategy which aims to make the UAE among the best countries in the world by the Golden Jubilee of the Union. In order to translate the Vision into reality, its pillars have been mapped into six national priorities which represent the key focus sectors of government action in the coming years and this includes Competitive Knowledge Economy and Sustainable Environment and Infrastructure. Reflecting the UAE Vision 2021, clean energy is core to the UAE's INDC, which sets a national target to increase clean energy to 24% of the total electricity generation mix by 2021, from under less than 1% today. Advancing innovation and technological breakthroughs is critical to addressing climate change and also aligns with the UAE's long-term commitment to diversify our economy and energy mix. On November 30th 2015 the UAE joined the world leaders in Paris to launch Mission Innovation which aims to accelerate the public and private global clean energy innovation with the objective to make clean energy widely affordable. 2

In 2014, the UAE launched a National Innovation Strategy and the Science and Technology with the aim of making the UAE one of the most innovative nations in the world within seven years. The strategy aims at: insuring an innovation friendly ecosystem (including enhanced regulatory framework, technology infrastructure, supporting services, investments and incentives); creating a culture of innovation among individuals, firms, and the public sector; focusing on seven main sectors to lead innovation on the national level. Renewable and Clean Energy is one among the seven main sectors identified by the government.

Following the launch of the National Innovation Strategy the Science Technology and Innovation policy was prepared and which identified 24 focus areas including Solar and Alternative Energy Technology Systems and Smart City Applications and Solutions. Under the guidance of the national strategies the UAE is moving towards innovation in clean energy and energy efficiency to address economic growth and energy security.

In line with the vision of the mission innovation the UAE pledges the doubling clean energy R&D by 2021 based on the baseline set in 2015. These support highlight UAE's strong believe in research and development for resolving the challenge which hinder the implementation of clean energy and energy efficiency programs in UAE.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2015
- Baseline Funding Amount: USD $10 million
- Doubling Target-Year: 2021
- Doubling Target Amount: USD $34.1 million
- First-Year Mission Innovation Funding Amount: USD $12.2 million
- First-Year Mission Innovation Funding Increment: USD $2.2 million
- First-Year Funding Percent Increase: 22%

Country-Definition of Clean Energy R&D Investment

Low C/GHG technologies, including End-Use Efficiency, Renewables Energy, Nuclear, CCUS, Electric Grid, Storage technologies, Sustainable Transport system and fuel, Use-Inspired Basic and Exploratory Research.

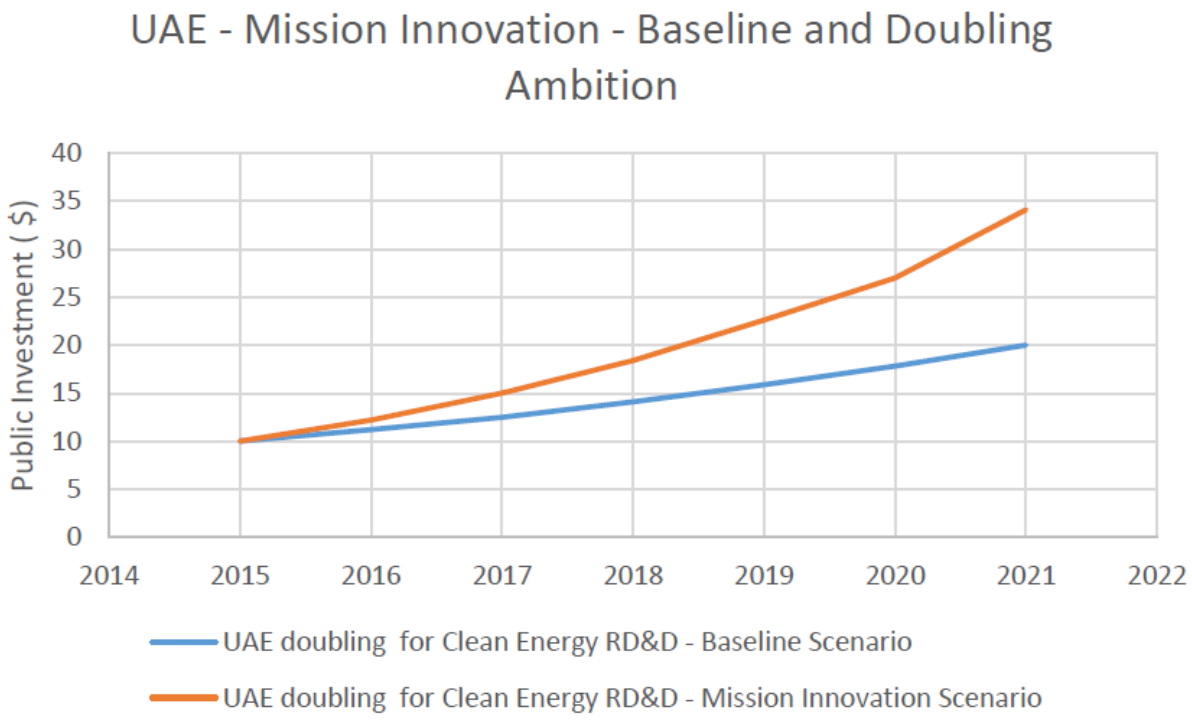
Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	●
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	●
Hydrogen & fuel cells	
Cleaner fossil energy	
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	●

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Materials

Budget:



	Year	Baseline Scenario (USD Million)	Mission Innovation Scenario (USD Million)
Reference Year	2015	$10	$10
	2016	$ 11.2	$ 12.2
	2017	$ 12.59	$ 15
	2018	$ 14	$ 18.4
Year of Doubling	2019	$ 15.8	$ 22.6
	2020	$ 17.8	$ 27.8
	2021*	$ 20	$ 34.1

*The above figure reflects the commitment of the UAE for innovation of new clean energy technologies that will address the challenge which could prevent the wide application of clean energy technologies in the UAE.

Quote:

"Recently, the UAE has witnessed record reduction in levelized cost of power generation from utility grade solar pv plants. The latest auction for a 800 MW plant in Dubai achieved a new record price of 2.99 US Cents/Kwh. The UAE's investment in solar is part of a broader national strategy to diversify the power supply mix and reduce reliance on natural gas which has been fueling water and power generation in the country almost entirely. UAE's national target of 24% clean power in overall generation mix by 2021 shall be exceeded by current projects only. In addition to the 800 MW, another 350 MW solar power project tender was floated in Abu Dhabi, which received bids from over 30 companies highlighting a rapidly evolving solar market in the country. These solar projects are being developed through an IPP framework which has brought in significant investment to the country in solar power generation. To facilitate the deployment of solar in UAE, the government has also invested in innovative applied research projects. In particular, the research and development seeks to tailor the solar technologies to the harsh climate of the region. The knowledge developed shall be useful for increased adoption of solar in all desert countries."

— H.E. Dr. Matar Hamed Al Nyadi, Undersecretary of the Ministry of Energy of the United Arab Emirates

Related websites:

Ministry of Foreign Affairs

His Highness Sheikh Mohammed bin Rashid Al Maktoum's website

Masdar

Masdar Institute

UNITED KINGDOM

Narrative

Access to secure, affordable, clean energy is critical to the world's ability to keeping global warming below 2 degrees. We have seen the cost of some clean energy technologies fall significantly in recent years but more innovation across a range of technologies is needed if we are to meet the challenges of population growth, increased consumption and increased urbanisation in a sustainable manner.

The UK has a long history and strong capabilities in research, development and demonstration (RD&D). We want to ensure we harness and support the creativeness, ingenuity and entrepreneurship of our universities and businesses in tackling the challenge of ensuring secure, affordable and clean energy for all. Doing so will require both public and private sector investors to invest more in energy RD&D and to work in far closer partnership to ensure that the best ideas are developed, tested and pulled through to market as quickly as possible. Investing in low carbon energy now will drive down the costs and ensure countries can take more ambitious action to cut their emissions before 2030 and grow their economies sustainably in the long term.

For those reasons the UK government has joined with other countries and private sector investors to form Mission Innovation, and we expect to double our spending on relevant energy RD&D to in excess of £400 million in financial year 2020-21.

Funding Programme

Our programmes will include support for the full range of RD&D projects - from early stage, disruptive ideas, through to partnerships with private sector investors to test and prove new technologies in real world applications as an enabler of widespread deployment.

We wish to focus our resources on those areas where we can have the optimal impact to deliver our programme objectives and we are currently developing the details of our plans for the 5 years to 2020/21, informed in part by the insights Mission Innovation is providing us. Further details of our priorities and plans will be announced in due course and we will share that detail with fellow Mission Innovation countries.

To keep up to date with information on our Energy Innovation Programme, please visit https://www.gov.uk/guidance/energy-innovation.

Baseline

We expect that our programmes will accelerate technology development that will have benefits for developed and developing countries alike, but as part of that up to £100 million of our total spend in 2020 will be specifically focused on projects that will help address the energy needs of developing countries.

The UK is committed to the objectives of Mission Innovation and is playing an active role in progressing its work through our roles as vice-chair of the Steering Committee and co-chair of the Analysis and Joint Research working group, including coordinating the development of the Innovation Challenges.

Baseline and Funding Plans

- Country-Determined Baseline Year(s): 2013-2015
- Baseline Funding Amount: GBP £200 million (USD $290 million)
- Doubling Target-Year: FY 2020
- Doubling Target Amount: GBP £400 million (USD $580 million)

Methodology for Determining Baseline

The baseline is based on the average annual investment over the 3-year period from 2013 to 2015. This figure does not include investments made by Scotland, Wales or Northern Ireland.

Country-Definition of Clean Energy R&D Investment

The emphasis will be on TRLs 3-8, that is, for applied energy R&D through to demonstration, focused on renewable energy, smart grid, nuclear, CCS, and other technologies.

Overview of Clean Energy R&D Focus Areas Emphasized in Mission Innovation Portfolio

Industry & buildings	●
Vehicles & other transportation	
Bio-based fuels & energy	●
Solar, wind & other renewables	●
Nuclear energy	●
Hydrogen & fuel cells	●
Cleaner fossil energy	
CO_2 capture, utilization & storage	●
Electricity grid	●
Energy storage	●
Basic energy research	

Indicators are for key areas of Mission Innovation R&D investment but do not imply a comprehensive representation of a country's full R&D portfolio.

Additional Information

Related websites:

National portal

GOV.UK news story, "UK joins new international clean energy initiative", 30 November 2015

Department for Business, Energy & Industrial Strategy

UNITED STATES

Narrative

The United States is committed to supporting the development of affordable and reliable energy as a foundation for economic growth and energy security. Indeed, reliable, affordable energy goes hand in hand with a strong economy. Innovation in science and technology has been a cornerstone of America's economic progress. The private sector funds and performs the majority of U.S. R&D, but the Federal government has an important role in funding R&D in areas that industry does not have a strong incentive to invest.

Over the past 25 years, U.S. emissions have declined while the U.S. economy grew 80%. To a large extent, this decoupling of emissions from economic growth is the result of technology innovations that improved energy performance while cutting costs—from supply to end use.

Decoupling of emissions from economic growth is the result of technology innovations…

Commitment to Innovation

Innovation continues to be a top priority for the United States through both strategic public funding for early-stage R&D and strong private sector investment to support the development and commercialization of the most promising ideas. Novel technologies open fresh avenues to expand domestic energy supplies and drive down energy costs. Broad access to affordable and reliable energy will further stimulate economic growth—bringing jobs and prosperity to millions of U.S. consumers and businesses and throughout the global economy.

Many of the most innovative technologies shaping global energy markets today can trace their origins to public investments in basic science, exploratory research, and early-stage technology development. Innovations arising from these investments have created new technologies and lowered their cost, which in turn have had transformative effects on whole industries.

The Department of Energy's National Laboratories have worked with American universities, research institutions and industry partners, and international collaborators around the world, to push the frontiers of basic science and research. They explore novel concepts to meet high-priority national needs. They discover new knowledge, share it with private partners, and create a wellspring of ideas that help spur technological breakthroughs.

The U.S. government plans to continue to support investments in early-stage research to advance energy technology innovation. The outcomes are expected to feed the innovation pipeline, stimulate entrepreneurs, attract investors, and enable U.S. companies to secure leadership positions in global energy markets. The United States seeks to nurture an efficient research enterprise that will realize the overarching goals of Mission Innovation, namely, to make clean and advanced energy technology widely accessible and affordable worldwide.

Role of the Private Sector

The U.S. government is committed to responsible spending. Strategic public funding in early-stage research and development (R&D) will be designed to feed innovation that unlocks the ingenuity of the private sector. Publicly-supported research should focus on the creation of new knowledge and discovery. The private sector is best positioned to evaluate the commercial potential of energy technology advancements and therefore must identify, evaluate, and carry innovations forward to commercialization. Investors and businesses will finance and commercialize innovative technologies, turning promising research into transformative products scaled for entry into diverse energy markets.

Public-private partnerships are also effective ways to accelerate innovation. Working with private partners and multidisciplinary teams facilitates rapid commercialization. Such partnerships leverage the expertise and efficiencies of the private sector while mitigating government risk. Ultimately, these activities can help strengthen, transform, and improve the energy infrastructure, increasing access to reliable, secure, affordable, and flexible sources of energy.

Public-private partnerships leverage the expertise and efficiencies of the private sector…

International Engagement

The United States will continue working with other countries that are members of Mission Innovation. Like many other members, the United States is a vast country with varied geography, weather patterns, and resources. The most effective technology for one region may differ from that which is most effective in another. Ensuring that energy research collaborations are mutually beneficial will advance the energy security and economic interests of the United States and other Mission Innovation members. Cutting-edge energy technologies that unleash America's full energy potential in all its forms will not only strengthen energy security and grow the global economy; it will also foster a stable, more secure global energy market. Innovative ideas can help the world transition into a more sustainable, secure, and prosperous energy future.

Funding Programs

The funding of energy-related research and development programs are currently under review by the new Administration. The priority for U.S. energy research efforts will be to advance knowledge through early-stage research that is unlikely to be undertaken by the private sector. Both the public and the private sector play complementary and dynamic roles in driving innovation and revolutionizing markets. The U.S. budget reflects an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies and will refocus resources on early-stage R&D.

Baseline and Funding Plans

United States Mission Innovation activities are currently under review. The U.S. remains committed to prudent investment in early-stage R&D that underlies technology breakthroughs.

Additional Information

Related website:

White House Energy Plan