

# ENERGY 2014

## Strategy 2014

*National strategy for research, development, demonstration and commercialisation of new energy technology*

PART 1/2



# ENERGI21

---

## *Strategy 2014*

**PART 1** Priority focus areas and implementation measures for the strategy



# Preface

---

The Energi21 board presents in this document the third national strategy for research, development, demonstration and commercialisation of new climate-friendly energy technology. The strategy is targeted towards value creation and efficient utilisation of resources in the energy sector through investment in R&D activities and new technology to benefit society as a whole. Trade and industry has played a leading role in the strategy processes, and close cooperation with universities and research institutes has been emphasised.

Climate, security of energy supply, and economic competitiveness are the main drivers of the development of the national and international energy sector. Norway's energy situation is unique in that it has a power supply that is almost exclusively based on renewable forms of energy, excellent access to additional renewable energy resources, a well-established energy intensive sector, and plentiful oil and gas resources.

The Energi21 strategy addresses nationwide objectives for utilising renewable resources and developing an efficient, flexible energy system. It also deals with the objectives of enhancing both Norwegian industrial competitiveness and Norwegian expertise in the international energy market.

In the period from 2009 to 2011, in the wake of the Storting's [Norwegian parliament] first Agreement on Climate Policy from 2008, the authorities significantly increased research investments in the areas of renewable energy, raising energy efficiency and carbon capture and storage. The subsequent agreement from 2012 continued along the same ambitious lines and Norway's new government is keeping a strong focus on energy and climate initiatives. The availability of the clearly designated strategies developed in the Energi21 processes has proven very useful in the context of the operative research system. Plans have been in place for implementing

the increased commitments approved by the authorities, and the business sector and research system have been prepared for the capacity increase needed to carry out the research.

Internationally, investment in R&D is rising sharply in the energy sector and this represents a major component of the EU initiatives under Horizon 2020, the new EU framework programme for research and innovation. Reliable, clean and efficient energy has been defined there as one of the seven Grand Challenges. It will be important for the Norwegian research community and trade and industry to gain a strong foothold in research cooperation within the EU.

In the view of the Energi21 board, this strategy lays the foundation for an even more targeted increase in public and private investments in RD&D towards new climate-friendly energy technology. A long-term, concentrated research drive will yield major advances in terms of effective utilisation of energy resources, development of a flexible and efficient energy system, and the expansion of internationally competitive industry.

We would like to take this opportunity to thank everyone who has provided input and taken part in the process, thereby making it possible to draw up a broadly-supported, integrated national R&D strategy for new climate-friendly energy technology. It is our hope that the recommendations provided here will be followed up and implemented by the Norwegian authorities and the national energy industry.

Oslo, september 2014

**Sverre Aam**  
*Chair of the Energi21 board*

# Summary

---

Energi21 is the Ministry of Petroleum and Energy's strategic body for research, development and demonstration (RD&D) in the energy sector.

The main purpose of the Energi21 strategy reports is to provide the Ministry of Petroleum and Energy with recommendations on future strategic priority areas for efforts to develop new climate-friendly, environment-friendly solutions in the renewable energy sector. The Energi21 strategy documents are drawn up in cooperation with the business sector, academia and the relevant authorities.

The guiding principles for national and international strategies in the energy sector revolve around the need to address climate challenges and safeguard both security of energy supply and competitiveness. These drivers, together with assessment of the potential to meet targets and of Norway's national competitive advantages, form the basis for the recommended strategic priority areas and proposed measures.

In the third strategy report, the Energi21 board recommends strong growth in public funding for research, development and demonstration within the following six areas:

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

These are areas in which Norway enjoys competitive advantages in future energy markets, thanks to its natural energy resources, substantial technology and competency base and industrial experience. Among these six priority focus areas, the Energi21 board recommends devoting special attention to *Hydropower and Flexible energy systems*. These two areas represent the very foundation of Norway's energy system and are vitally important for current as well as future value creation, nationally and internationally.

In addition, the board stresses the importance of maintaining and continuously developing the competency platform that underpins all the energy-related thematic and technology areas.

The Energi21 report recommends wide-ranging activities based on access to ample, predictable public research funding, beneficial market incentives and the commitment and active participation of the energy business community. The report highlights the following measures as essential for successful implementation of the strategy:

- Expanding efforts to create an integrated, harmonised incentive structure along the entire innovation chain;
- Adapting incentive structures to future climate-friendly energy systems;
- Strengthening innovation and renewal in the energy sector;
- Increasing the involvement of the business sector in research and innovation;
- Facilitating Norwegian participation in international testing and demonstration projects;
- Enhancing research and innovation cooperation in the EU arena;
- Increasing recruitment to strengthen Norway's position as a renewable energy nation;
- Developing dynamic research groups and a strong national technology and competency base;
- Promoting greater sectoral cooperation at the government administrative level to ensure effective implementation.

The Energi21 report is recommending a plan to step up funding over a four-year period, with overall growth of NOK 1 billion in public allocations.

PREFACE	4
SUMMARY	5
<b>1 INTRODUCTION</b>	<b>8</b>
<b>2 ENERGI21</b>	<b>12</b>
2.1 Role and function	14
2.2 Vision for Energi21	15
2.3 Energi21 – Strategic objectives	15
<b>3 TRENDS AND DEVELOPMENTS UNDERLYING THE ENERGI21 STRATEGY</b>	<b>16</b>
3.1 The climate challenge – security of energy supply and competitiveness	18
3.2 Other key trends and changes	18
3.3 International research cooperation	20
3.4 The EU research arena	20
3.5 Norway’s competitive advantages	20
<b>4 SIX PRIORITY FOCUS AREAS FOR RD&amp;D</b>	<b>22</b>
4.1 The six priority focus areas	26
<b>5 IMPLEMENTING THE STRATEGIC RECOMMENDATIONS</b>	<b>30</b>
5.1 Expanding efforts to create an integrated, harmonised incentive structure along the entire innovation chain	32
5.2 Adapting incentive structures to future climate-friendly energy systems	33
5.3 Strengthening innovation and renewal in the energy sector	33
5.4 Increasing industry involvement in research and innovation	33
5.5 Facilitating Norwegian participation in international testing and demonstration projects	34
5.6 Enhancing research and innovation cooperation in the EU arena	35
5.7 Increasing recruitment to strengthen Norway’s position as an energy nation	36
5.8 Developing dynamic research groups and a strong national technology and competency base	36
5.9 Promoting greater sectoral cooperation at the government administrative level to ensure effective implementation	36
5.10 Recommendations and measures for the strategy’s priority focus areas	38
5.11 Funding	39

# Contents

## Part 2 **Background, analysis and assessments**

---

[Part 2]

1. NORWAY AS AN ENERGY NATION

2. INTERNATIONAL RESEARCH COOPERATION

3. ENERGY – STRATEGIC ANALYSIS

4. CHALLENGES AND INCENTIVES ALONG INNOVATION CHAIN

### ATTACHMENTS

Attachment 1: Mandate for and membership of the Energi21 board

Attachment 2: Working group: Solar Power technology

Attachment 3: Strategic expert group

Vedlegg 4: Begrepsliste

1





# *Introduction*





Svartisen kraftstasjon, Statkraft. Photo: Christian Hauge

## Introduction

The Energi21 initiative was launched by the Ministry of Petroleum and Energy in 2008 with the aim of designing an integrated strategy for research, development and commercialisation of new, climate-friendly energy technology. The main purpose of the Energi21 strategy reports is to provide the Ministry of Petroleum and Energy with recommendations on priorities for research, development, demonstration and commercialisation of new, climate-friendly energy technology. The strategy encompasses the entire value chain for energy systems as well as the entire innovation chain, from idea to market.

The mandate for the board of Energi21 states that the strategy is to be revised every two to three years. This is the third edition of the Energi21 strategy report. The first was published in 2008. The second, published in 2011, made the 2008 strategy more specific and action-oriented. This document comprises a revision of the 2011 strategy report.

### FRAMEWORK UNDERLYING THE STRATEGY

The current situation in Norway, together with national and international trends during the past three years, provide the backdrop for the strategic recommendations. Multidisciplinary cooperation between the business sector, research and educational institutions, and the authorities has been of key importance in the planning and implementation of this strategy process. The Energi21 forum attaches great importance to extensive involvement of energy sector stakeholders to ensure that the strategic recommendations reflect the needs of the sector to the greatest possible degree.

The Energi21 board has chosen to build on the scientific framework underlying the strategy from the previous period, which still remains relevant. In addition, new knowledge has been added from the efforts of scientific working groups and reports. The forum has carried out a number of processes to establish a solid, underlying framework that encompasses key perspectives related to the needs of society, the ambitions of trade and industry, and the opportunities for value creation in future energy and technology markets. The strategic research areas and administrative means to attain the strategic goals have been assessed in this light.

The framework underlying the strategy incorporates the following activities and documentation:

- ♦ Segments of the strategy reports drawn up by the Technology Target Areas (TTA) working groups in the previous strategy period [2011].
- ♦ Results of the mapping project on public funding in 2012-13 for research, development and demonstration projects on climate-friendly stationary energy technology, CCS, low-carbon transport and stationary hydrogen.
- ♦ Strategic working meetings with various research groups to identify R&D ambitions, strategic R&D areas and necessary measures to be implemented [April 2013].
- ♦ Report with R&D recommendations from the working group for solar power [October 2013]. The members of the solar power working group are presented in Attachment 2 to Part 2 of this report.
- ♦ Input from a multidisciplinary expert group comprised of representatives of the energy sector and research and educational institutions [autumn 2013].
- ♦ The members of the expert group are presented in Attachment 3 to Part 2 of this report.
- ♦ Dialogue meetings with experts and research groups in selected thematic and technology areas.
- ♦ Input from a broad-based consultative review [April–May 2014] and concluding review meeting.

The mandate from the Ministry of Petroleum and Energy has been essential in shaping the structure and content of this strategy document. The document is divided into two parts: Part 1 presents strategic recommendations relating to priority areas and implementation measures; Part 2 presents a review of all the thematic and technology areas on which the strategic recommendations and priorities are based. Part 2 also includes a more detailed description of the premises for the strategic recommendations, as well as a discussion of challenges and incentives along the innovation chain. This document has been authored by Lene Mostue and Trond Moengen in collaboration with Sverre Aam. Tor Ivar Eikaas has contributed input for the description of the EU research system.

2





# *Energi21*



# 2.1

## Role and function

The main function of the Energi21 initiative is to provide strategic input and recommendations to the authorities on research, development and demonstration activities targeted towards the development of new, climate-friendly, stationary energy technology. The Energi21 strategy is to be an integrated, unifying strategy for the energy sector where the stakeholders, through their active participation, give support to collective strategic objectives and measures. The Ministry of Petroleum and Energy uses the strategy when determining its allocations to research, development and demonstration in the energy sector.

Energi21 is led by a board appointed by the Minister of Petroleum and Energy, with 12 representatives from trade and industry, research and educational institutions, and public agencies within the research and innovation system in the energy sector. The Ministry of Petroleum and Energy and the Norwegian Water Resources and Energy Directorate (NVE) take part as observers. The day-to-day activities are led and carried out by a secretariat in collaboration with relevant stakeholders in the energy sector.

The scope of Energi21 encompasses thematic and technology areas within climate-friendly stationary energy pro-

duction, energy transmission (infrastructure) and efficient use of energy, as well as carbon capture and storage. OG21 is a corresponding strategic forum appointed by the Ministry of Petroleum and Energy for the oil and gas sector. Energi21 also shares an interface with Skog22, which encompasses the management and use of forest-based biomass. Bioenergy and biofuels are a shared thematic area here. Similarly, off-shore wind power is a thematic area shared with Maritim21, an integrated research and innovation strategy for the maritime industry in Norway. The Bygg21 strategy will be published in autumn 2014 and will present measures for improving competency and implementation capacity throughout the construction industry. Energi21 only addresses issues relating to energy consumption and production in buildings.

The Energi21 strategy shares interfaces with other technologies and thematic areas that are not directly encompassed by the Energi21 mandate or other strategic R&D bodies. Transport is an important area, and developments in electrification and renewable fuels have a major influence on the stationary energy sector. To ensure that these considerations are adequately dealt with, the Energi21 forum seeks close collaboration with related research groups and resource persons to assess relevant issues and integrate them into strategic activities.

The mandate from the Ministry of Petroleum and Energy stipulates the tasks of the Energi21 board. The mandate for Energi21 and the members of the board are presented in Attachment 1 to Part 2 of this report.

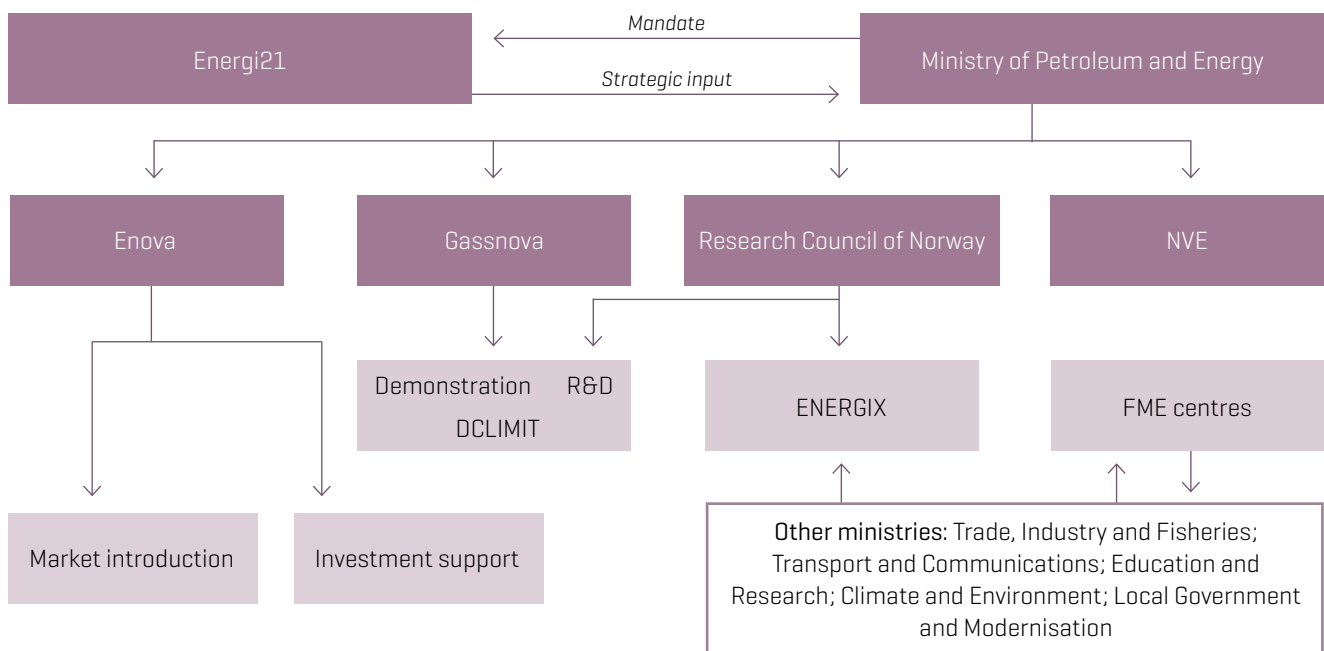


Figure 1 Organisation of energy research under the Ministry of Petroleum and Energy

## 2.2

### Vision for Energi21

The following vision has been formulated for Energi21 based on Norway's foundation as an energy nation, energy-related challenges and Norway's competitive advantages in future energy markets:

#### Norway – a climate-friendly energy nation

*and an international supplier of energy, power, technology and knowledge.*

Research, development and demonstration activities as well as education are essential to innovation, development of knowledge and technology, future value creation and adequate security of energy supply. Norway is a strong energy nation that enjoys competitive advantages thanks to its extensive experience and substantial technology and competency base. Norwegian actors have the ability to secure a leading position and supply technology, products and services to national and international energy markets in the years ahead. The country's national resources also provide an excellent basis for supplying energy and power as well as products that require large amounts of energy to manufacture. Norway is in an excellent position to become an important, high-profile contributor of relevant solutions for dealing with the global climate challenge.

Norway will have to set its sights high internationally to be able to develop the potential for value creation that lies in resource utilisation and knowledge and technology delivery.

## 2.3

### Energi21 – Strategic objectives

Objectives for Energi21 are laid out in the mandate from the Ministry of Petroleum and Energy. These provide an important basis for the strategic recommendations.

#### OBJECTIVE 1: Increased value creation on the basis of national energy resources and utilisation of energy

Norway is an energy nation. Utilisation of national energy resources represents an important source of value creation both today and well into the future. There is major resource potential as well as promising opportunities for satisfying national energy needs, supplying energy and system services internationally and developing technology products in which renewable energy input is an important factor in the production process.

#### OBJECTIVE 2: Energy restructuring through efficient use of energy and increased flexibility in energy systems.

Climate challenges will have to be taken into consideration when meeting the need for energy and transport services in the years ahead. The solutions that will ensure adequate security of supply and are at the same time effective in the context of a climate strategy will entail the restructuring of current energy systems, also in Norway. Energy restructuring comprises the phasing out of fossil energy sources and phasing in of energy- and climate-efficient solutions such as new renewable production capacity, raising energy efficiency and enhancing flexibility and efficiency in the end-user segment. There will also be closer integration between the energy and transport sectors in the transition to more sustainable transport solutions. A robust Norwegian climate strategy will include the reduction of greenhouse gas emissions from industry as well. In addition to technology, the ability of the individual and society as a whole to integrate new systems and solutions will be crucial to the effective development of energy- and climate-efficient energy systems.

#### OBJECTIVE 2: Energy restructuring through efficient use of energy and increased flexibility in energy systems.

Climate- and energy-policy objectives are paving the way for a radical restructuring of the international energy system. Sustainable development in emerging economies will in addition require a considerable increase in energy production and capacity and energy services. Together, these represent the main drivers of the rapidly growing markets for climate-friendly energy technologies. The Norwegian business sector is in a good position to gain a foothold in emerging energy-related markets, both nationally and internationally.

Access to knowledge is a vital competitive advantage for Norwegian business, and dynamic educational and research environments are critical factors for recruitment and innovation in the energy sector. Norway must have strong, competitive, internationally recognised research and educational communities that can take the lead in international research cooperation.

33





# *Trends and developments underlying the Energi21 strategy*

The need to address climate challenges, security of energy supply and ensure commercial competitiveness constitute the three most important guiding principles for national and international strategies in the renewable energy sector. In the three years that have elapsed since the 2011 Energi21 strategy was issued, new developments in the renewable energy sector have further shaped the challenges and opportunities ahead and thus have an impact on the recommendations proposed in the new Energi21 strategy.



## 3.1

---

### The climate challenge – security of energy supply and competitiveness

Section 1 of the IPCC<sup>1</sup> Fifth Assessment Report, published in September 2013, underscores the **climate challenge**, stating with 95–100% confidence that the global temperature increase since 1950 is largely due to human activities and that the temperature may rise by 3.7 to 4.8°C by 2100 if no corrective action is taken. The agreements on climate policy reached on the basis of broad-based political consensus in the Storting (2008 and 2012) have committed Norway to the goal of limiting global warming to 2°C. At the same time, Norway has decided to implement two-thirds of its greenhouse gas emissions reductions domestically, amounting to a reduction of 15–17 million tonnes of CO<sub>2</sub>-equivalents by 2020. The Norwegian Environment Agency's status report from March 2014 states that adjusted emissions projections will exceed the national emissions target for 2020 by 8 million tonnes, but that there is the potential to cut 4.9 to 8.4 million tonnes through further measures in various sectors. In its political platform, the Government states it will adhere to a proactive climate policy and further strengthen the Agreement on Climate Policy.

The climate challenges must be addressed in the context of safeguarding the **security of energy supply**. The International Energy Agency (IEA) calculates in its World Energy Investment Outlook (WEIO) 2014 that the world needs to invest roughly USD 48 000 billion over the next 20 years to ensure a secure supply of energy<sup>2</sup> (under the IEA's New Policies Scenario). Roughly 20% of this would go towards raising energy efficiency. Under the IEA's 450 Scenario, meeting the 2°C target would require investments of USD 53 000 billion, which is only 10% greater. However this entails a fundamental change in investment profile away from fossil fuels and towards renewables, as well as raising to 25% the portion of investment going to energy efficiency measures. Such a change would yield a reduction in annual emissions from 37 to 21 gigatonnes of CO<sub>2</sub>-equivalents by 2035, a cumulative cut of 145 gigatonnes of CO<sub>2</sub>-equivalents.

Efforts to safeguard energy security must combine increased access to renewable energy, reduced CO<sub>2</sub> emissions from fossil energy carriers, and enhanced energy efficiency. To achieve the reductions needed to fulfil the 2°C target, the IEA estimates in its Energy Technology Perspectives (ETP) 2014<sup>3</sup> that a significant proportion of greenhouse gas reductions must come from improved energy efficiency in industry and buildings (19 % and 13 % respectively). An additional 41% share must be achieved through reducing emissions

from electricity production. IEA analyses show that growth in hydropower, solar cells and wind power is keeping up with projections for the targets. Bioenergy, geothermal energy and offshore wind power are currently lagging somewhat behind expectations, so efforts need to be intensified. Carbon capture and storage and marine energy are well behind their anticipated development so accelerated efforts are needed. Despite growth in renewable energy, the IEA estimates that fossil fuels will still be providing more than 40% of the total energy supply in 2050. Carbon capture and storage may thus emerge as a key technology which, together with intensified efforts towards renewable energy technologies, can maximise the overall share from these components. The IEA further points out that the new growing economies will play an increasingly leading role in implementing low-carbon energy technologies. This is an area where the Norwegian business sector will find important markets.

The mutual **competitiveness** of the individual countries and regions is the third major principle that is shaping the framework for necessary efforts in the energy sector. Current trajectories outlined in the ETP 2014 indicate strong growth in international markets for energy and energy technology and reveal at the same time the need for research. A strategic approach to these markets must be based on competitive national advantages, opportunities and expertise, as well as our national capacity to make a contribution.

These trends provide the backdrop for several of the recommendations in the Energi21 strategy and are a focal point of the strategic analysis presented in Part 2, Chapter 3.

## 3.2

---

### Other key trends and changes

#### INTERNATIONAL

When the Japanese nuclear power plant Fukushima was badly damaged by an earthquake and ensuing tsunami in March 2011, the event prompted safety concerns around the world about the role of nuclear power in supplying energy. Many countries began taking measures to promote the phasing in of alternative energy sources. Some countries, however, continue to develop nuclear power, with China, India, Finland and the US among the most active pursuers.

The event mobilised the German parliament to undertake **Energiwende**, a radical transition of the country's energy sector approved in June 2011 that is to phase out nuclear power, reduce consumption of oil, coal and natural gas, and expand energy production from renewable sources. This has led to substantial incentives for renewables, spawning rapid growth. The decision received unprecedented broad-based political support.



Askjelldalsvatnet, the intake reservoir for the Evanger hydroelectric power station, BKK's largest. Photo: BKK

In recent years Europe has seen strong growth in **solar and wind power**, with rising proportions of intermittent energy production. Power systems with a large proportion of solar and wind power require **balancing power** to offset this intermittency with e.g. back-up production or alternative solutions for **energy storage**. The IEA estimates a need for 100 GW<sup>1</sup> of new thermal capacity in Europe to ensure security of energy supply, emphasising at the same time that Europe must improve its cross-border cooperation.

Rapid growth in production capacity of solar cells along with advances in technology have pushed solar electricity prices dramatically downward. **Price developments in electricity from solar and wind power** play a central role in shaping the energy market.

The **shale gas revolution** has had a large impact on natural gas prices in the US, where gas now costs only around 40% of European prices. This has brought about a transition from coal power to gas in the US, while the opposite has occurred in Europe due to high prices for gas, low prices for coal and low CO<sub>2</sub> taxes. Taxes on CO<sub>2</sub> must be raised significantly to reverse this trend in Europe.

In January 2014 the European Commission recommended cutting greenhouse gas emissions 40% by 2030 based on 1990 levels and increasing the proportion of renewable energy to 27%. The proposal is being processed in the EU decision-making bodies.

<sup>1</sup> IPCC. Intergovernmental Panel on Climate Change. Fifth Assessment Report. <http://www.ipcc.ch/>

<sup>2</sup> IEA - World Energy Investment Outlook, May 2014. <http://www.iea.org>

<sup>3</sup> IEA - Energy Technology Perspectives 2014 [ETP 2014]. <http://www.iea.org>

<sup>4</sup> IEA - World Energy Investment Outlook, May 2014. <http://www.iea.org>

## IN NORWAY

In its political platform, the Norwegian Government states it will boost research efforts and establish world-class research environments at universities. The aim is to make Norway one of the most innovative countries in Europe. The Government also asserts that the restructuring of Europe's energy supply opens wide opportunities for value creation in Norway based on national energy resources.

The first and second agreements on climate policy reached by the Storting provide a basis for an ambitious Norwegian climate policy, and establish targets and a direction for activities in several areas.

Through a common Norwegian-Swedish market for green electricity certificates, an additional 26.4 TWh will be commissioned in the two countries' energy market by 2020 during a period of low growth in demand. As a result of this increased future supply, a significant electricity surplus is expected in the Nordic market, estimated by Statnett at 25-30 TWh in 2020. This anticipated surplus in the Nordic countries may decline, however, if Sweden begins phasing out its nuclear plants in the period from 2025 to 2035.

Large-scale investments in the Norwegian power system are planned in the years ahead. Production and grid facilities have an average age of roughly 45 years and there is a need for renovation and modernisation.

Major changes have transpired in Norway's transport sector in recent years as electrification of the vehicle fleet has progressed faster than expected. As of May 2014 there were 30 000 rechargeable vehicles on the roads of Norway. Developments in the transport sector have important implications for the stationary energy supply and will require additional capacity and flexibility.

## 3.3

---

### International research cooperation

Tomorrow's climate-friendly energy systems will require innovative solutions developed through multidisciplinary national and international cooperation on both research and education. The Energi21 strategy emphasises participation in international research cooperation as a critical component of success. National research groups of high international calibre are crucial for establishing and gaining access to international knowledge production. International cooperation will also promote and further develop a competitive, internationally oriented, knowledge-based industrial sector in Norway.

Norway's presence in the international R&D arenas is crucial if the country is to gain a position at the international research front. It is important that Norway maintains its role in international cooperation efforts and enhances this role in areas in which it will have the greatest effect. The EU is the most important international research arena for Norway. In addition, Norway participates on a broad scale in the IEA's Technology Collaboration Programme, particularly in Multilateral Technology Initiatives (also known as Implementing Agreements) on renewable energy, end-use/electricity, and fossil fuels.

Priority should also be given to bilateral cooperation with rapidly-growing research nations outside Europe in areas in which it will boost research quality, expand the knowledge base and cultivate opportunities for Norwegian trade and industry in international markets. North America, the fast-growing economies of Asia, South America and South Africa are particularly relevant partners for cooperation.

## 3.4

---

### The EU research arena

The European research arena sets the framework for Norway's national energy research agenda. Since 1994 Norway has participated in and benefited greatly from the EU Framework Programmes for research. Norway is an active participant in several initiatives under the SET Plan<sup>5</sup> and has participated in many projects funded under the EU Seventh Framework Programme<sup>6</sup>. The new EU Framework Programme for Research and Innovation, Horizon 2020, has now been launched, and there are many opportunities for Norwegians to participate in its various areas.

The EU research arena and its implications for Norwegian activities are discussed more thoroughly in Part 2, Chapter 2.

## 3.5

---

### Norway's competitive advantages

Norway's access to national resources, technological competency base and experience provides a solid foundation for developing a profitable energy industry with an international focus.

Plentiful renewable energy resources have enabled Norway to build up a substantial energy-intensive sector and many of the country's companies are among the world's foremost in terms of expertise and experience. This is a sound basis for further development towards supplying new markets with energy services, new technology and new energy-intensive products. Availability of renewable energy resources will be ample in the foreseeable future. There is also substantial potential for increased energy production. Strong industrial development based on expertise and renewable energy will enhance Norway's role as a renewable energy nation in years to come. An integrated Norwegian energy and climate policy should facilitate growth opportunities for Norwegian companies and institutes in the areas of renewable energy and raising energy efficiency both in Norway and internationally.

There is a large international market with opportunities for Norwegian exports of equipment, services and expertise. Particularly in the solar and hydropower industries, cable technology and offshore wind power, Norwegian companies are already internationally recognised suppliers of technology and services.

Extensive international market growth is opening up opportunities for Norwegian full-service suppliers and sub-contractors of new technology and solutions. An internationally respected supplier industry has been built in Norway to serve the country's petroleum activities. These companies are well equipped to become able to supply technology to other energy-related markets in addition to the petroleum industry. In a longer-term perspective this may become part of a diversification strategy for individual companies – and a step in promoting development of new, long-term business activities with a scope that extends beyond petroleum.

It is important for Norway to take advantage of its competitive advantages in an effective, profitable way to ensure future value creation and proper utilisation of resources. The table below shows examples of Norwegian competitive advantages in the energy sector.

## COMPETITIVE ADVANTAGES – ENERGY RESOURCES AND EXPERTISE

### ENERGY RESOURCES

- |                                  |  |
|----------------------------------|--|
| Major renewable energy resources | <ul style="list-style-type: none"><li>♦ Water – energy, energy storage, and energy as an input factor for industry</li><li>♦ Wind – energy, energy as an input factor for industry</li><li>♦ Land-based and marine biomass</li></ul> |
|----------------------------------|--|

- |                        |   |
|------------------------|---|
| Petroleum <sup>7</sup> | <ul style="list-style-type: none"><li>♦ Large natural gas resources</li></ul> |
|------------------------|---|

### EXPERTISE, EXPERIENCE AND TECHNOLOGY

- |            |   |
|------------|---|
| Hydropower | <ul style="list-style-type: none"><li>♦ Technology for tunnelling and underground facilities</li><li>♦ High-pressure facilities, flexible solutions</li><li>♦ Cost-effective project design, planning and operation</li><li>♦ Advanced methods/systems for optimal monitoring and operation</li><li>♦ Environmental design in both planning and operation</li></ul> |
|------------|---|

- |                                  |   |
|----------------------------------|---|
| Electric power systems expertise | <ul style="list-style-type: none"><li>♦ Planning, construction and operation of power infrastructure</li><li>♦ Electrical power components and parts</li><li>♦ Automated monitoring and operation of the power grid</li></ul> |
|----------------------------------|---|

- |  |  |
|--|--|
| Energy systems with high degree of electrification | <ul style="list-style-type: none"><li>♦ Planning, construction and operation</li><li>♦ Electrical power components and sub-deliveries</li><li>♦ Automated monitoring and operation of grid</li><li>♦ Power markets – market design</li></ul> |
|--|--|

- |                               |   |
|-------------------------------|---|
| Offshore petroleum activities | <ul style="list-style-type: none"><li>♦ Construction, operation and maintenance of large offshore installations</li><li>♦ Geology and geotechnics</li><li>♦ Experience in carbon capture, transport and storage</li></ul> |
|-------------------------------|---|

- |                   |   |
|-------------------|---|
| Maritime industry | <ul style="list-style-type: none"><li>♦ Marine operations</li><li>♦ Specialised vessels</li></ul> |
|-------------------|---|

- |                       |   |
|-----------------------|---|
| Processing technology | <ul style="list-style-type: none"><li>♦ Generic – extensive industrial experience and research expertise</li><li>♦ CO<sub>2</sub> separation from natural gas and flue gas</li><li>♦ Refining for converting fossil fuels relevant for biorefining</li><li>♦ Electrolysis</li></ul> |
|-----------------------|---|

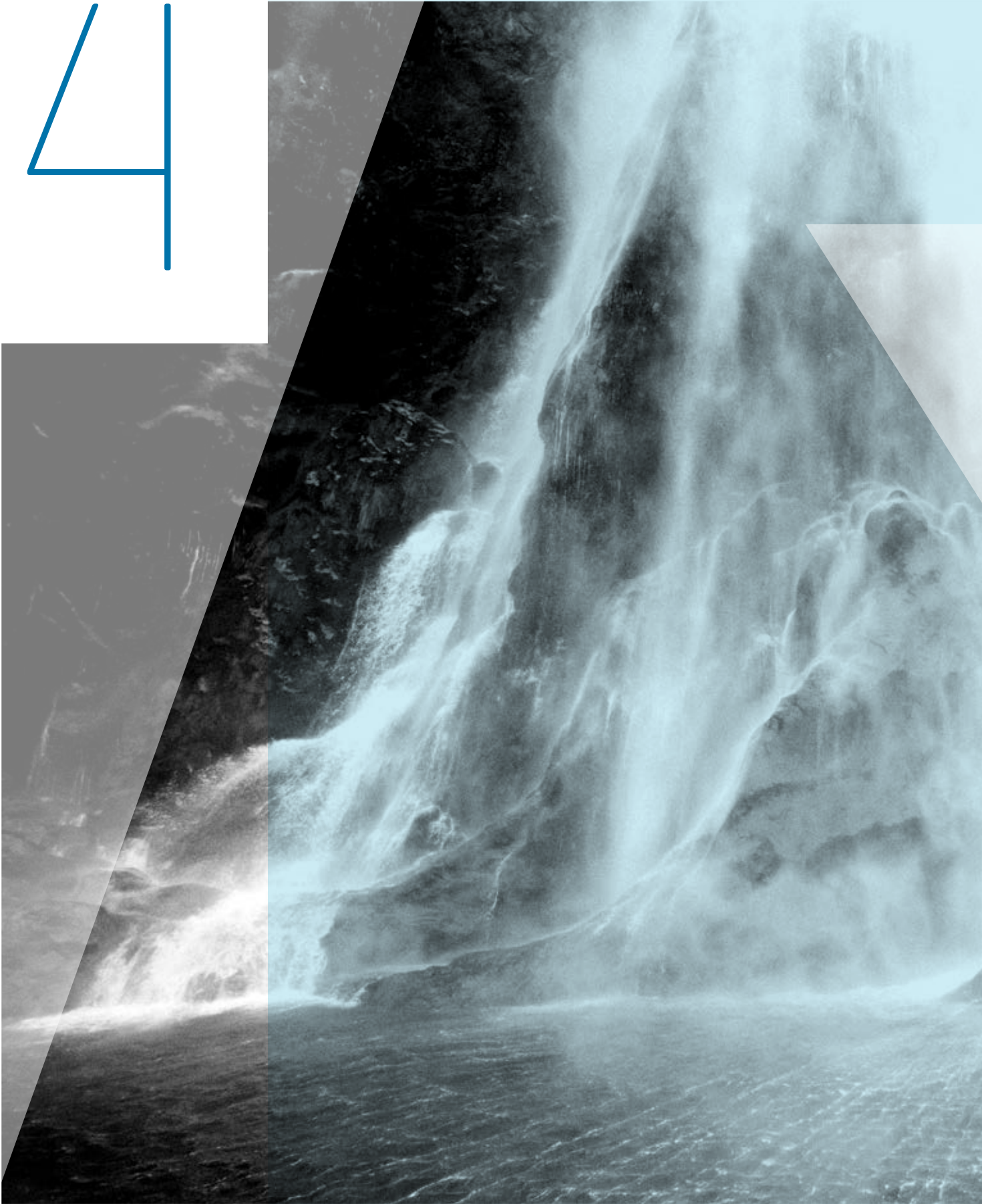
- |                      |   |
|----------------------|---|
| Materials technology | <ul style="list-style-type: none"><li>♦ Extensive industrial experience and research expertise</li><li>♦ Metal/chemical refining [e.g. Si, FeSi, Al and more]</li></ul> |
|----------------------|---|

<sup>5</sup> EU: The European Strategic Energy Technology Plan – SET Plan.

<sup>6</sup> The EU Seventh Framework Programme (2007-2013) comprises an array of research programmes with durations of 3–5 years. Its successor is Horizon 2020.

<sup>7</sup> The use of petroleum as a natural resource falls under the OG21 strategy and not part of the Energi21 strategy.

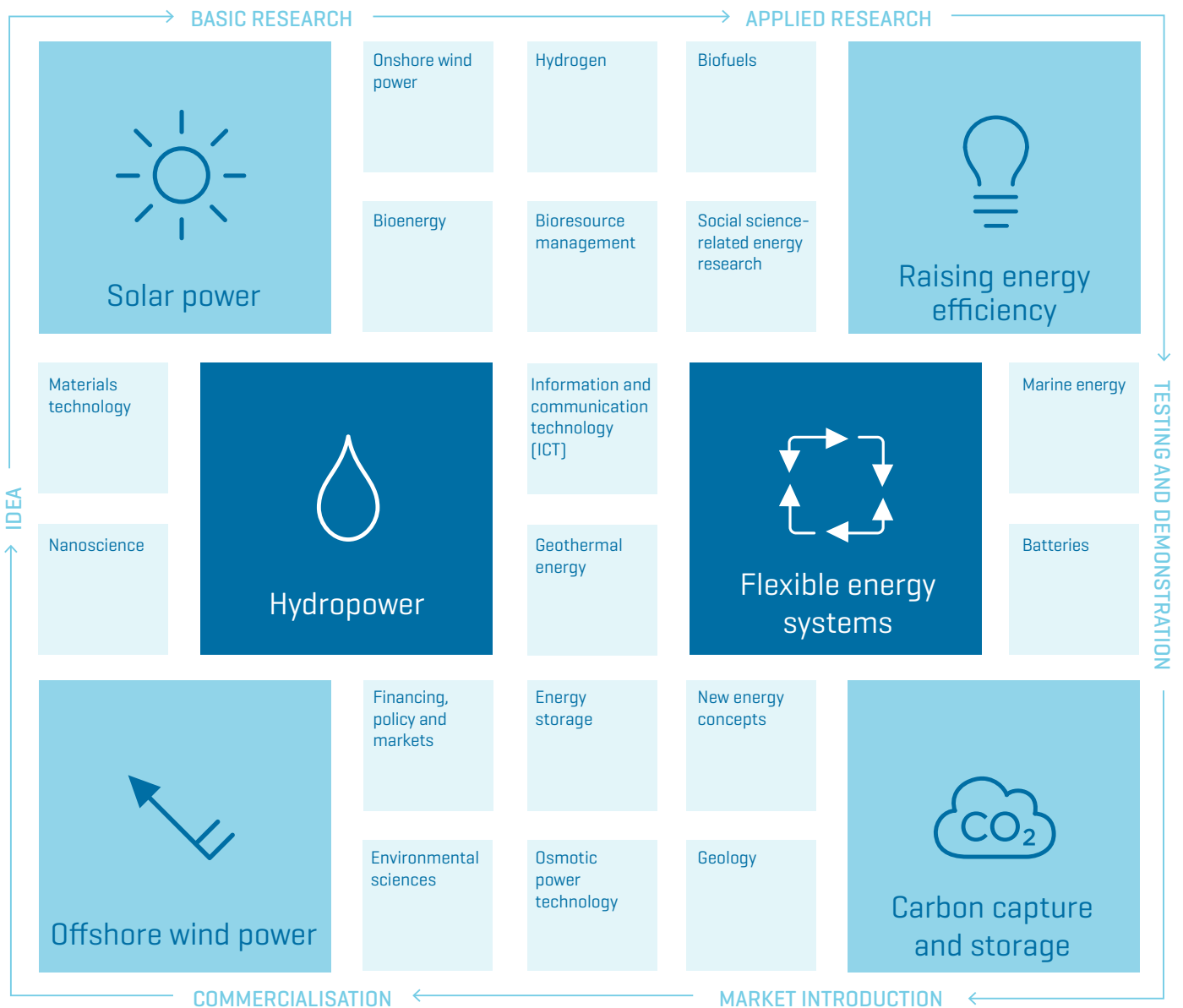
4



*Six priority focus areas for RD&D*



The Energi21 report recommends strong funding growth and concerted efforts targeting research, development and demonstration in the six key areas highlighted in the figure below:





Each of these areas is characterised by significant potential, major challenges and tremendous opportunity. These are areas in which Norway enjoys competitive advantages in future energy markets, thanks to its natural energy resources, substantial technology and competency base, and widespread industrial experience.

The achievement of effective initiatives entails access to ample, predictable public research funding, beneficial market incentives and the commitment and active participation of industry actors. The authorities and industry must work together to identify and reduce bottlenecks and dismantle barriers in order to realise solutions. In addition, the public agencies within the research and innovation system must focus special attention on all segments of the innovation chain to promote implementation and facilitate commercial actors, not least those that operate internationally.

Among the strategy's six priority focus areas, the Energi21 board recommends devoting special attention to Hydropower and Flexible energy systems. These two areas represent the very foundation of Norway's energy system and are vitally important for current as well as future value creation. There is a wide array of challenges as well as opportunities to be found in developing the national and international energy system of the future, and current levels of RD&D activity are too low in relation to future needs.

Compared to the strategy from 2011, the new Energi21 report focuses more broadly in the area of hydropower. The

previous strategy emphasised solutions for balancing power and to some extent pumped-storage technology. Based on projections and expected developments for power transmission solutions to the Continent as well as international market models, the Energi21 board has moderated somewhat its ambitions for Norway to achieve a role as a major supplier of power system balancing services to Europe. In addition to balancing power solutions, the new strategy emphasises R&D activities that both help to ensure the value of Norway's hydropower resources and develop an industry able to supply an international hydropower market.

Raising energy efficiency has now become an independent priority focus area, and encompasses energy use in both buildings and industry. Whereas the previous strategy report highlighted the pan-industrial area "Low-grade heat to electricity conversion", the Energi21 board has chosen to expand this focus area in light of the key role of energy efficiency in the future energy system both as an essential measure for cutting greenhouse gas emissions and as a means of improving energy utilisation.

In addition to the special efforts targeting the six priority focus areas, the Energi21 board stresses the need to maintain a competence platform that underpins all the energy-related thematic and technology areas. Steady advances in specific and generic technologies and disciplines will continually open up new opportunities and provide a foundation for new solutions.

Statnett power lines in southwest Norway. Photo: Johan Wildhagen



# 4.1

## The six priority focus areas

### HYDROPOWER

- Plans are being made to construct major hydropower facilities around the world. According to the IEA, hydropower accounted for the largest share of renewable electricity production in 2013, with roughly 3 500 TWh worldwide. Hydropower development is on schedule for the 2°C scenario targets, with production projected to be 5 500 TWh in 2025. Nearly all this growth is occurring in non-OECD countries, representing a large market for the expertise of Norwegian energy companies, consultants and supplier industry.
- The average age of Norway's hydropower plants is 45 years. A high proportion of this infrastructure will be renovated and upgraded in the coming decades, which offers a wealth of opportunity for integrating new technology and solutions and creating added value from better utilisation of energy resources.
- In Norway, hydropower activities are mainly concentrated on renovation, expansion, environmental adaptation, small-scale hydropower, and assessing hydropower for supplying power system balancing services.
- The justification for public funding for research, development and demonstration to a large degree lies in:
  - increased value creation on the basis of national energy resources and utilisation of energy;
  - development of internationally competitive industry and expertise in the energy sector.

### AMBITIONS

- Increase the value of hydropower by better utilising the unique storage facilities of reservoirs in the context of the Nordic and European power systems.
- Promote the environment-friendly, cost-effective construction of new hydropower capacity in Norway and internationally.
- Optimise operations, maintenance and renewal of the hydroelectric system, adapting to future changes in markets, climate and environmental requirements.
- Further strengthen Norwegian hydropower-related expertise and industry to achieve national objectives and be an attractive partner for owning, constructing and operating facilities internationally.

### FLEXIBLE ENERGY SYSTEMS

- A flexible energy system is a critical factor for achieving Norway's energy and climate-policy targets while safeguarding security of energy supply.
- A flexible energy system encompasses all energy-related infrastructures and their coordination. The system must accommodate both centralised and decentralised production with varying degrees of predictability as well as the storage of energy and changing energy consumption patterns, including restructuring of the transport sector.
- Coordination of subsystems will be optimised through the extensive use of automation, monitoring, control, information systems and new market mechanisms that also incorporate consumer behaviour.
- The justification for public funding for research, development and demonstration to a large degree lies in:
  - energy restructuring through the development of new technology and production of environment-friendly energy;
  - development of internationally competitive industry and expertise in the energy sector.

### AMBITIONS

- Develop an energy system with cost-effective, operationally efficient integration of renewable energy in order to achieve targets for new production from renewable sources, distributed production and energy storage.
- Enhance knowledge about increasing the proportion of renewables in the energy system, including outside Europe.
- Establish a dynamic, efficient energy system with greater flexibility for interaction between production and consumption at every transmission level, particularly with regard to distribution-related flexibility.
- Innovate new energy services in keeping with developing flexibility and new business models.
- Modernise the energy system to maintain security of energy supply during demanding weather conditions [e.g. extreme weather events].
- Take advantage of future renovation/upgrade projects and grid investments in Norway as well as within and outside Europe as opportunities to promote a Norwegian supplier industry for smart-grid components and systems.
- Substantially accelerate innovation within electricity supply based on a national strategy for smart grids.
- Improve the funding instruments for RD&D in the industry.



The Sheringham Shoal Offshore Wind Farm off the east coast of England can generate 317 MW. Photo: Statoil

## SOLAR POWER

- Solar power is one of the fastest-growing renewable energy technologies. In its ETP 2014, the IEA reports that solar cells are advancing faster than expected. System prices have fallen 40% since the ETP 2012 report. Due to this dramatic price drop and high growth rate over many years, end users in many markets are beginning to see electricity from solar cells as competitive with conventional power. Solar electricity is starting to play an increasingly meaningful role in supplying energy throughout the world, including in emerging economies.
- Advances and the market will provide openings for suppliers and other companies looking to supply technology or solutions to larger or smaller segments of this value chain.
- The justification for public funding for research, development and demonstration thus to a large degree lies in development of internationally competitive industry and expertise in the energy sector.

## AMBITIONS

- Build up a silicon-based solar industry for the future – an upstream industry that is at the European forefront in quality and innovation.
- Develop business within multiple segments of the value chain, including applications for solar power internationally and in Norway.
- Cultivate prominent research groups that are attractive as international partners.
- Generate a knowledge base for further developing Norway's solar cell cluster and new industry based on existing and new business areas.

## OFFSHORE WIND POWER

- In ETP 2014 the IEA states that the growth trajectory of offshore wind power is lagging behind for the 2°C scenario, underscoring the need for intensified RD&D activity.
- Current development is targeted at an international market where suppliers of technology can gain a position. Norwegian expertise and experience in oil, gas and maritime activities provide a strong basis.
- The theoretical energy potential from Norwegian offshore wind power is so large that utilising it must be based on supplying power to an international market with adequate infrastructure. This scenario is far into the future.
- The justification for public funding for research, development and demonstration lies:
  - to a large degree in development of internationally competitive industry and expertise within the energy sector;
  - to some degree in increased value creation based on national energy resources and utilisation of energy – at least in the long term.

## AMBITIONS

- Develop a Norwegian supplier industry for the offshore wind power market.
- Build up Norwegian companies' technological and industrial expertise and develop solutions that:
  - increase energy production from wind farms;
  - cut costs throughout the entire value chain, from design to decommissioning.

## RAISING ENERGY EFFICIENCY

### *Raising energy efficiency in buildings*

- The construction sector is a major energy consumer, accounting for 31% of energy use worldwide. Efficient utilisation of energy is an overall objective, and advances in the construction sector are essential for achieving this.
- New requirements and new technology will ensure that the buildings of tomorrow are built to low-energy and zero-energy standards, and in the long run will become net-producers of energy in certain periods.
- The slow rate of turnover in buildings makes it essential to exploit the potential for energy efficiency in existing buildings, which calls for new technology for simple, effective measures. There is great potential here as well.
- Buildings of the future will be an important component of the flexible energy system. The trend in the construction sector is towards “smart building” concepts and ultimately “Smart Cities and Communities”, and the sector’s development must be increasingly viewed as part of the energy system’s restructuring.
- The justification for public funding for research, development and demonstration lies to a large degree in energy restructuring through the development of new technology and production of environment-friendly energy.

### *Energy-efficient industrial processes*

- Efficient utilisation of energy in energy-intensive industries is a critical competitive factor.
- Future access to energy with a minimal negative environmental impact will be increasingly important.
- Economic assessments play a key role in raising energy efficiency in industry; energy costs versus the cost of measures/technology often determine the extent to which efficiency measures are implemented.
- Waste heat from industry is a substantial resource that is underutilised, often because industrial facilities are located far from potential heat consumers and district heating infrastructure. Thus there is potential for new solutions that make use of waste heat, particularly where low-grade heat can be utilised.
- There is potential for other efficiency measures as well, and technological content will vary from industry to industry.
- The justification for public funding for research, development and demonstration lies:
  - to some degree in increased value creation based on national energy resources and utilisation of energy;
  - to some degree in energy restructuring through the development of new technology and efficient production of environment-friendly energy;
  - to a large degree in development of internationally competitive industry and expertise in the energy sector.

## AMBITIONS

### *In buildings:*

- Raise energy efficiency in Norwegian buildings.
- Encourage local and building-integrated renewable energy production.
- Achieve flexible integration of energy-efficient buildings into the energy system (electricity, heating, cooling).

### *In industry:*

- Expand the scope of energy-refining industries in Norway.
- Reduce specific energy consumption and greenhouse gas emissions.
- Increase the utilisation of surplus heat in all land-based industries, including better use of low-grade heat for heating and electricity production.

## CARBON CAPTURE AND STORAGE

- For many years Norway has defined carbon capture and storage (CCS) as a priority focus area, and Norwegian research groups and companies are among the foremost in the world.
- The IEA states in its 2°C scenario that in 2050, 40% of the global energy supply will still come from fossil fuels. The agency stresses that CCS will need to play a significant role, contributing 14% of total cuts in greenhouse gas emissions in 2050. In its ETP 2014 the IEA also reports that technological progress is lagging behind targets and that efforts must be escalated.
- There is great potential for carbon storage on the Norwegian continental shelf, where Norway has a competitive advantage. In addition, the Norwegian maritime cluster holds a strong position in the field of transporting liquefied natural gas (LNG), with expertise relevant to ship transport of CO<sub>2</sub> and, in the longer term, hydrogen.
- Future carbon taxes levied may reduce the value of Norwegian natural gas reserves. Efforts to develop technology for decarbonising Norwegian natural gas may help to preserve its value under future tax regimes.
- The justification for public funding for research, development and demonstration lies:
  - to a large degree in increased value creation based on national energy resources and utilisation of energy;
  - to some degree in development of internationally competitive industry and expertise in the energy sector.

## AMBITIONS

- ♦ Reduce greenhouse gas emissions, thereby increasing the value of Norwegian oil and gas reserves and other core industries by:
  - achieving large-scale CCS in industrial or gas-fired power plants in Norway;
  - establishing a central carbon storage site, preferably with potential for enhanced oil recovery (EOR);
  - establishing infrastructure for CO<sub>2</sub> transport;
  - reviewing the possibility of importing CO<sub>2</sub> to said central storage site;
- ♦ Ensure competence-building throughout the entire CCS chain.

Elkem Solar Silicon® (ESS®) is produced in Kristiansand, Norway. Photo: Elkem Solar



5



# *Implementing the strategic recommendations*

It is essential to promote greater innovation in the energy sector. Investment in research, development, demonstration and commercialisation of new climate-friendly energy technologies and solutions must be increased. It will take involvement and effort on the part of the authorities, trade and industry and research and educational institutions to achieve the ambitions set out in the Energi21 strategy and accomplish the research activity required. A commitment to long-term objectives combined with effective action targeting the more immediate future will be critical to successfully implementing the strategy.

This chapter presents the strategic recommendations of the revised Energi21 strategy. An explanation of the basis for each recommendation is provided in the text following it.



# 5.1

## Expanding efforts to create an integrated, harmonised incentive structure along the entire innovation chain

The Energi21 strategy emphasises the importance of a harmonised, dynamic system of instruments that addresses the needs of actors along the entire innovation chain. It is vital that the public agencies within the research and innovation system employ a common strategic foundation to ensure that thematically relevant projects receiving support early in the development process will also have access to support further along in the innovation chain, provided their quality is sufficiently high.

### The Energi21 board recommends:

- ♦ *Common strategic foundation for the public agencies within the research and innovation system*  
The public agencies within the research and innovation system must achieve a stronger strategic foundation for funding announcements and allocation of public funding for developing knowledge and new climate-friendly energy technology.
- ♦ *Differentiated instruments that include all types of actors and positions in the innovation chain*  
Funding instruments must be flexible and dynamic and take into consideration the position and maturity of technologies and markets, as well as the technology developers' location, size and financial base.

- ♦ *A top-level management forum for the public agencies within the research and innovation system*

Meetings should be organised for the top-level managers of public agencies within the research and innovation system to harmonise their strategic foundation. These meetings should also involve the exchange of information and knowledge about trends, number of applicants, industry structure and mobilisation measures to promote involvement and participation in projects. The meetings should also incorporate presentations from industry actors to gain insight into obstacles preventing the performance of R&D and commercialisation activities.

- ♦ *A meeting-place for the stakeholders within the research and innovation system and project developers – Transnova and Investinor should be integrated into the meeting-place*

The Research Council, Innovation Norway, Gassnova and Enova should continue their productive cooperation on shared communication and dialogue with trade and industry related to the purpose, structure, function and opportunities of available instruments. Transnova should also be included in this cooperation. The number of interfaces and need for cooperation is growing. Investinor should also be considered for inclusion in order to strengthen the link between industrialisation and commercialisation.

A mobile capture facility is testing amine-based CO<sub>2</sub> capture at Norway's Mongstad oil refinery (OFG/Aker Solutions). Photo: Oscar Graff





## 5.2

### Adapting incentive structures to future climate-friendly energy systems

Public funding instruments must use flexible assessment and award criteria that are tailored to tomorrow's energy systems with associated technologies and markets. In the years ahead, the energy system's enhanced flexibility and dynamic structure will be important benchmarks of energy policy, along with increased installed capacity, enhanced energy efficiency and new energy production. It will be crucial to have effective instruments that can accommodate the future development of the energy system.

#### The Energi21 board recommends:

- ♦ *Flexible award criteria*  
The Energi21 board recommends the use of funding instruments with award criteria that take into account new challenges in the future energy system.
- ♦ *Comprehensive, relevant macro-economic research as a basis for targeting funding instruments*  
The Energi21 board recommends continued use of comprehensive social science research with extensive user involvement to generate relevant knowledge as a basis for targeted and efficient use of funding instruments.

## 5.3

### Strengthening innovation and renewal in the energy sector

It is the Government's stated ambition for Norway to become one of Europe's most innovative countries in the long-term<sup>8</sup>.

The Research Council promotes innovation based on existing industry as well as on research results from universities and research institutes. The universities and some of the research institutes have established technology transfer offices (TTOs) to verify the research results that are best suited for commercialisation. The TTOs receive funding for their activities under the Research Council's programme Commercialising R&D Results (FORNY2020). In addition Innovation Norway has established a seed fund with private capital where newly-established companies may seek equity

in an early phase. As these companies mature, there are venture funds of both private and public nature (via Investinor) that can inject further equity as the need increases.

Boosting allocations under the FORNY2020 programme and establishing more seed funds to help young companies gain access to early-phase equity should be considered. Companies in the field of sustainable energy must be ensured appropriate standing in the overall context of a funding instrument system of this type.

#### The Energi21 board recommends:

- ♦ *Strengthening funding for innovation and new thinking via FORNY2020*  
Increase annual allocations to the FORNY2020 programme from NOK 155 million to NOK 250 million in keeping with the work programme.<sup>9</sup>
- ♦ *Strengthening funding for innovation and new thinking via seed funds*  
Increase Innovation Norway's investments in seed funds by NOK 1 billion.
- ♦ *Increase funding for innovation and new thinking via Innovation Projects*  
Ensure adequate frameworks for funding to Innovation Projects under the Research Council's Large-scale Programme for Energy Research (ENERGIX) and the Norwegian RD&D CCS programme (CLIMIT).

## 5.4

### Increasing industry involvement in research and innovation

The involvement and active participation of industry actors is pivotal to the success of research and innovation activities. Industry must both take the initiative itself and seek to participate in good research projects together with the research institutions. Industry partners are also critical for ensuring that solutions being developed will be relevant and applicable in the marketplace. The participation of energy and grid companies will play a decisive part in Norway's ability to restructure towards a flexible, future-oriented energy infrastructure. Grid companies are now allowed to enter research expenses into their cost accounts as a supplement to their permitted revenue cap. This

<sup>8</sup> Political platform of the new Government, 2013

<sup>9</sup> FORNY2020 work programme, 2011

enhances the potential of grid companies to get involved, but their participation is still inadequate. The internal situation regarding resources and personnel is often highlighted as a fundamental obstacle to company involvement in research. Measures should thus be devised for addressing this and facilitating increased participation.

**The Energi21 board recommends:**

- *Measures to boost the innovation capacity of energy and grid companies*

Additional steps must be taken to promote active, research-relevant participation from the grid companies beyond the provision from the Norwegian Water Resources and Energy Directorate (NVE) allowing them to enter research expenses into cost accounts as a supplement to the permitted revenue ceiling.

- *Enhanced innovation arenas for industry*

The authorities should facilitate the development of common innovation arenas where research groups, universities and industry can cooperate. An important objective of innovation arenas should be to promote the exchange of knowledge, network building and the design of good ideas for R&D projects that are not competition-sensitive and thus well suited to cooperation between industry actors. The Teknologisk<sup>10</sup> møteplass technology arena is one such arena that has succeeded and should be continued.

## 5.5

### Facilitating Norwegian participation in international testing and demonstration projects

Europe is moving steadily forward on restructuring its energy systems. Horizon 2020, the new EU framework programme for research and innovation, places far more emphasis on demonstration projects than has been the case in previous framework programmes. Development of new technology with a strong helping hand from industry will be a key component of these efforts.

Many Norwegian industry actors develop technology exclusively for the international market. The absence of a domestic market means they need entry into international testing and demonstration projects in the relevant markets. A case in point is offshore wind power. Under current national funding instruments, support is only granted to projects involving activity in Norway with Norwegian industry partners, which poses obstacles to carrying out projects targeting international markets. The market for offshore wind power technology is relatively immature, its development is occurring on the continental shelves of countries other than Norway, and risk-mitigation instruments are needed.

Electrification – power from the mainland grid to offshore installations. Photo: ABB



If the Norwegian public agencies within the research and innovation system are to help Norwegian actors to position themselves for developing internationally competitive technologies, the funding instruments currently in place must be adapted for this purpose. They must make it possible for Norwegian companies to participate in international demonstration projects outside Norway. Instruments of this type would be in accordance with the authorities' objective to promote internationally competitive industry actors. Internationally oriented funding instruments should both be targeted towards Norwegian industry actors and at the same be adapted to EU state subsidy regulations.

**The Energi21 board recommends:**

- ♦ *Access to good infrastructure for testing and demonstration of new energy technology*  
Infrastructure for testing and demonstration is an essential part of the tool set for completing the innovation cycle and qualifying new energy technology for the market.
- ♦ *Funding instruments that support participation in international testing and demonstration projects*  
Although current funding instruments are effective, there is a need for a greater degree of international orientation and adaptation. The public funding instruments should pave the way for Norwegian actors to participate in international testing and demonstration projects, both in and outside Norway.

## 5.6

### Enhancing research and innovation cooperation in the EU arena

EU research programmes are important for Norwegian actors both financially and strategically. It is essential to achieve good interaction between national R&D priority areas and corresponding areas in the EU.

The EU research and innovation arena, with activities such as Horizon 2020, SET-Plan and programme cooperation (ERA-NET, COFUND, ECCSEEL) and more, creates opportunities for Norwegian actors to gain access to the international knowledge front as well as new markets. EU cooperation on research and innovation is wide-ranging, and it can be daunting both to understand the opportunities involved and to find resources for participation.

The budget for Horizon 2020 is NOK 650 billion over seven years, and Norway is expected to contribute 2.5–3% of this amount, i.e. NOK 15–20 billion. The Minister of Education and

Research has made it clear that the Government has a target of winning grants for more than 2% of this budget back for Norwegian partners. If Norway is to succeed in this, Norwegian actors will on average need to more than double the research activity directed towards European cooperation compared to activities under the EU Seventh Framework Programme (FP7, 2007–13). This will require a variety of measures from the Norwegian side.

Strong Norwegian research groups must be able to position themselves within the EU's grant-winning research alliances in selected scientific fields. This will enhance the quality of Norwegian research as well as bring it more to the fore in international circles. Close cooperation between the research community, trade and industry and the authorities will be critical to achieving this. Trade and industry must participate in international research, and the authorities must establish framework conditions that facilitate this process.

**The Energi21 board recommends:**

- ♦ *An industry-oriented system for communication, knowledge and guidance regarding research and innovation cooperation in the EU*  
Norway must further develop and strengthen its system for communication, knowledge and guidance regarding participation in the EU research and innovation arena for the energy sector. This service must first and foremost address the obstacles and challenges to participation facing the actors, which will require efforts to map these elements and more concentrated dialogue with the industry actors.
- ♦ *Increase funding to the STIM-EU scheme from NOK 55 million to NOK 250 million per year*  
Industry and the universities will benefit from favourable conditions from both the EU and national funding schemes under Horizon 2020. The financial framework of the research institutes is weaker under Horizon 2020 than under the EU's Seventh Framework Programme (FP7). The research institutes play a significant role in involving Norwegian industry in EU research, and they have also accounted for a major proportion of Norway's participation in FP7 activities. To achieve the Government's target of winning back 2% of the Horizon 2020 allocations, it has been estimated that funding to the STIM-EU stimulation scheme must be increased to roughly NOK 250 million annually to encourage independent research institutes to seek greater participation in the EU Framework Programmes.

<sup>10</sup> Teknologisk møteplass: collaboration arena for promoting R & D cooperation between the stakeholders in the energy sector.

## 5.7

---

### Increasing recruitment to strengthen Norway's position as an energy nation

Adequate, targeted recruitment is needed to maintain and expand Norway's existing energy system and to safeguard Norway's standing as an energy nation.

Managing and developing the Norwegian energy system requires maintenance and new investment in both materials and competency. This investment needs to be boosted at several levels. It will be important to ensure that there is an adequate personnel with the competency needed to deal with the problems of tomorrow. Recruitment is vital, and access to the right candidates is dependent on competent educational environments as well as promoting science studies at early educational levels. Cooperation between the authorities, educational institutions and trade and industry is valuable for updating curriculums, conducting practical training and marketing job opportunities in the energy sector. Such cooperation should be encouraged.

#### The Energi21 board recommends:

- ♦ *Strengthening educational institutions*  
Educational institutions should be expanded and adapted to the future needs of the energy sector in a close dialogue between the authorities, the energy industry, and educational and research institutions. It is also important that adequate funding is provided for this purpose.

## 5.8

---

### Developing dynamic research groups and a strong national technology and competency base

The broad-based agreement on climate policy reached in the Storting in 2008 has led to an escalation of energy-related research activity and has contributed to the development of several highly active research groups and a wide-ranging portfolio of research projects. It is important to continue to develop the research groups and research projects in a way that provides a robust platform for increased value creation and a solid knowledge base both for industry and for the development of tomorrow's energy system.

#### The Energi21 board recommends:

- ♦ *Reinforcing and further developing the national technology and competency base*  
Strengthen and further develop Norway's technology and competency base through greater focus on research, development, demonstration and education for the energy sector.
- ♦ *Continue the FME scheme*  
When the current scheme for Centres for Environment-friendly Energy Research [FME] concludes in three years, it should be continued with additional emphasis on internationalisation and developing modern laboratories.
- ♦ *Dynamic, internationally competitive research groups*  
Access to internationally competitive research groups is a key factor in encouraging national and international actors to decide to carry out R&D activities in Norway. It is also critical to enabling Norwegian research institutions to compete successfully for funding under the EU research programmes, particularly Horizon 2020.

## 5.9

---

### Promoting greater sectoral cooperation at the government administrative level to ensure effective implementation

The energy sector has an impact on many segments of society's infrastructure and functions, and multiple government ministries will have a say in the development of the priority focus areas set out in the Energi21 strategy. Several of the strategy's technology areas are dependent on sectoral cooperation at the central government administrative level to achieve effective implementation, and there are synergies that can be exploited here. The Energi21 strategy stresses the importance of integrated, strategically targeted R&D activities in the energy sector. A negative ramification of inadequate strategic cooperation within this sector is that certain technology areas can end up in a "no-man's land", causing much-needed R&D efforts to fall by the wayside. This is unfortunate for research and industry actors alike as well as for value creation in general within the technology area in question.

Below, the Energi21 board highlights some of the technology areas where there are clear synergies to be gained from increased sectoral cooperation between government ministries, but which are currently at risk of inadequately integrated R&D investment.

*Technology area 1: Electrification of road transport*

Ministry of Petroleum and Energy  
Ministry of Transport and Communications

*Technology area 2: Electrification of the continental shelf*

Ministry of Petroleum and Energy  
Ministry of Climate and Environment

*Technology area 3: Sustainable management, utilisation and refinement of biomass*

Ministry of Petroleum and Energy  
Ministry of Transport and Communications  
Ministry of Agriculture and Food

*Technology area 4: Raising energy efficiency in buildings*

Ministry of Petroleum and Energy  
Ministry of Local Government and Modernisation

*Technology area 5: Grid power in Norwegian harbours*

Ministry of Petroleum and Energy  
Ministry of Transport and Communications  
Ministry of Climate and Environment

*Technology area 6: Sustainable power production and environmental requirements in river systems*

Ministry of Petroleum and Energy  
Ministry of Climate and Environment

Additionally, the guidelines and policy instruments of the Ministry of Trade, Industry and Fisheries are of great significance for the implementation of the Energi21 strategy's priority focus areas relating to industrial development and innovation.

**The Energi21 board recommends:**

♦ *Interministerial working groups*

The Energi21 board recommends establishing interministerial working groups for each of the areas above to draw up a common strategic basis for these areas.

Turbine at a Sira Kvina power station. Photo: Sira Kvina kraftselskap



## 5.10

### Recommendations and measures for the strategy's priority focus areas

The Energi21 board recommends targeted investment in and specific concentration on six selected priority focus areas. In consultation with industry actors, concrete measures for implementation have been identified for each of these areas. These are presented in more detail in Chapter 3 of Part 2, and are summarised in brief below.

#### Hydropower

- Establish measures specifically targeted towards master's and doctoral-level education and ensuring researcher recruitment, particularly through further developing the Centre for Environmental Design of Renewable Energy (CEDREN) and the Norwegian Hydropower Center.
- Establish constellations of cooperation between Norwegian and international research institutions and universities to encourage development of a common approach to solutions for power system balancing services.
- Provide funding for testing and demonstration facilities as well as a large-scale laboratory for testing and verifying new technology and environmentally adapted solutions. Such a facility would also function as a training centre for competencies in hydropower, with an emphasis on short- and long-term balancing power.
- Provide funding for initiatives from industry which may have potential for value creation.
- Launch Knowledge-building Projects and Researcher Projects within the identified strategic research areas.

#### Solar power

- Make it easier to include international partners in research projects.
- Provide funding for establishing pilot and demonstration facilities.
- Help to unify and coordinate the FME centres in order to enhance expertise in the use of solar power in the energy system. Relevant candidates include the Norwegian Research Centre for Solar Cell Technology (Solar United), the Research Centre on Zero Emission Buildings – ZEB, the Centre for Sustainable Energy Studies (CenSES) and the Norwegian Smartgrid Centre.
- Provide funding for initiatives from industry which may have potential for value creation.
- Launch Knowledge-building Projects and Researcher Projects within the identified strategic research areas.

#### Offshore wind power

- Contribute to EU demonstration programmes seeking to reduce the costs of offshore wind power. The Norwegian authorities must assume an adequately active role in these processes. Strategic cooperation with other countries on development and testing of technology should be considered.
- Facilitate and set aside resources for Norwegian actors seeking to invest in these processes.
- Provide funding for initiatives from industry which may have potential for value creation.
- Launch Knowledge-building Projects and Researcher Projects within the identified strategic research areas.

#### Carbon capture and storage

- Start up testing and demonstration projects.
- Provide funding for initiatives from industry to develop competitive CCS technology and services.
- Examine measures and framework conditions to find those that are conducive to removing legal obstacles to implementing CCS. Of particular relevance in this context are legal issues relating to transport and storage offshore.
- Facilitate and provide funding for active Norwegian participation in international CCS networks such as Horizon 2020, the ERA-NET scheme, EERA and ECCSEL.
- Provide funding for initiatives from industry which may have potential for value creation.
- Launch Knowledge-building Projects and Researcher Projects within the identified strategic research areas.

#### Raising energy efficiency

- Help to follow up the Bygg21 strategy process for the construction industry and ensure that energy use is included on the agenda.
- Create arenas of cooperation and encourage projects partnering industry actors, supplier companies and research groups to facilitate the development of energy-saving technology and solutions.
- Support initiatives from industry for projects with potential for value creation relating to utilising surplus heat or other areas that may benefit industry in the form of higher energy efficiency.
- Provide funding for initiatives from industry which may have potential for value creation.
- Launch Knowledge-building Projects and Researcher Projects within the identified strategic research areas.

#### Flexible energy systems

- Enhance incentives and framework conditions that substantially accelerate the pace of innovation of power distribution companies.
- Facilitate and provide funding for large-scale testing

and demonstration facilities for developing flexible grid solutions.

- Provide funding for initiatives from industry which may have potential for value creation.
- Launch Knowledge-building Projects and Researcher Projects within the identified strategic research areas.

## 5.11

### Funding

The 2008 Agreement on Climate Policy resulted in a significant rise in funding for research and development relating to renewable energy, the efficient use of energy, and CCS in 2009 and 2010. No corresponding boost has taken place in subsequent years, however, with the exception of CCS research, which received a NOK 10 million increase in 2014.

An analysis carried out by the Research Council shows that the funding escalation plan approved in the wake of the first climate policy agreement had a very positive impact. It provided an excellent framework and not least stability in funding that enabled actors to plan and mobilise for the long term. This reliability proved to be invaluable, and the positive experiences also form part of the foundation for the investment framework recommended here.

The Energi21 board is supportive of the Government's fund to promote new energy and climate technology, administered by Enova. There should be substantial focus on continued development and realisation of results from research activities when allocating grants from the Energy Fund. The Energi21 board sees the energy and climate technology initiative as a valuable instrument for promoting testing and demonstration activities and climate-friendly technologies and solutions.

#### The Energi21 board recommends:

- ♦ *Growth in public funding for R&D and demonstration of new energy technology*

The Energi21 board recommends increasing allocations for research and testing and demonstration facilities by NOK 450 million and NOK 550 million, respectively, by 2018. This is a funding framework which the current research system and industry actors will be able to utilise well, and which will also help Norway to achieve its energy and climate-policy targets more rapidly.

- ♦ *Proposed funding escalation plan for 2015-18*

The Energi21 board recommends the implementation of an escalation plan for public funding of R&D and commercialisation of climate-friendly technology for the stationary energy sector and CCS. The escalation plan is proposed for the period 2015-18, with public funding distributed among the Research Council's ENERGIX and CLIMIT programmes, the FME centres, and testing and demonstration projects. The table below outlines the proposed growth in funding amounts.

The Multikomfort Larvik demonstration home, a pilot building for the Research Centre on Zero Emission Buildings – ZEB. Owners: Brødrene Dahl and Optimera Illustration: Snøhetta/EVE.



# Notes

Lined area for notes.









## **ENERGI21**

Energi21  
P.Box 564  
1327 Lysaker  
Telephone: +47 23 03 70 00  
www.energi21.no

**Published by:**  
Energi21

**Main Authors and editors:**  
Lene Mostue, Energi21  
Trond Moengen , Energidata Consulting AS  
Sverre Aam, chairman Energi2

**Translated by** Carol B. Eckmann, Darren Mc. Kellep and Victoria S. Coleman

**Design**  
TANK Design

**Printing**  
07 Gruppen  
Oslo, January 2015

**ISBN:** 978-82-12-03385-6 [trykk]

**ISBN:** 978-82-12-03386-3 [pdf]

