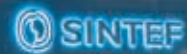




SINTEF Energy Lab



# SINTEF ENERGY RESEARCH

ANNUAL REPORT 2018

# SINTEF ENERGY RESEARCH is growing. We are an international research institute that will be playing a key role in meeting the challenges linked to global climate change

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In 2018 many of our research scientists contributed with documentation in support of the Research Council of Norway's report on the positive influence on industrial profitability of investing in energy research ("*Effektstudie*"). The study revealed both the economic impact of, and potential inherent in, research work and how technology contributes towards the reduction of greenhouse gas emissions. A large number of the technologies illustrated in the study have been developed as part of our projects, in close collaboration with NTNU and our industrial partners.

Many of the results have been obtained from projects directly and indirectly incorporated in our Centres for Environmentally-Friendly Energy Research (CEERs). Our newest CEER centre is already two years old and its work is well underway. The work at these centres is at the heart of our mission: *We shape tomorrow's energy solutions*. I have high hopes and am looking forward to the results emerging from the CEER centres in the future.

Once again, we can boast a record number of summer researchers. In 2018 we welcomed as many as

37 talented young scientists who worked on exciting research projects together with our best scientists, providing value to us and our clients. It is important that we encourage new, young talent. This is why one of the highlights of the year was when Senior Research Scientist Øivind Wilhelmsen was awarded the Research Council of Norway's 2018 prize for young research scientists in the fields of mathematics, natural sciences and technology.

I am looking forward to the imminent opening of our two new laboratories – the HighEffLab and the ElPowerLab. I was very pleased last summer to take part in the opening of the first “package” linked to our ElPowerLab, comprising two new high-speed cameras worth NOK 1.2 million. With single-photon light sensitivity and nanosecond shutter speeds, these cameras can record in

3D the progression of rapid low-light phenomena such as incipient electrical flashovers. We will be using these cameras to look into new materials and fluids for the transport and production of eco-friendly energy.

SINTEF Energy Research is working actively to advise politicians in both Norway and the rest of Europe of the need to invest in technologies that promote positive climate change mitigation and adaptation. We believe that research funding represents a profitable investment in the future, as the RCN's report has demonstrated.

In December we received word from the Norwegian Ministry of Petroleum and Energy that we will be the host organisation for the new Norwegian research centre called LowEmission, dedicated to addressing emissions reductions in the petroleum sector. This centre shall contribute towards

achieving dramatic emissions reductions from the Norwegian shelf in the years leading up to 2050.

SINTEF Energy Research is growing. Our focus is global and we will be playing a key role in meeting the challenges linked to global climate change. This makes it even clearer to me why it is both right and important that SINTEF Energy Research should have a presence in Brussels. The technologies that will contribute towards climate change mitigation and adaptation are global in nature, and our activities must reflect this.

You can read more about this in this annual report and online:

[www.sintef.no/Energi\\_2018](http://www.sintef.no/Energi_2018)

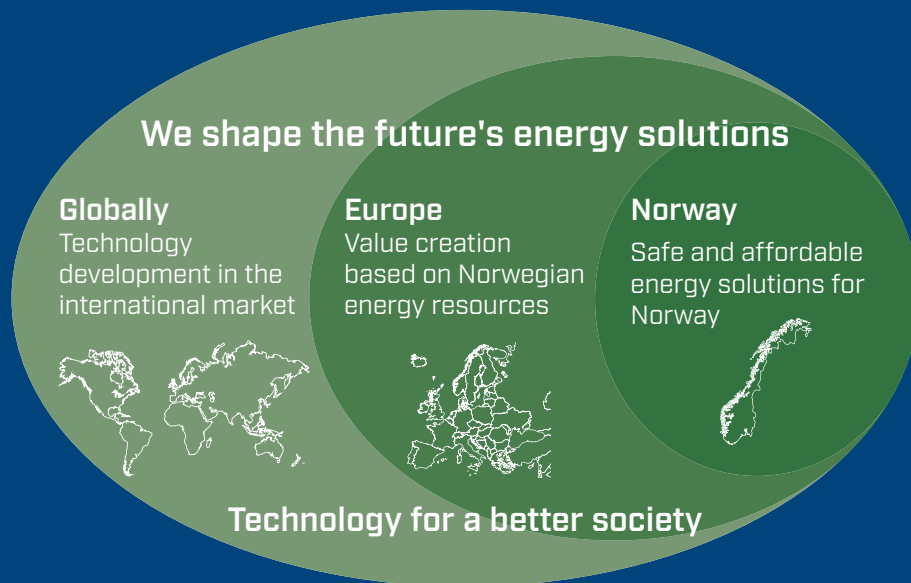


Inge R. Gran,  
President SINTEF Energy Research

# Who are we and what do we do?

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SINTEF Energy Research is an applied research institute dedicated to providing innovative energy solutions. We offer cutting-edge research-based knowledge in Norway and globally with the aim of providing our clients with added-value solutions and services. SINTEF Energy Research is part of the SINTEF Group, which is one of Europe's largest independent contract research centres.



# Our 10 areas of focus

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Smartgrids



Transmission



Offshore  
energy system



Offshore wind



Hydrogen



Energi-  
efficiency



CCS



Hydropower



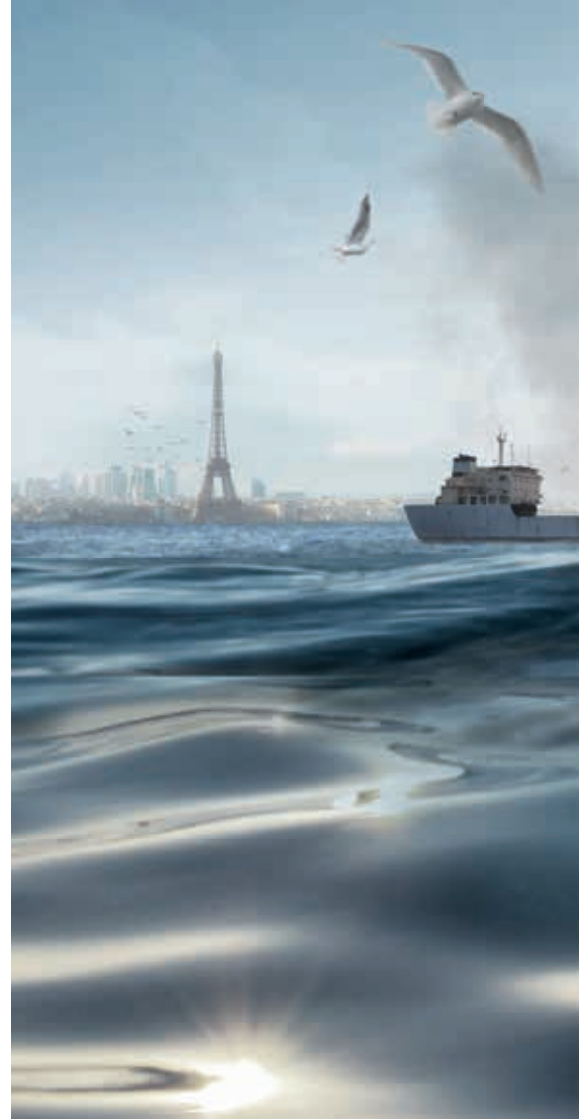
Bioenergy



Zero emission  
transport

SINTEF Energy Research acts as host institute for three Centres for Environmentally-Friendly Energy Research (FMEs)

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## NCCS

The main objective of the NCCS is to apply industry- and research-driven innovation to bring about the rapid implementation of carbon capture, transport and storage (CCS). The NCCS shall also ensure that Norway remains a global leader in the field of CCS and contributes to achieving the large-scale storage of CO<sub>2</sub> in North Sea reservoirs. Read more about the centre and its achievements in 2018 here

[www.sintef.no/nccs2018](http://www.sintef.no/nccs2018)

## HighEFF

HighEFF aims to develop know-how and technology that will promote more energy-efficient, competitive and environmentally-friendly industrial processes at equipment, factory and regional scales. Read more about the centre and its achievements in 2018 here:

[www.sintef.no/higheff2018](http://www.sintef.no/higheff2018)



 HighEFF

÷ 10 %

Greenhouse gas emissions

÷ 30 %

Specific energy consumption



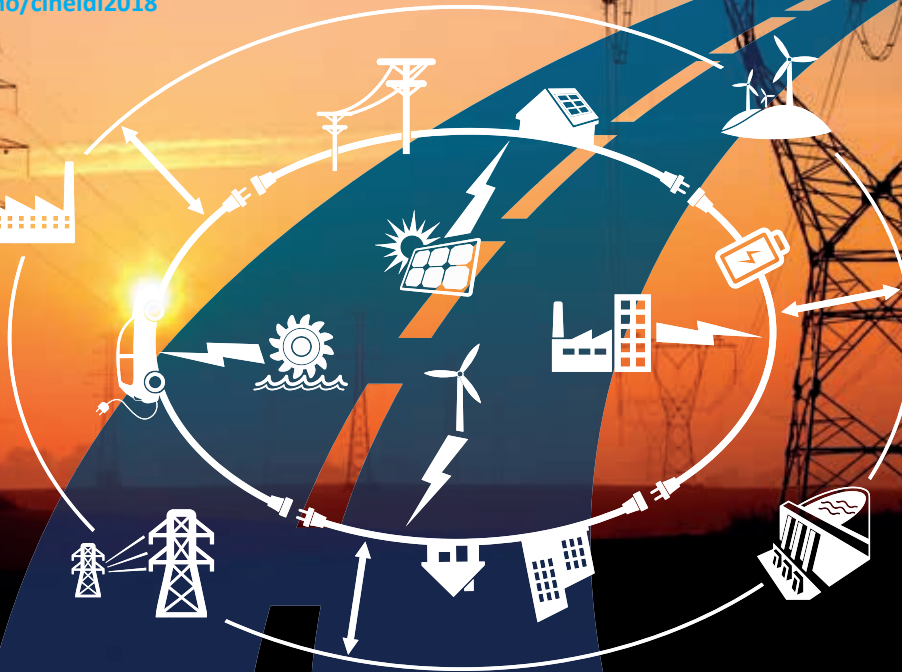
Increased value creation



## CINELDI

Research carried out at CINELDI into tomorrow's smart energy systems will, among other things, facilitate the introduction of more energy from renewable sources into the electricity grid, the electrification of transport, and the more efficient use of energy both in private households and by industry. Read more about the centre and its achievements in 2018 here:

[www.sintef.no/cineldi2018](http://www.sintef.no/cineldi2018)



# Summer researchers in 2018

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In 2018, for the twelfth year in succession, we welcomed researchers to work at SINTEF during the summer. This was a new record year with as many as 37 young scientists selected from 330 applicants.

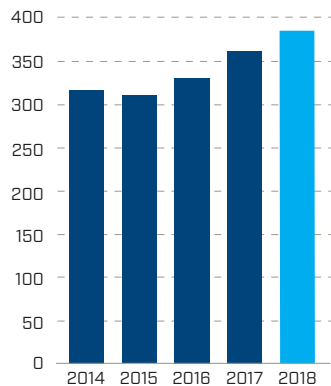


# Key figures 2018

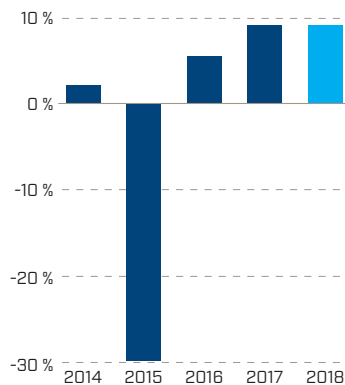
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## Net operating income (MNOK)



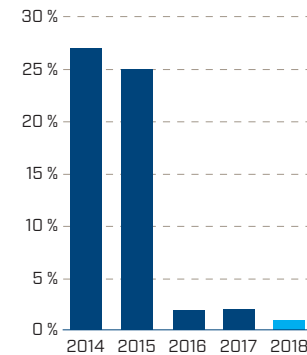
## Net operating margin [%]



\* Operating margin inclusive of a one-off expenditure item of NOK 79 million in connection with the change-over to the new pension scheme.

## Investments

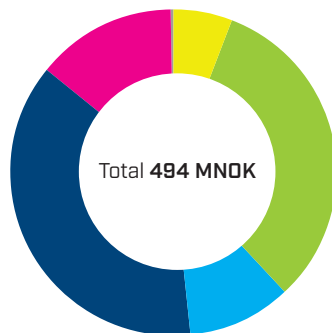
Scientific equipment and buildings  
[% of net operating income]



SINTEF Energi has partly funded EIPower Lab (to be finished in 2020) and HighEFF Lab (to be finished in 2022) through own contributions.

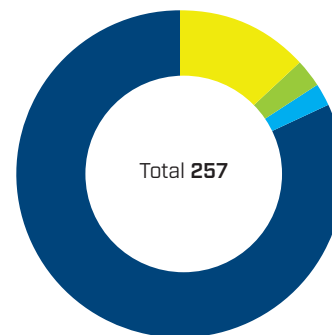
## Sources of finance

[% of gross operating income]



RCN basic grant	5,9 %
TCN project support	32,2 %
Public support	10,5 %
Business and industry	37,4 %
International contracts	13,8 %
Other	0,2 %

## Employees



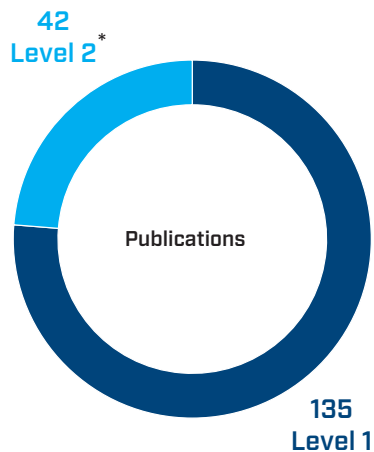
Administration	34
Technical personnel	7
Engineers	6
Researchers	210*

\*of whom 120 hold doctorates

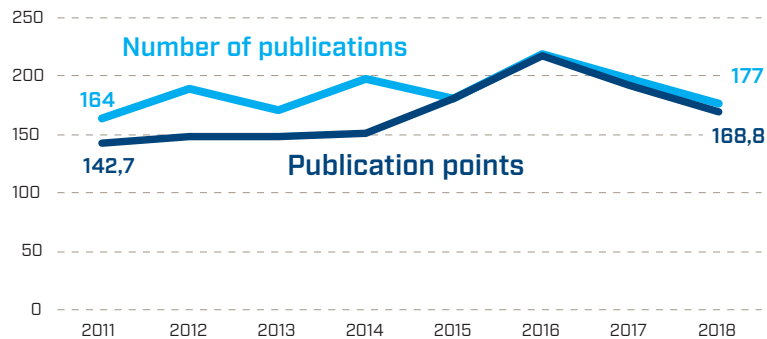
## Key financial figures

MNOK	2014	2015	2016	2017	2018
<b>Result</b>					
Gross operating income	399	397	439	438	494
Net operating income	316	310	331	362	385
<b>Operating result</b>	<b>7</b>	<b>(92)</b>	<b>18</b>	<b>33</b>	<b>35</b>
<b>Annual result</b>	<b>13</b>	<b>(63)</b>	<b>14</b>	<b>28</b>	<b>28</b>
<b>Balance</b>					
Fixed assets	219	252	237	221	210
Current assets	404	292	288	384	408
<b>Sum assets</b>	<b>623</b>	<b>544</b>	<b>524</b>	<b>605</b>	<b>618</b>
Equity capital	406	325	339	368	396
Liabilities	217	219	185	237	222
<b>Sum equity and liabilities</b>	<b>623</b>	<b>544</b>	<b>524</b>	<b>605</b>	<b>618</b>
<b>Profitability</b>					
Operating margin %	2,1 %	-29,7 %	5,4 %	9,1 %	9,1 %
Total profitability %	5,0 %	-13,9 %	4,6 %	7,0 %	6,5 %
Profitability of equity capital %	6,9 %	-23,2 %	6,1 %	10,6 %	10,0 %
<b>Liquidity</b>					
Net cash flow from operational activities	-32	49	33	98	14
Degree of liquidity	1,9	1,3	1,6	1,6	1,8
<b>Solidity</b>					
Equity capital in %	65,2 %	59,7 %	64,7 %	60,8 %	64,1 %
Operating working capital	189	74	104	148	187

# Research and dissemination



\* The Norwegian scientific index divides journals and publishers into "level 1" and "level 2", where level 2 is reserved for the internationally most prestigious journals. Only 20 % at most are on level 2 nationally.





## A selection of scientific articles published in 2018

*Sevault, Alexis; Banasiak, Krzysztof; Bakken, Jørn; Hafner, Armin.*

### **A novel PCM accumulator for refrigerated display cabinet: design and CFD simulations.**

*I: 12th IIR/IIF International Conference on Phase-Change Materials and Slurries for Refrigeration and Air Conditioning - PCM 2018 : book of proceedings. International Institute of Refrigeration 2018  
ISBN 978-2-36215-025-8. s. 43-49*

In the future, Phase Change Materials (PCM) may help to change many

aspects of our lives. They can be used to store thermal energy in the form of heat or cold for a given period. The article above addresses the integration of PCM-based cold accumulators in refrigerated cabinets used in supermarkets. The cooling units in such cabinets are turned off many times a day in order to prevent ice formation in the heat exchangers, or evaporators, that cool the circulating air. These periods without cooling are called defrosting cycles. The PCM unit will store cold when demand is low and can provide free cooling when the standard refrigeration system is turned off for defrosting (in order to prevent ice formation in the system), or if there is an electrical power outage. Free cooling of this type can also be provided at night when the cabinet doors are closed for several hours. Initial results are promising, so work

is now being carried out to refine the design and conduct experiments to test the concept.

*Aasen, Ailo; Blokhuis, Edgar M.; Wilhelmsen, Øivind.*

### **Tolman lengths and rigidity constants of multicomponent fluids: Fundamental theory and numerical examples.**

*Journal of Chemical Physics 2018 ;Volum 148:204702.(20) s. 1-17*

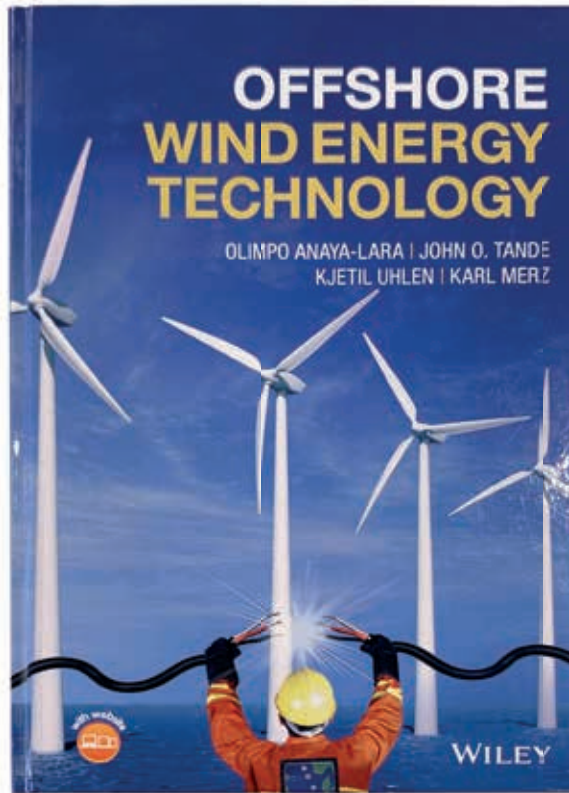
Institute Ph.D Ailo Aasen has, together with Øivind Wilhelmsen and research partner Edgar M. Blokhuis from the University of Leiden in the Netherlands, succeeded in publishing an article in the prestigious Journal of Chemical Physics. The article has been very well received. So well indeed that it has been included in the journal's prestigious collection of articles



known as “Editors Choice”. The article sets out and explains the basic theory of how the surface tension of droplets and bubbles in mixtures depends on surface curvature.

*Anaya-Lara, Olimpo; Tande, John Olav Giæver; Uhlen, Kjetil; Merz, Karl Otto.*  
**Offshore Wind energy technology.**  
*John Wiley & Sons 2018*  
*(ISBN 978-1-119-09779-2) 456 s.*

The textbook “Offshore Wind Energy Technology” was published by Wiley in April 2018. It is a comprehensive work written for students and scientists working in the field of offshore wind. It is based on research results generated by the NOWITECH CEER (Centre for Environment-Friendly Energy Research), and contains the latest developments in the field of offshore wind technology.



# Research and dissemination

The Research Council of Norway's 2018 prize for young and outstanding researchers was awarded to Øivind Wilhelmsen from SINTEF Energy Research. Øivind Wilhelmsen is a research scientist at SINTEF and adjunct professor at NTNU. He was awarded the prize for young and outstanding researchers in the fields of mathematics, natural sciences and technology in recognition of his exceptional research into thermodynamics and hydrogen technology.

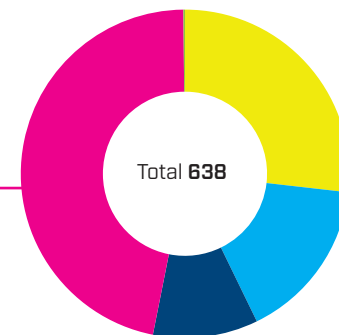
“Wilhelmsen’s research has resulted in new and original ideas and has contributed to a fresh and greater understanding of nanoscale bubble and droplet formation. The research work has great application potential

in the fields of materials technology and biological systems”, wrote the jury in its citation.





**Publications**  
(including popular dissemination)



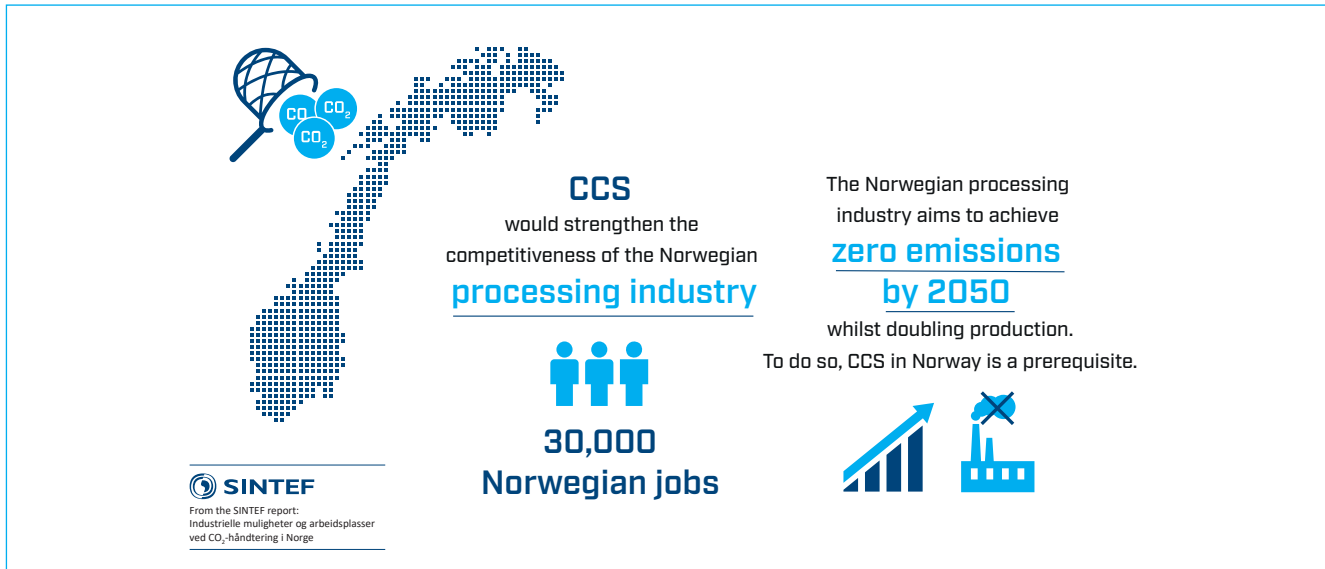
Category	Count
Academic articles in journals, series or anthologies	171
Academic lectures and poster	102
Reports	66
Popular articles and talks	298
Books	1

## CCS report

In April a report was published presenting the opportunities that will emerge on completion of a full-scale CCS project in Norway. The report was written by SINTEF and NTNU

(the latter in an advisory role) under contract to the Confederation of Norwegian Enterprise (NHO), the Norwegian Confederation of Trade Unions (LO), the United Federation of Trade Unions, the Federation of

Norwegian Industries, the Norwegian Oil and Gas Association and the trade union Industri Energi. The report has been used as a reference in several media outlets and in external feature articles.



## EIPowerLab

In 2018 our new EIPowerLab procured two new cameras worth NOK 1.2 million. With single-photon light sensitivity and nanosecond shutter speeds, these cameras can record in 3D the progression of rapid low-light phenomena such as incipient electrical flashovers. We will be using these cameras to look into new materials and fluids for the transport and production of eco-friendly energy, and to ensure that Norway remains a global leader in this field.

The cameras are funded by the Research Council of Norway's INFRA programme, and are available for use in relevant research projects.









# SINTEF Energy Research

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