



IEA Technology Collaboration Programme  
on Energy Efficient End-Use Equipment (4E)

2019  
ANNUAL REPORT

# Contents

<b>Chair’s Statement</b> .....	1
<b>Key 4E achievements in 2019</b> .....	2
<b>The Technology Collaboration Programme on Energy Efficient End-Use Equipment (4E)</b> .....	4
The world of Energy Efficient Equipment, Appliances and Lighting (EAL) .....	6
The role played by 4E .....	8
<b>Overview of 4E Structure and Activities</b> .....	10
Executive Committee .....	12
Annexes .....	14
4E Projects .....	16
Co-ordination with other organisations .....	20
<b>Annex Achievements in 2019</b> .....	22
Electric Motor Systems Annex (EMSA) .....	24
Solid State Lighting Annex (SSL) .....	26
Electronic Devices and Networks Annex (EDNA) .....	28
Power Electronic Conversion Technology Annex (PECTA) .....	30
<b>4E Outreach and Communication</b> .....	32
<b>4E Group Finances</b> .....	36
<b>Attachments: 2019 Record of Activities and delegates</b> .....	38
Attachment 1: 4E Executive Committee .....	40
Attachment 2: All 4E publications .....	42
Attachment 3: 4E workshops and presentations .....	44
Attachment 4: Electric Motor Systems (EMSA) .....	46
Attachment 5: Solid State Lighting (SSL) .....	48
Attachment 6: Electronic Devices and Networks Annex (EDNA) .....	50
Attachment 7: Power Electronics Converter Technology Annex (PECTA) .....	52
<b>About the IEA</b> .....	54
About the International Energy Agency (IEA) .....	55
IEA Technology Collaboration Programmes .....	55

# Chair’s Statement

Any summary of achievements in 2019 should start by acknowledging the International Energy Agency’s approval of 4E’s extension for a third five-year term to 2024.

Our exciting 2019-2024 strategy has been jointly developed by all 4E Members, whose continued commitment to 4E demonstrates how much they value 4E’s contribution to their local policy processes. It is extremely gratifying to see so much of 4E’s work used directly in the energy efficiency policies implemented by governments, and I look forward to seeing more examples over the forthcoming years.

4E Members particularly value the opportunity to share information and expertise amongst one another, and the addition of the European Commission and New Zealand to the 13 existing Members of 4E in 2019 will strengthen these opportunities. It is noteworthy that policies implemented by 4E Members directly impact about one-third of the world’s population.

During 2019, 4E continued to tackle a range of topical issues related to the challenges of digitalisation, capacity building and standardisation – all reflected in practical 4E projects undertaken throughout the year. Digitalisation is perhaps unique in offering both the potential for large future energy savings, as well as drivers for future increases in energy consumption. It has been very pleasing to see 4E at the forefront of global discussions in shaping the policy environment needed to ensure that the digital world is also a more energy-efficient world. The work undertaken by EDNA has been especially important in 2019, and I look forward to the additional contributions in the lighting, motors, and power electronics fields by the SSL, EMSA, and PECTA annexes, respectively.

The ability to test products accurately is the cornerstone of most energy efficiency policies implemented by 4E Members. This requires precise test procedures and laboratories with the equipment, staff, and expertise to conduct them. The international round-robin projects managed by the SSL and EMSA annexes, involving laboratories spread around the



During 2019, 4E continued to tackle a range of topical issues related to the challenges of digitalisation, capacity building and standardisation.

globe, will greatly improve the capacity of laboratories to test LEDS and motor convertors, enabling governments to implement more effective policies.

Similarly, the 4E project in 2019 to closely examine test methods for residential air conditioners amongst 4E Members has identified many opportunities for improvement. As the global consumption of air conditioners grows rapidly, such practical steps to ensure that our policies result in real energy savings are vitally important on many fronts.

Of course, these are only a few highlights from a year packed full of activities which are described in the following Annual Report. On a personal note I would like to add my thanks to all 4E Members, whose devotion of time and energy ensures the work of 4E remains focussed on the support of national policy agendas. Most notably, our sincere thanks go to Michelle Croker whose leadership has guided 4E through to its third term before she moved on to other fields in 2019.

John Cymbalsky  
Acting Chair 4E  
February 2020

# Key 4E achievements in 2019



The world must quickly implement massive energy efficiency and conservation practices and must replace fossil fuels with low-carbon renewables.

A new report by 11,258 scientists in 153 countries. Appearing in *BioScience*, Volume 70, Issue 1, January 2020.

JANUARY	<b>4E POLICY BRIEF</b> Policy Guidelines for Pumps, Fans and Compressors	MARCH	<b>4E REPORT</b> 4E 2018 Annual Report	<b>EMSA REPORT</b> Round Robin of Converter Losses (Phase 1)	<b>4E</b> Launch of PECTA	
APRIL	New Zealand joins 4E	<b>EMSA WEBINAR</b> Efficient Electric Motors and Motor Systems	<b>SSL WORKSHOP</b> Certification, Standards & Requirements of Solid State Lighting	MAY	<b>IEA REPORT</b> Tracking Clean Energy Progress 2019	
JUNE	European Commission joins 4E	<b>EDNA REPORT</b> Total Energy Model for Connected Devices	JULY	<b>EDNA REPORT</b> Bridging the Network Standby Gap between Mobile and Mains-Powered Products	AUGUST	<b>EDNA REPORT</b> Measuring Network Standby Power
SEPTEMBER	<b>EMSA CAPACITY BUILDING</b> Launch of DTI-HydraCalc	<b>EMSA PRESENTATION</b> Presentation Five papers delivered to EEMODS'19	<b>SSL CAPACITY BUILDING</b> Nucleus Laboratory Comparison Report	<b>EDNA WEBINAR</b> Key Role of Internet-Connected Devices	<b>PECTA PRESENTATION</b> Austrian IEA National event of 2019	
OCTOBER	<b>SSL WORKSHOP</b> International Research on LED Quality Metrics and New Lighting Regulations in Europe	NOVEMBER	<b>IEA REPORT</b> Energy Efficiency 2019	<b>EDNA WORKSHOP</b> Network Zero	DECEMBER	<b>EDNA NEWSLETTER</b>

# The Technology Collaboration Programme on Energy Efficient End-Use Equipment (4E)



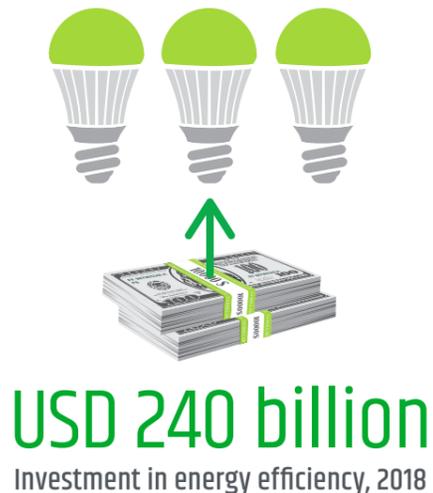
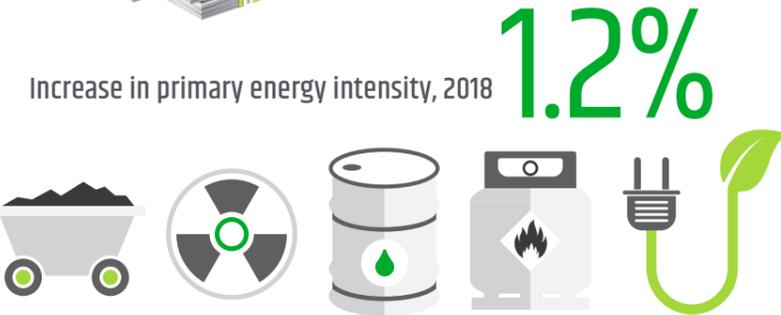
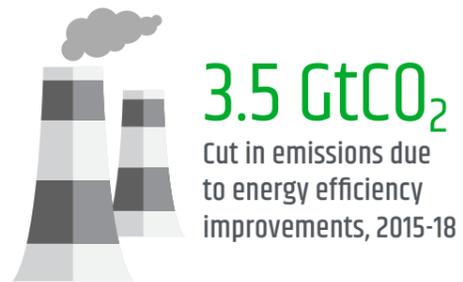
Enabling policies are crucial to strengthening energy efficiency. A combination of regulations, market-based instruments, incentives, capacity building and information provision have a proven capacity to deliver large-scale energy efficiency improvements.

IEA Energy Efficiency Market Report 2019

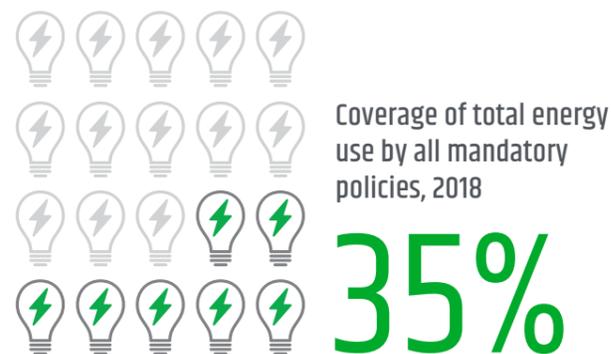
# The world of Energy Efficient Equipment, Appliances and Lighting (EAL)

Source: IEA Energy Efficiency 2019

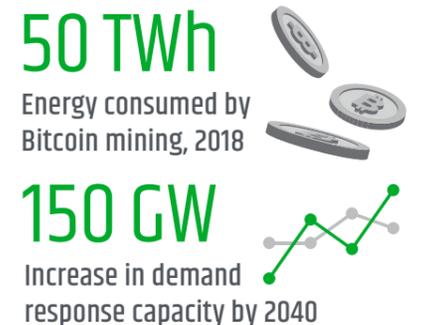
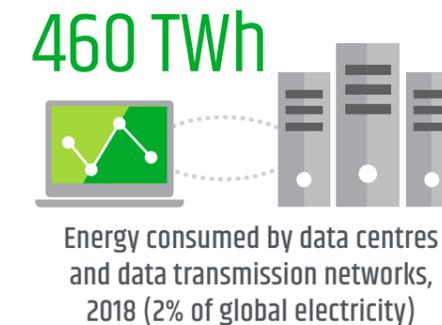
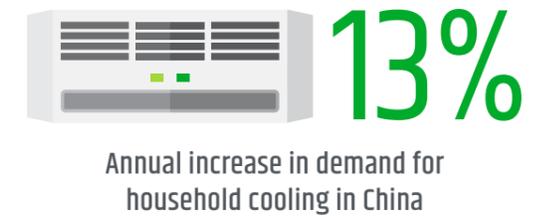
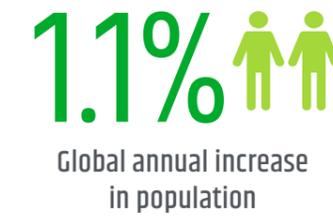
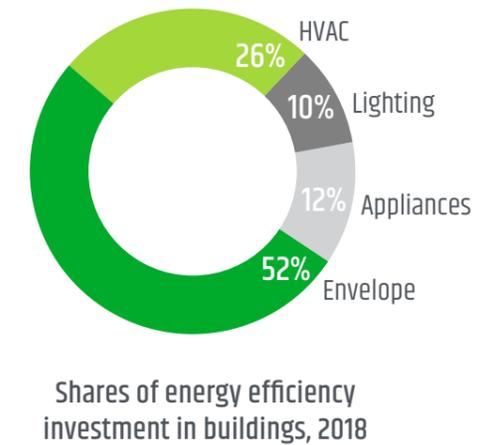
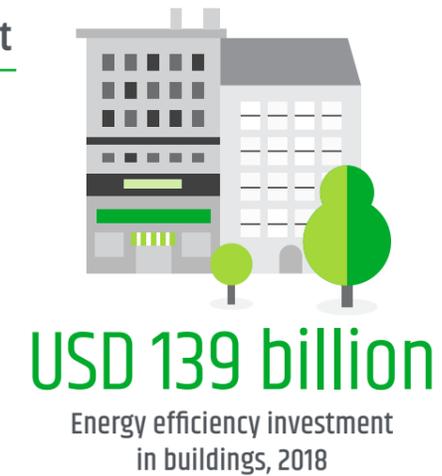
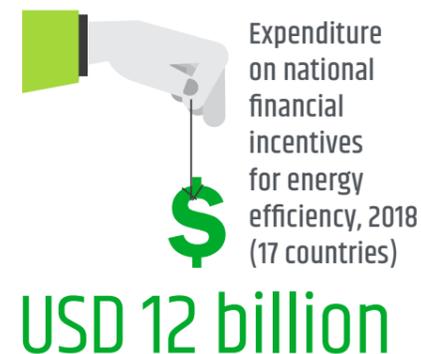
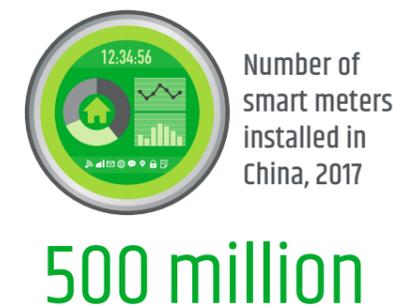
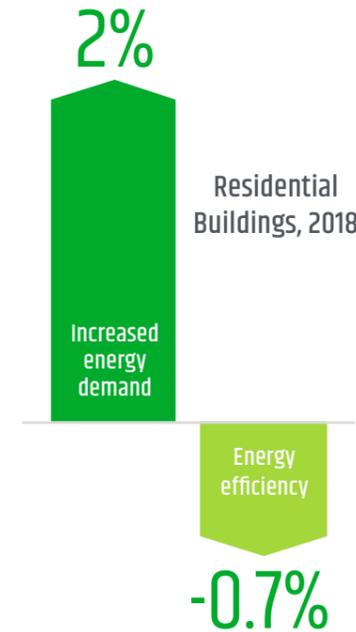
## Energy efficiency achievements



## Policies



## Appliances and Equipment



## The role played by 4E

4E aims to promote energy efficiency as the key to ensuring safe, reliable, affordable and sustainable energy systems.

As an international platform for collaboration between governments, the 4E TCP provides policy guidance to its members and other governments concerning energy using equipment and systems. The 4E TCP prioritises technologies and applications with significant energy consumption and energy saving potential within the residential, commercial and industrial sectors (not including transport).

In order to stimulate internationally accepted approaches that promote energy efficient equipment, 4E harnesses the expertise of governments, industry, experts and other TCPs to:

1. Collect data, analyse information, share expertise and pool resources.
2. Support and strengthen government policy and regulation.
3. Disseminate information to develop greater understanding and promote government actions that encourage the uptake of energy efficient equipment.

Through international collaboration, 4E enables national energy efficiency programmes to be consistently evaluated and improved so that they are ambitious, internationally aligned and effective. The 4E platform provides the means to achieve this at least cost to member governments through the pooling of resources.

4E's international comparisons of appliance performance levels are used by policy makers to set national thresholds which enable their citizens to access the best performing products, now and into the future.

The 4E platform encourages countries to quickly expand their programme coverage by leveraging off the work of other members. Similarly, sharing the learnings of different implementation and administrative approaches enables countries to better understand and copy from strengths of other programmes.

As economies increasingly seek the opportunities to meet future energy demand through the more efficient use of current energy resources, there is huge potential to learn from the experiences of others and to collectively explore some of the technological and policy challenges ahead. This is particularly evident in the field of appliances and equipment, a large proportion of which are internationally traded.



New ways of policy thinking that move beyond traditional approaches are required, particularly to maximise the potential efficiency gains from digitalisation.

IEA Energy Efficiency Market Report 2019

### 4E Executive Committee meetings, 2019



China, March 2019



Belgium, November 2019



# Overview of 4E Structure and Activities



Energy efficiency alone could enable energy sector greenhouse gas emissions to peak before 2020, achieving the energy efficiency target in the Sustainable Development Goals. Unfortunately, data from 2018 reveal that the world is veering away from this pathway.

*Dr. Fatih Birol, Executive Director, International Energy Agency*  
IEA Energy Efficiency Market Report 2019

# Executive Committee

4E is managed by an Executive Committee (ExCo) comprising one voting delegate from each participating country. Like all IEA Technology Collaboration Programmes, participation is open to all countries. The executive group meets twice yearly to manage the work programme of 4E, including the dissemination of 4E's research results. Secretariat functions for the ExCo are provided by the Operating Agent, funded by annual membership fees.

During 2019, the 4E office-bearers comprised:

- > Chair of 4E:**
  - » Michelle Croker (Australia) – retired August 2019
  - » John Cymbalsky (USA) - acting Chair from August 2019
- > Vice-chairs of 4E:**
  - » Hans-Paul Siderius (Netherlands),
  - » John Cymbalsky (USA).
  - » Katherine Delves (Canada) - retired June 2019

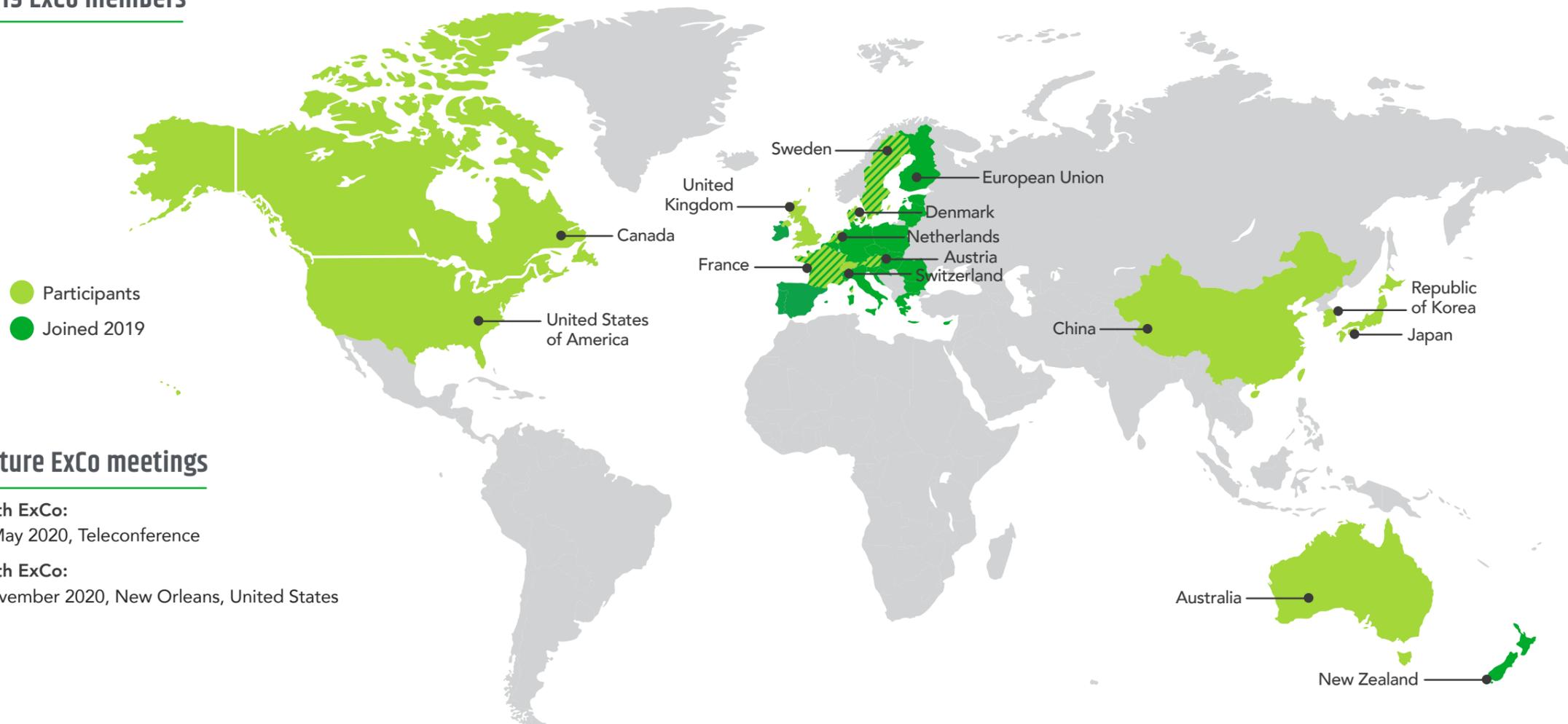
The 23rd and 24th meetings of the Executive Committee (ExCo) were held in Beijing, China (27-28 March 2019) and Brussels, Belgium (14 November 2019). Attendance at these meetings is shown in the table on the right.

During 2019, New Zealand and the European Commission join 4E, joining the 13 existing Members of 4E. A full list of the Members of the ExCo during 2019 is shown in Attachment 1.

Attendance at 2019 ExCo meetings

Contracting Party	23rd ExCo - Beijing	24th ExCo - Brussels
Australia	✓	✓
Austria	✓	✓
Canada	A	✓
China	✓	✓
Denmark	✓	✓
European Commission	Not a member	✓
France	A	A
Japan	✓	✓
Korea	✓	✓
Netherlands	✓	✓
New Zealand	Not a member	✓
Sweden	✓	✓
Switzerland	✓	✓
United Kingdom	✓	✓
United States of America	✓	✓
Observers	IEA	IEA

## 2019 ExCo members



## Future ExCo meetings

- 25th ExCo:**  
7 May 2020, Teleconference
- 26th ExCo:**  
November 2020, New Orleans, United States



## Annexes

Targeted collaborative research and development activities under 4E are undertaken within our Annexes, each of which has a particular focus and agreed work plan.

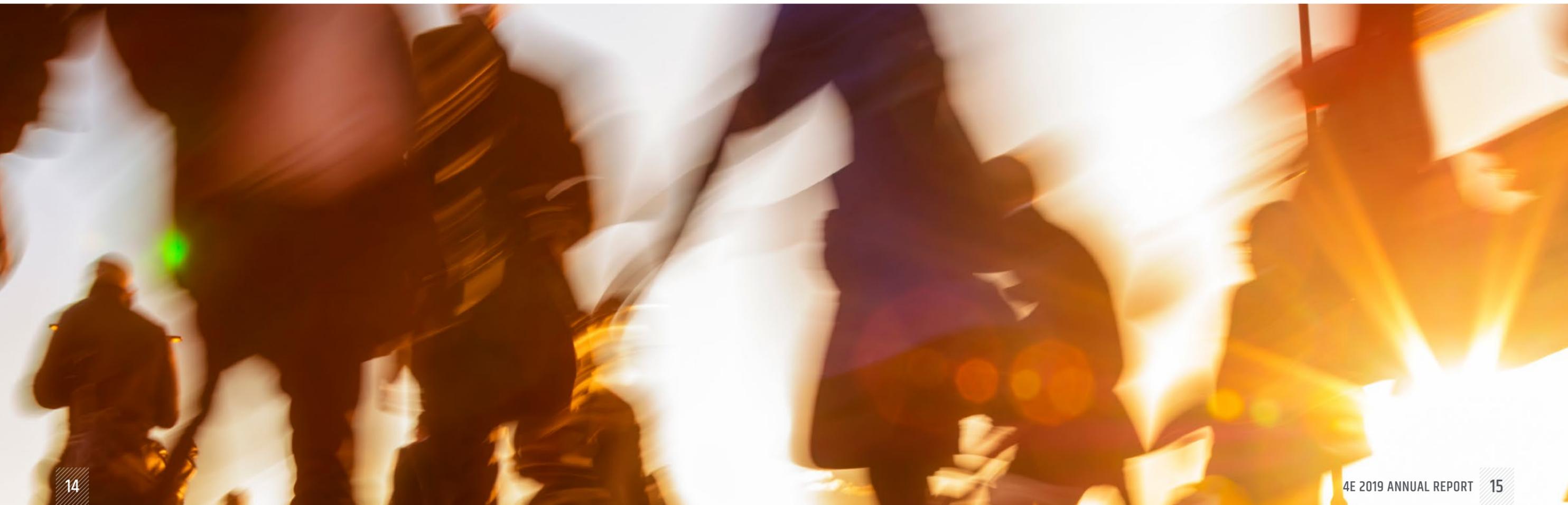
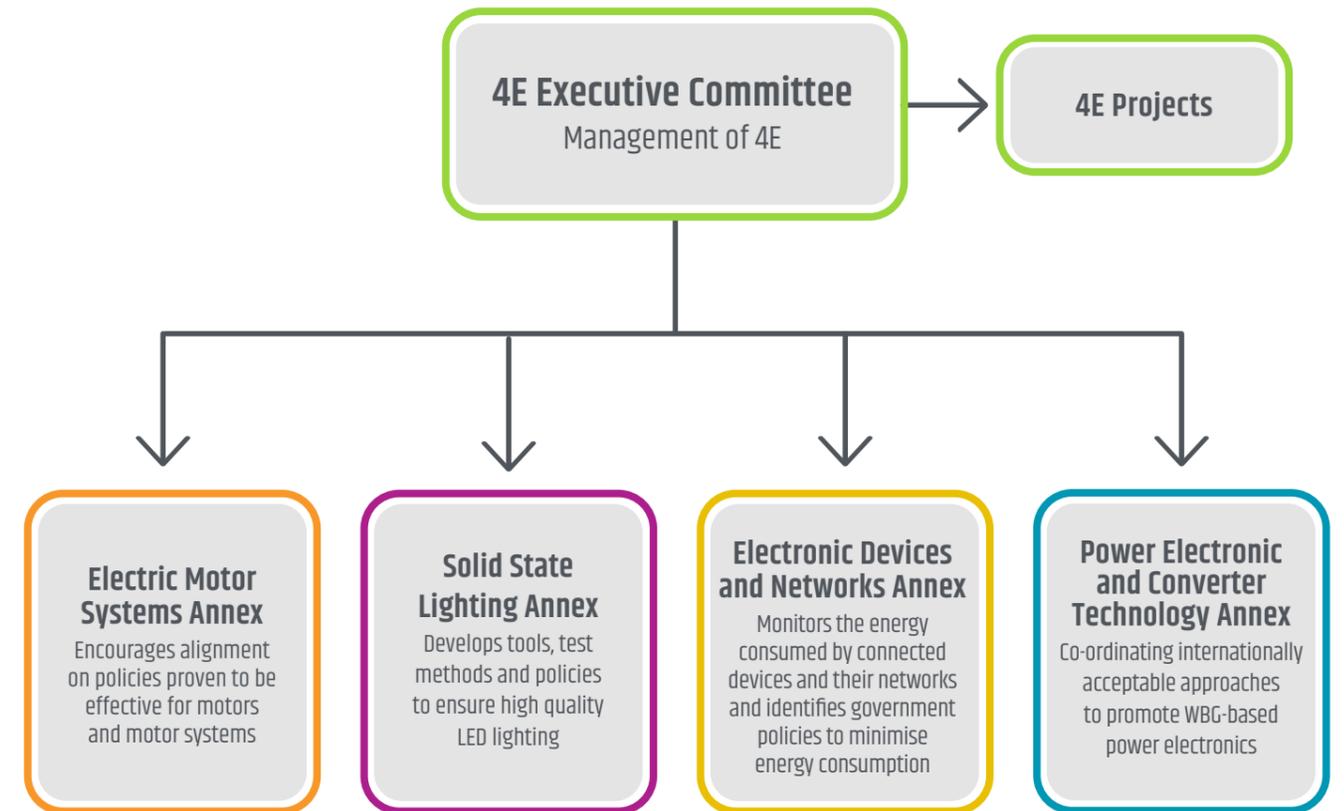
These work plans, and their respective budgets, are typically set for a three year period and are negotiated amongst the participating countries.

The 4E structure is shown alongside, and this highlights the three existing Annexes and one new Annex launched in 2019:

- **Electric Motor Systems Annex (EMSA)**, launched in October 2008 and chaired by Switzerland.
- **Solid State Lighting (SSL) Annex**, launched in June 2010 and chaired by Sweden.
- **Electronic Devices and Networks Annex (EDNA)**, launched in 2014 and chaired by the Netherlands in 2019.
- **Power electronic Conversion Technology Annex, (PECTA)**, launched in 2019 and Chaired by Sweden and then Switzerland.

Reports on all currently operating Annexes are included later in this report.

## 4E Structure



# 4E Projects

## 4E members initiate projects into topics to support policies for efficient end-use equipment.

These may be special one-off activities or potentially lead to the development of a 4E Annex or other avenues for pursuing more in-depth consideration.

### Active projects in 2019 included:

- Product Energy Efficiency Trends
- Policies for Energy Efficient Systems
- Monitoring, Verification and Enforcement
- Domestic Air Conditioner Test Standards and Harmonization
- IEA Publications

### Product Energy Efficiency Trends (PEET)

In 2019, 4E initiated a major new project to collate data on product energy efficiency trends and the potential for future technologies, as well as progress with policies and test methods for major equipment types. In addition to sourcing and analysis of data from members, the project harnesses the expertise of Annexes for their market and technology developments.

The PEET project is designed to assist 4E Members in assessing the performance improvement of products within their market compared to those in other economies, and identify future policy opportunities.

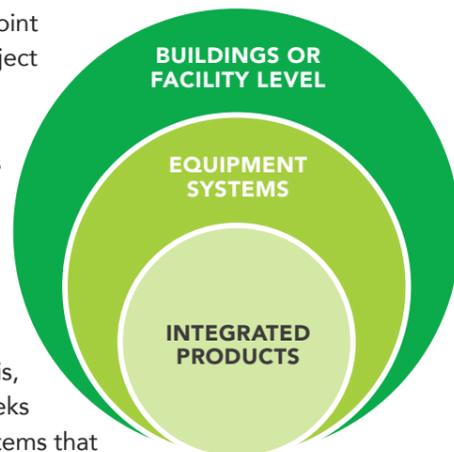
### Policies for Energy Efficient Systems

4E research into policies for energy-using systems continued during 2019 with the appointment of specialist consultants to lead the research. Building on the existing expertise within the EMSA the SSL Annex and EDNA, 4E is investigating how energy efficiency policies can be expanded beyond individual appliances and equipment to cover energy-using

systems in order to deliver greater energy savings and increased flexibility.

System policies pose many challenges, for example how can regulators accurately verify the performance of equipment that needs to be assembled on-site before it can function, and who might be legally responsible for compliance?

The starting point for this 4E project is tackling the definitions for different types of energy-systems in a manner that is appropriate for regulation. Building on this, the project seeks to identify systems that might be most suitable for the next generation of energy efficiency regulation.



### Regulators Forum on Monitoring, Verification and Enforcement (MV&E)

MV&E is a vital component of regulatory policies to ensure that expected energy efficiency gains are realised in practice. Building on the considerable experience of 4E Members and their national MV&E programmes, 4E provides a unique mechanism for regulators to raise issues of concern and share approaches to market surveillance and enforcement in confidence.

4E provides a unique forum for regulators to meet face-to-face alongside each ExCo to share information on topical issues relating to compliance and enforcement.

## Policy Domestic Air Conditioner Test Standards and Harmonization

Energy consumed by air conditioning systems has tripled since 1990: no other building end-use is growing as fast. Air conditioning not only makes up a significant and growing share of energy consumption, it is also the primary contributor to peak demand in many geographies.

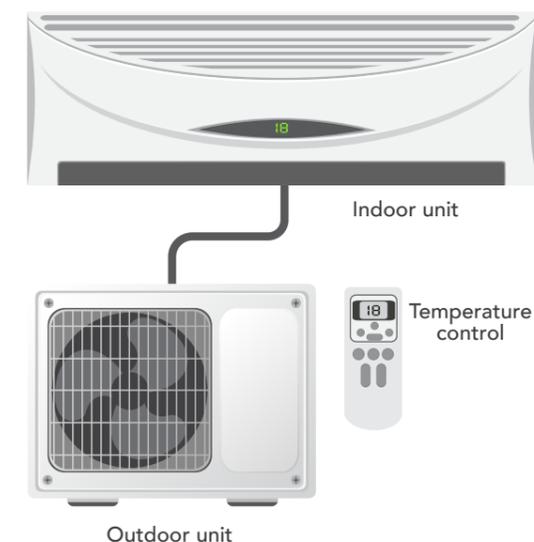
Across the globe there are numerous governing bodies that currently regulate and test air conditioners (ACs) and more than 60 countries have regulatory requirements on the energy performance. These proven, cost-effective strategies for slowing the growth of energy consumption and reducing peak demand on electrical systems around the world rely upon accurate and repeatable test procedures.

However, the test procedures and metrics established by these different countries often vary, making it difficult to compare the energy performance of ACs across jurisdictions. This can confuse consumers, provide inappropriate drivers for product developers, and increase the testing burden on manufacturers attempting to comply with many different regulatory schemes.

This 4E project undertook a detailed examination of current test procedures and metrics across its Member countries. The resulting publication identified several recommendations to improve

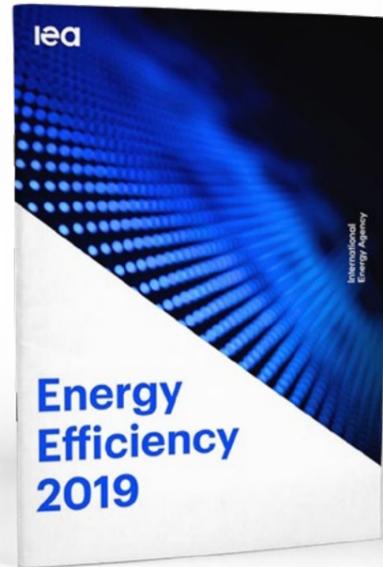
international alignment and noted the work underway in several regions to develop new methods for testing variable capacity air conditioners. The report highlighted the significant challenges for manufacturers and regulators in accurately testing these products and indicated the role of international round robin testing as a means to better understand and align any differences in these test methods.

4E will publish the report early in 2020, when it will also hold a workshop/webinar to discuss the findings.



In setting and applying MEPS, policy makers need to take into consideration the actual energy efficiency of ACs on the market and use accurate energy performance measurement standards, protocols and testing procedures.

IEA The Future of Cooling, 2018



In 2018, mandatory policy coverage increased in line with recent trends but over 95% of the growth in coverage was due to existing policies. The strength of mandatory policies increased by over 0.4%. Although this increase was slightly higher than in the previous two years, it was still below the five-year historical average, indicating more can be done to ensure mandatory policies are effective. There was also little change in the coverage and strength of energy efficiency obligation programmes, the main market-based instrument tracked by the IEA.

IEA Energy Efficiency 2019

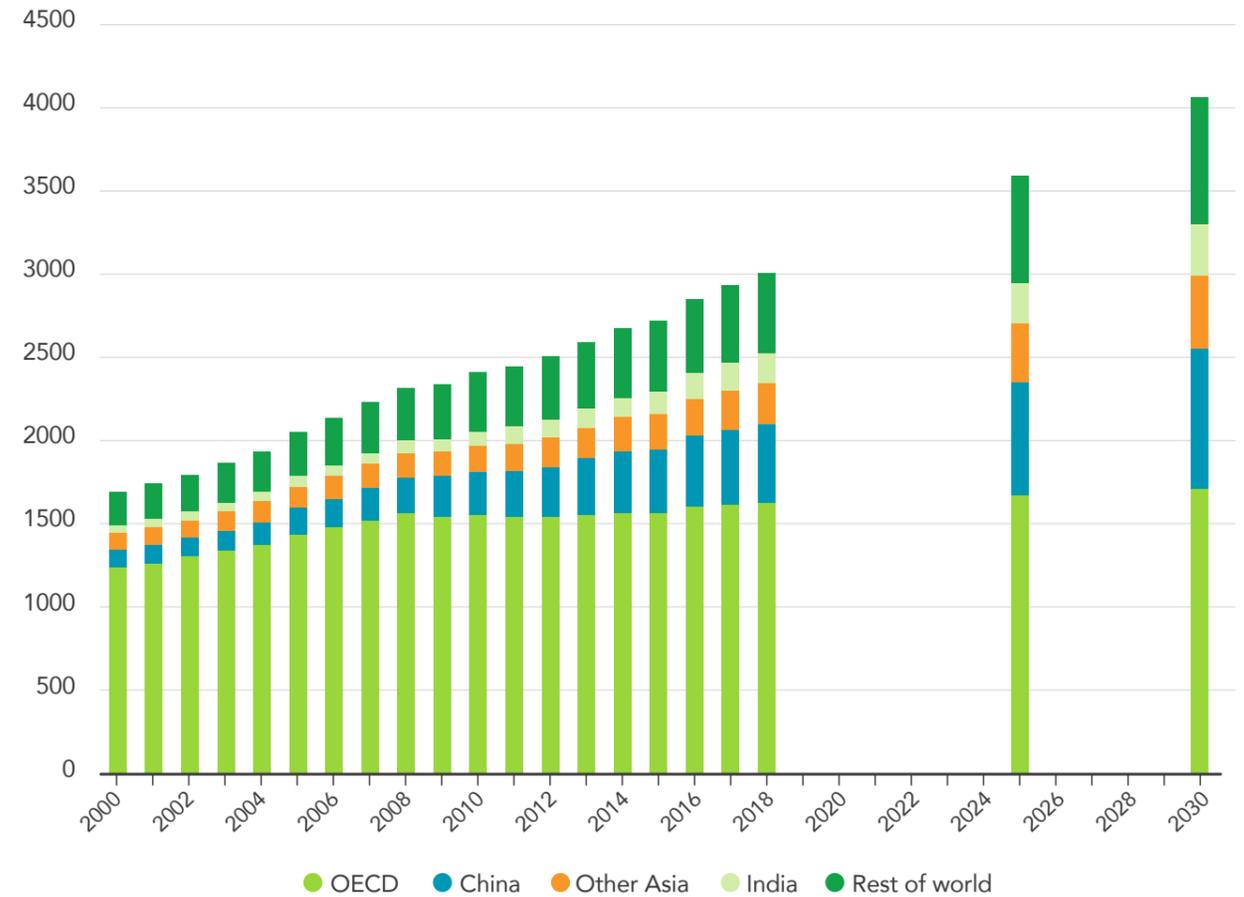
## IEA Publications

4E works closely with the IEA on topics of common interest, and provides expert input to many reports, including combining on joint publications and events. This gives high level visibility to much of 4E's research work. Some examples of this collaboration are shown below.

4E makes a significant contribution to the Appliance & Equipment sections of the *Energy Efficiency Market Report*, the IEA's flagship publication on energy efficiency, including in 2019. This quantifies the latest trends, tracks global progress, and examines key drivers and market issues.

4E EDNA presented the third in a series of IEA Webinars on Digitalisation and Energy in September 2019. Titled: *'The Key Role of Internet-Connected Devices'*, the talk explained how connecting everyday, internet-connected devices can have profound implications for energy use. Connected devices can participate in new kinds of digital ecosystems: systems of connected devices can be managed intelligently to save energy, within a building or even within a city. Within an electricity grid, connected devices can be controlled to match the variable loads generated by renewables. However, good policy is required to derive the best outcomes, and to ensure that the "energy cost" of connectivity is minimised.

4E also made substantial contributions to *'Tracking Clean Energy Progress'*, published in May 2019. The IEA's *Tracking Clean Energy Progress* (TCEP) reports assess the status of 45 critical energy technologies and sectors and provides recommendations on how they can get 'on track' with the Sustainable Development Scenario (SDS). The SDS offers a pathway for the global energy system to reach three strategic goals: the Paris Agreement's well below 2°C climate goal, universal energy access and substantially reducing air pollution.



Consumption by household appliances and plug loads by region in the Sustainable Development Scenario, 2000-2030 by IEA



Growth in energy use by household appliances shows no signs of decelerating, having reached more than 3,000 TWh in 2018, or nearly 15% of global final electricity demand. Only one-third of appliance energy use today is covered by mandatory performance standards, and coverage is poor in markets that are expected to grow rapidly in the next decade.

Consumer electronics, connected devices and other small plug-loads, which are proliferating rapidly, continue to be unregulated in most countries. Expanded policy coverage and increased stringency are needed in all countries to get on track with the SDS.

IEA Tracking Clean Energy Progress, May 2019

IEA (2019), "Tracking Buildings", IEA, Paris available [here](#)

## Co-ordination with other organisations

As one of 40 Technology Collaboration Programmes established under the framework of the International Energy Agency (IEA), 4E has a particularly close relationship with the IEA Secretariat and provides expert input to many IEA publications on end-use energy efficiency.

4E also provides regular progress reports to IEA member governments and liaises with other Technology Collaboration Programmes. The IEA's Energy Efficiency Division provides a report to each 4E ExCo meeting, and is often represented at these meetings.

As the Secretariat for the G20 Networked Devices Task Force, 4E worked with the International Partnership on Energy Efficiency Co-operation (IPEEC) and the Clean Energy Ministerial (CEM) in 2019. Under this initiative, 4E continued to fund the Connected Devices Alliance (CDA) through the support of EDNA. Led by the United Kingdom, the IEA, Canada and The Netherlands, the CDA provides a unique forum for dialogue between industry and government representatives on an issue that is rapidly gaining global significance.

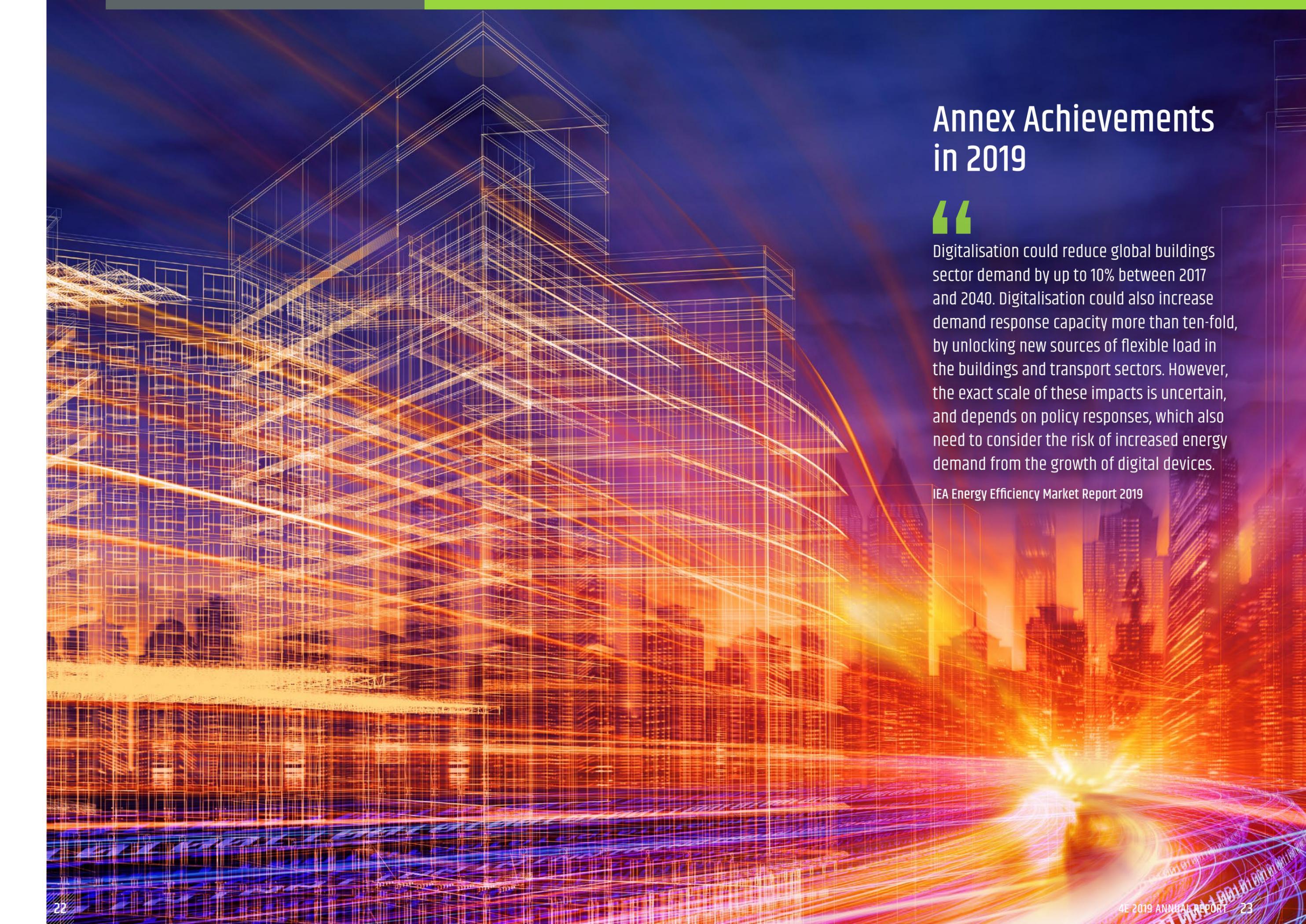
In addition, 4E regularly liaises with a range of public and private sector groups with an interest in end-use energy efficiency, including SEAD, APEC, the World Bank, the World Economic Forum, Sustainable Energy for All, international standards organisations and industry groups. Recognising the unique contribution that each is playing in the development of public policy, 4E continues to engage these organisations to promote a better understanding of issues relating to the efficiency of end-use equipment.

To gain input from relevant industry sectors to 4E's work, we run regular workshops and meetings in most regions. Depending on the topic, we may also seek industry comments on our published materials or conduct formal consultation processes.



The greenest watt is the one that doesn't have to be produced.





## Annex Achievements in 2019



Digitalisation could reduce global buildings sector demand by up to 10% between 2017 and 2040. Digitalisation could also increase demand response capacity more than ten-fold, by unlocking new sources of flexible load in the buildings and transport sectors. However, the exact scale of these impacts is uncertain, and depends on policy responses, which also need to consider the risk of increased energy demand from the growth of digital devices.

IEA Energy Efficiency Market Report 2019

# Electric Motor Systems Annex (EMSA)

The 4E Electric Motor Systems Annex (EMSA) promotes opportunities for energy efficiency in motor systems by disseminating best practice information worldwide.

It supports the development of internationally aligned technical standards and the implementation of national policies to improve the energy performance of new and existing motor systems.

EMSA provides a platform for in-depth technical and policy exchange between members and is a vehicle for collaborative projects.

In 2019, EMSA has contributed to gaining more scientific evidence about Variable Frequency Drives and their energy performance through the international Round Robin. This work will inform

the relevant standards development process by the International Electrotechnical Commission (IEC).

In 2019 the IEC ACEE CAISEMS project (Coordination and Alignment of Standards for Energy Efficient Electric Motor Driven Systems) kicked off with active participation by EMSA, which aims to connect the different elements of a motor system, including their standardisation by ISO and IEC.

EMSA's work currently focuses on international standards, digitalisation of motor systems and the dissemination of the EMSA tools (Motor Systems Tool, DTI-Hydracalc).



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## Major Achievements During 2019

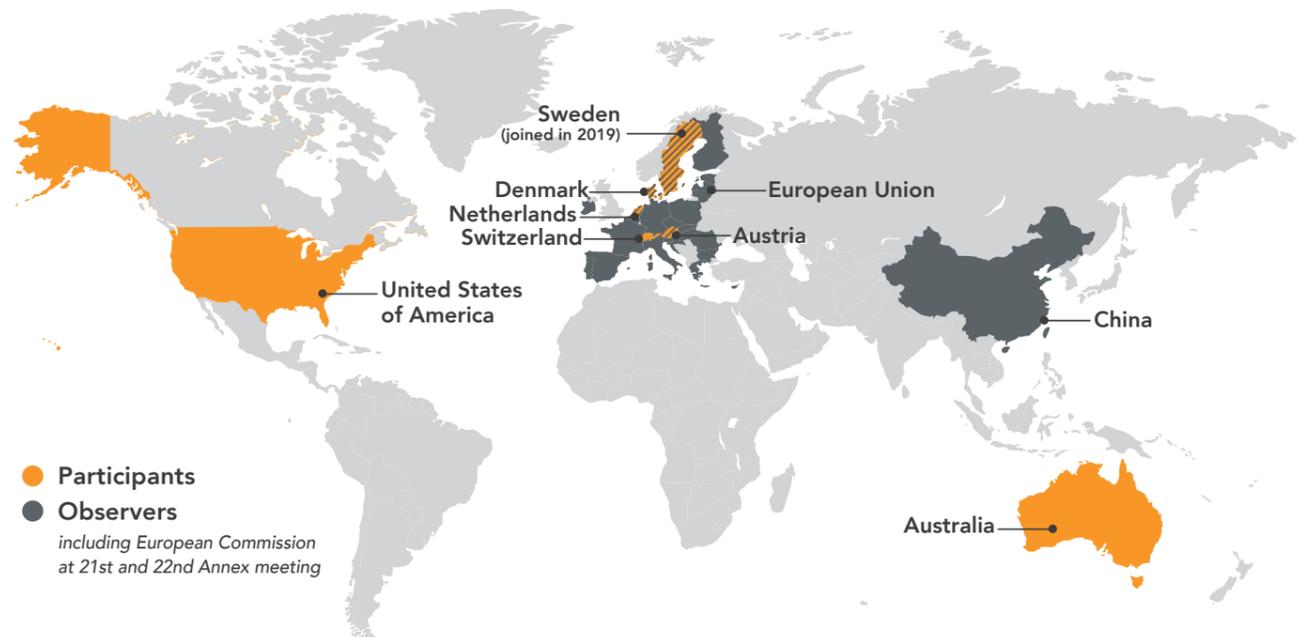
- EMSA welcomed Sweden as new member in the group. A joint group was formed by Austria, Netherlands and Sweden to work on the topic of digitalization and energy efficient motor systems in industry within EMSA.
- Phase 1 of the international Round Robin testing program for converters losses, launched by EMSA in cooperation with IEC, was concluded and the report published. Currently phase 2 is ongoing with the participation of 10 test labs worldwide. The goal of this Round Robin is to inform the revision of IEC 61800-9-2.
- EMSA actively contributed to starting the IEC ACEE CAISEMS project: Coordination and Alignment of Standards for Energy Efficient Electric Motor Driven Systems. The goal is to coordinate and align efficiency classification and testing standards for Motor Driven Systems between IEC and ISO to lower market barriers for energy efficiency.
- The independent DTI-Hydracalc Tool was published, which is the latest addition to the family of (motor systems) tools by EMSA. It evaluates all possible control strategies for a cyclic hydraulic installation

and calculates the best solution in terms of motor & pump sizing for the best efficiency possible.

- EMSA members stimulated the global debate of policy makers, standards developers, research, academia and industry concerning the efficiency of electric motor systems and possible market transformation avenues at the international conference on Energy Efficiency in Motor Driven Systems (EEMODS) on 17-19 September 2019 in Tokyo Japan, with a number of presentations.



## Annex Participants



A complete record of EMSA Annex activities in 2019 and participants is included in Attachment 4.

# Solid State Lighting (SSL) Annex

In February 2019, the Solid-State Lighting (SSL) Annex’s Management Committee adopted its new workplan and initiated its third term, planned to run from 2019 to 2024.

Now in our tenth year, the SSL Annex Member governments continue to actively engage with each other and exchange research and analysis to support SSL policies and programmes. The new workplan sets out an ambitious agenda which spans four critical areas of cooperation:

- I. **SSL product quality and performance;**
- II. **SSL testing, metrics and standards;**
- III. **Public health, productivity and environmental impacts; and**
- IV. **Smart lighting, digitisation and connectivity.**

These areas were selected following a careful review of the policy framework surrounding activities on lighting as well identifying the gaps that needed to be addressed. The strength of the Annex is its ability to cover all key areas related to member governments’ duties in relation to SSL technologies: regulation, advice and market enforcement. The body of work is carried out by member countries in-kind contributions through researchers, analysts and lab capacity. In addition, part of the work is contracted to experts where gaps exist in Annex expertise.

One of these gaps was the lack of peer-reviewed public literature on the threshold values associated with people’s perception of temporal light modulation – commonly known as ‘flicker’, but also other health aspects are also of importance. The Annex is not focusing on health aspects of lighting per se, but when assessing and recommending performance parameters on energy efficiency, it is important that health and quality-of-light aspects are not compromised in order to secure user acceptance.

Testing continues to be important and the SSL Annex also continued our work conducting the world’s largest interlaboratory comparison for goniophotometers, including over 40 instruments from all over the globe. The final report and recommendations for the standardisation community are expected in 2020. A new interlaboratory comparison of methods to test light modulation is now being planned.

The performance of products remains important, and the publication of updated performance tiers is expected in 2020. To support this work, the SSL Annex continues the development of a robust, secure lighting product database for member governments only.



LEFT: 19th SSL Annex Experts Meeting, Copenhagen, Denmark, October 2019. RIGHT: Participants in public workshop organised by DTU Denmark supported by the SSL Annex, Roskilde, Denmark, October 2019.

## Major Achievements During 2019

In 2019, the SSL Annex had some major milestones and achievements which derived directly from the strength of cooperation between the member governments of the SSL Annex:

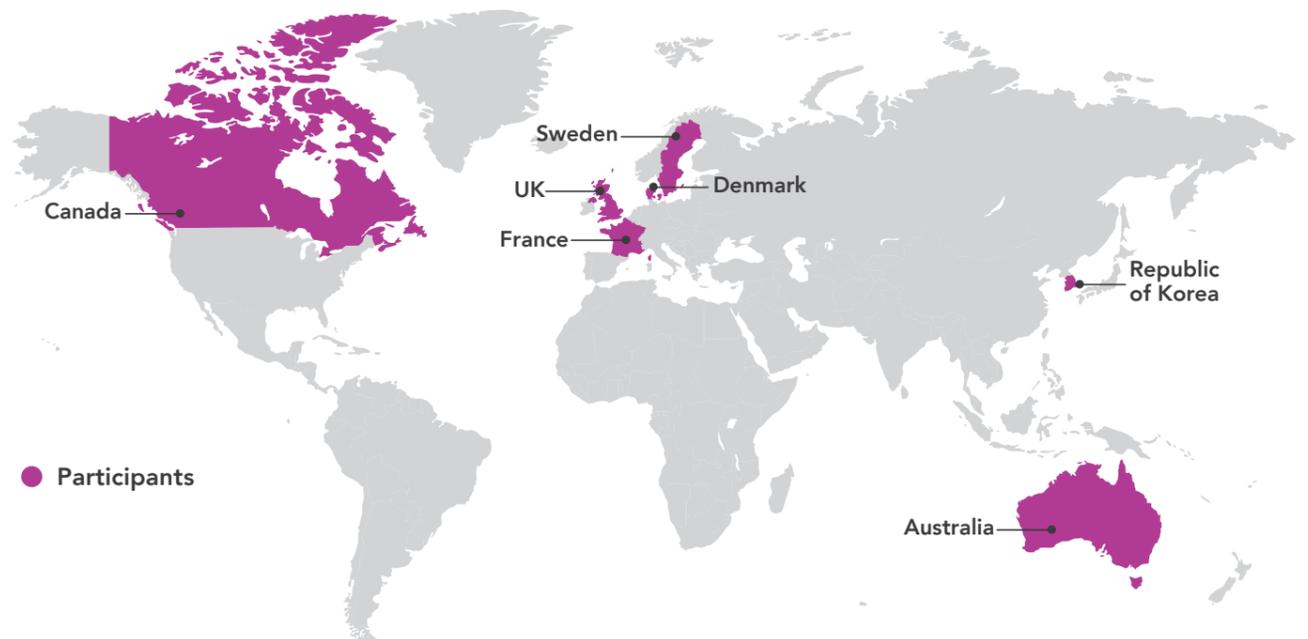
➤ **Stroboscopic Visibility Measure (SVM) Detection Study** – this lighting and health study was jointly conducted by researchers in Canada and France, aiming to address an important gap in the literature on the measurement of levels of Temporal Light Modulation (TLM) of light emitting diode (LED) light sources that may affect human health and productivity. This study tests the visibility of the stroboscopic effect for five levels of SVM using an experimental method similar to the previous research from which the metric was developed. The work was initiated in late 2018 with an interim report provided to the Annex. A peer-reviewed journal article was submitted by the researchers and a final report prepared. The journal article was published in mid-February 2020 and the final report is scheduled to be published in early March 2020. The work was funded by the SSL Annex’s common fund as well as through additional contributions from Australia, Canada, Denmark, France, Sweden and UK.

➤ **New Lifetime Test Method Adopted in Europe** – several SSL Annex governments, including Australia, Denmark, Sweden and the UK – worked together to design and trial a lifetime test method for SSL products that combines switching cycles and lumen maintenance. This new test was found to be effective in differentiating between good and poor quality lighting products, and was adopted by the European Commission as its lifetime test method for all LED lighting products on 5 December 2019.

➤ **Two technical seminars organised** – the SSL Annex held one-day technical seminars in 2019, one in Seoul, South Korea and one in Roskilde, Denmark. These two events had several SSL Annex Experts speaking, providing updates on current research and findings, as well as topical research and policy issues. Meetings were very well attended in both countries and all slides were made public on our website.



## Annex Participants



A complete record of SSL Annex activities in 2019 and participants is included in Attachment 5.

# The Electronic Devices and Networks Annex (EDNA)

The EDNA Annex continues to fulfil an important role for energy efficiency policy makers – at the nexus between energy-using devices and systems.

EDNA is focused on devices connected to the internet, as well as the systems in which they operate, such as a buildings, electricity networks and ICT systems.

Connecting devices to the internet increases energy use. The device itself can waste considerable energy when in “network standby” mode – maintaining communications but not providing any primary functions. Device communications can also increase energy use “upstream” from the device – in routers, mobile telephone or fixed access networks, and in the internet itself including data centres.

Under the right circumstances, connected devices can assist in the digitalisation of the energy system. By virtue of their connectivity, they can create new ways to save energy and support the deployment of renewables. However, not all connected devices are “smart” and not all smart devices can save

energy. A smart, energy-saving device is able to act independently in order to achieve one or more of the following:

- Operate more efficiently, by responding to changing conditions in the environment (also known as “intelligent efficiency”).
- Provide demand flexibility, by responding to signals from the grid to decrease or increase activity depending on the availability of energy supply.
- Provide operational information such as alerts for fault conditions and maintenance intervals.

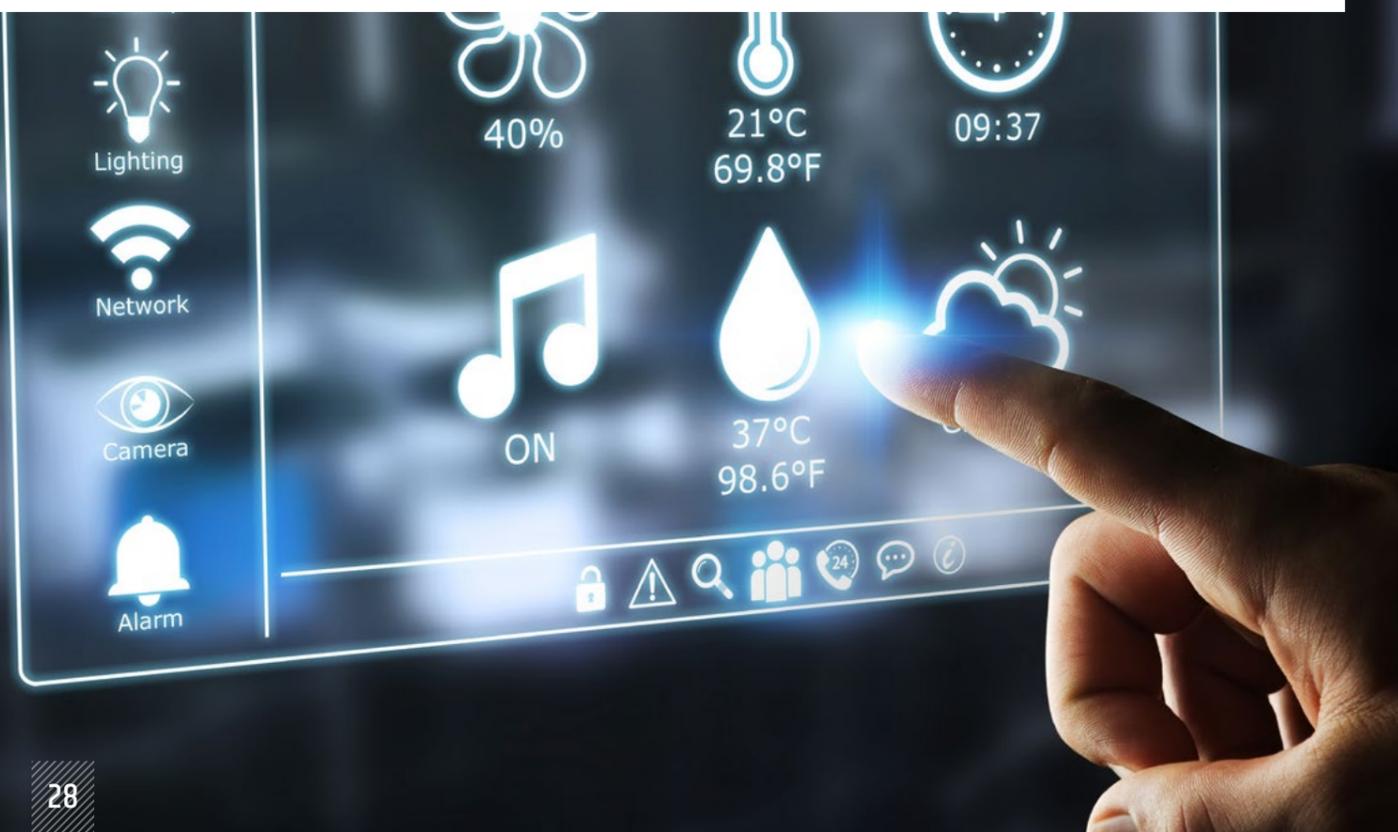
In all of the areas mentioned above, EDNA works with international bodies to support policy development aimed at reducing wasted energy both within the device and upstream, and to ensure that devices achieve their potential in digitalising the energy system.

## Major Achievements During 2019

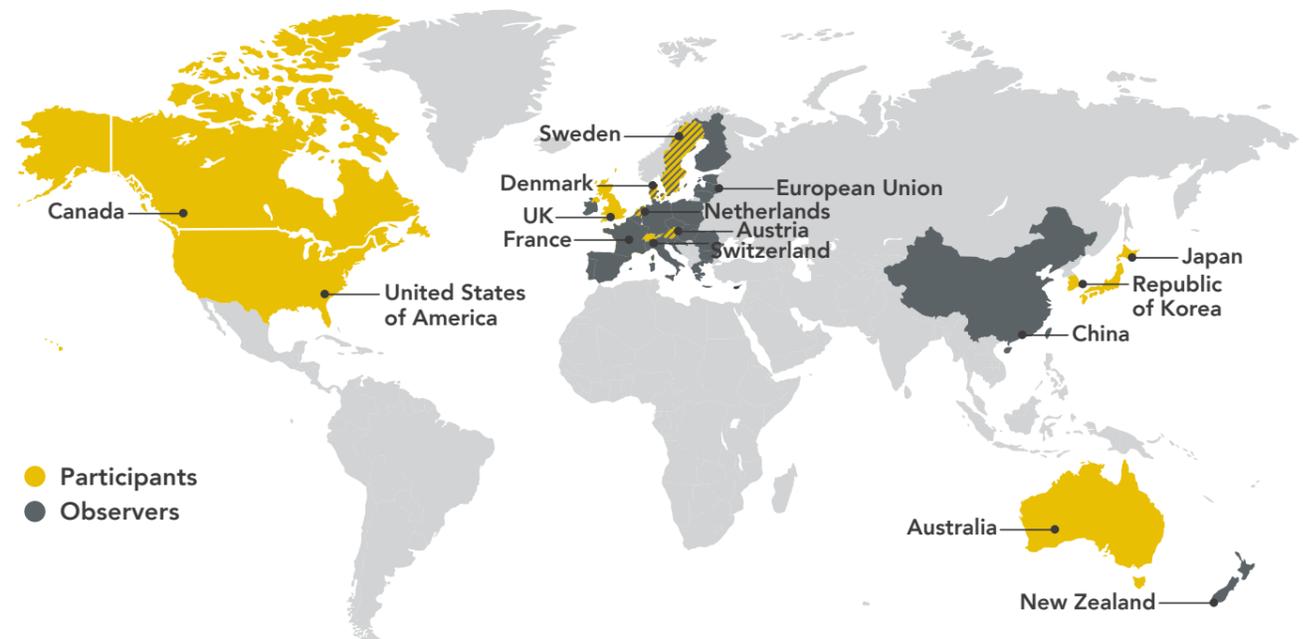
- In 2019 EDNA published 4 research reports in the areas of device wasted energy. These covered test procedures for network standby, the energy used for wireless charging of devices, an evaluation of how devices might use zero energy for network standby, and an examination of the techniques used by battery-powered mobile devices to conserve network standby energy and how these practices might be adopted in mains-powered devices.
- Two research reports were published related to upstream energy consequences. The first report covered the results from the EDNA Total Energy Model, which models the global energy used by connected devices and the energy consequences upstream - in local area and wide area networks and in data centres. The second report was an assessment of the intelligent techniques that can be used to reduce upstream energy use.
- In 2019 EDNA also launched a number of new research tasks - on “smart ready” and “demand-flexible” devices, as well as a review of the IoT and digitalisation strategies of a range of EDNA member countries.



- Finally, in 2019 EDNA commenced an investigation of how currently-available IoT devices embody energy-saving features, and how conventional devices might be retrofitted with connectivity in order to save energy.



## Annex Participants



A complete record of EDNA activities in 2019 and participants is included in Attachment 6.



# The Power Electronic Conversion Technology Annex (PECTA)

The source of electricity for many applications needs to be converted, in order to supply devices that use electric power, which is the task of power electronic semiconductors and circuits.

The PECTA investigates the efficiency potential of new semiconductor technologies in power electronic applications, in particular wide band gap semiconductors (WBG) based on silicon-carbide (SiC) and gallium nitride (GaN) materials. Due to their outstanding material characteristics, it is expected that WBG could overcome limitations faced by silicon (Si) applications. These components are commonly used in cell phones, laptops, electric vehicle chargers, and PV inverters, and therefore the energy savings potential is significant.

PECTA is a unique initiative bringing together international experts from industry, academia from countries all over the world, with government officials to explore the efficiency potential from the integration of existing and emerging WBG technology applications for different sectors, especially focusing on end-use equipment.

The initial work of PECTA has focussed on preparing an applications readiness map (ARM) for policymakers,

which considers market potential in areas such as mobility, electrification, integration of renewable energy sources, and digitalization in industry. The ARM synthesises existing roadmaps and provides the basis to discuss the need and impact of policy intervention to stimulate adoption of WBG technologies. The nature and timing of such policies will be examined by PECTA during 2020 and beyond, especially focusing on standardization opportunities.

PECTA is focusing on a number of end-use applications of interest to 4E, so it introduces expertise from the emerging field of WBG technologies into the existing work and knowledge body of 4E concerning commercial, industrial and residential electric and electronic products. Technical insights from PECTA experts complement the policy perspectives and bridges the gap in communication and understanding between researchers, engineers and policy makers.

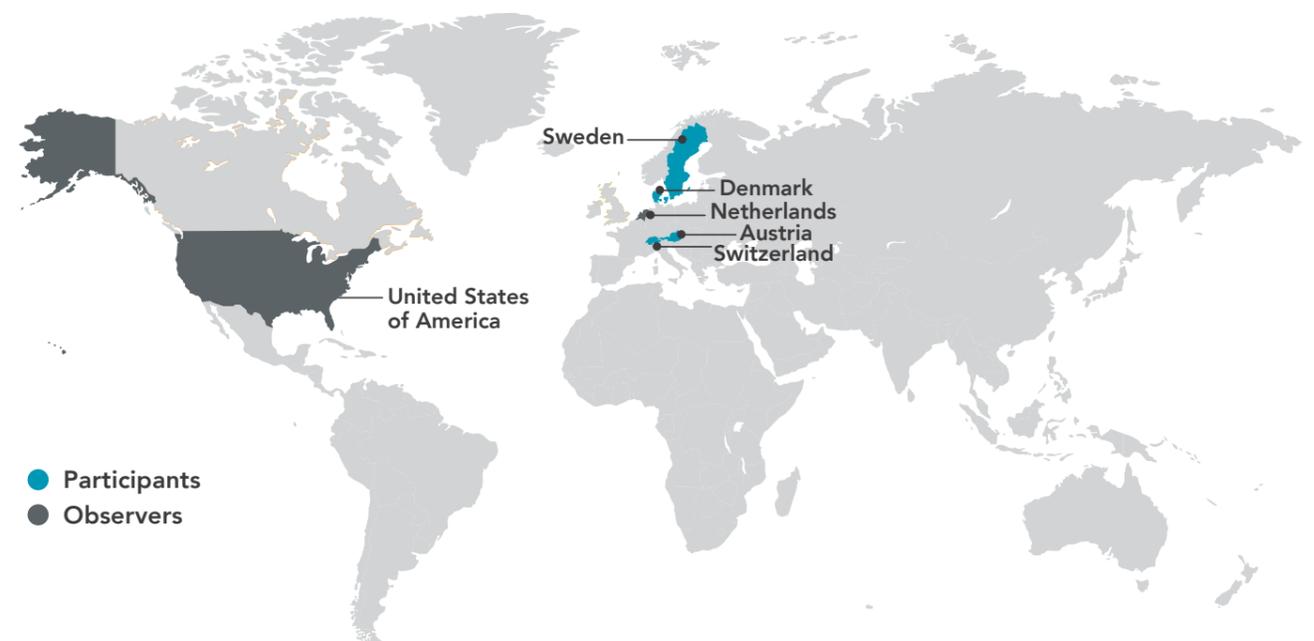
## Major Achievements During 2019

- ▶ PECTA started as an official 4E Annex in March 2019 with the support from Austria, Switzerland and Sweden. Denmark has subsequently joined PECTA.
- ▶ An industry advisory group (IAG) was established to harness additional expertise.
- ▶ A fully functional PECTA website with information in public and secured areas is online. Relevant applications for wide band gap semiconductors have been mapped and described according to PECTA's own areas of work and priorities.
- ▶ Data on potential energy savings estimates, based on a large review of power electronic applications are now available to PECTA experts and members. The fruitful cooperation with industry associations in the IAG has enabled the exchange of strategic important information, such as WBG roadmaps.
- ▶ Policy roadmaps for WBG devices are underway.
- ▶ PECTA was officially presented at the National 2019 IEA event of the Austrian Federal Ministry of Technology Transport and Innovation (in Innsbruck, September, 2019).



The applications readiness maps synthesises existing roadmaps and provides the basis to discuss the need and impact of policy intervention to stimulate adoption of wide band gap semiconductor technologies.

## Annex Participants



A complete record of PECTA activities in 2019 and participants is included in Attachment 7.

## 4E Outreach and Communication



Between 2015 and 2018, the amount of energy demand required to produce a unit of GDP continued to improve, but the annual rate of improvement steadily declined from 2.9% to 1.2%, the lowest level since 2010.

IEA Energy Efficiency Market Report 2019

4E communication activities, 2008-19

Between 2008 and the end of 2019, 4E has published over 520 reports and newsletters; and run or participated in 390 workshops, webinars and policy exchanges.



4E uses a wide range of channels to reach its target audience and operates a group of linked websites that are the hub of 4E's communication activities, providing access to all 4E publications and notice of forthcoming events. Visit the 4E site [here](#).

The location of 4E's site traffic is extremely geographically diverse, with visitors from around 150 separate countries.

50% of website traffic comes from countries that are not current members of 4E, with high usage by organisations based in India, Germany and Brazil.



Between 2014–2019, the 4E TCP produced 4 short videos to explain the 4E TCP, the work of the SSL Annex, EDNA and the CDA.



# 4E Group Finances



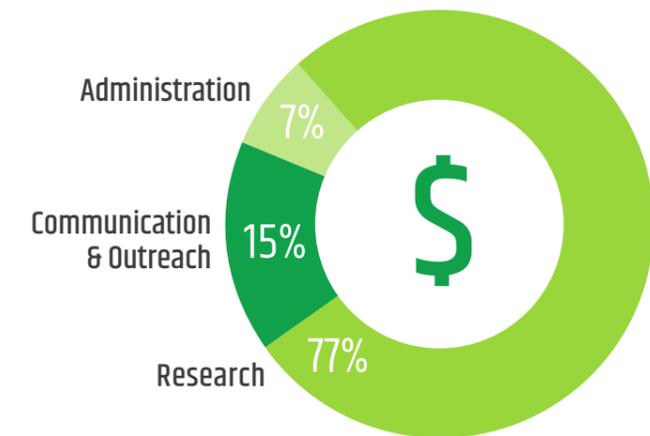
All 4E membership fees have not altered since 2016 and are considered by existing Members to represent excellent value – often saving them money.

4E activities are made possible through the contributions of member countries: taking the form of annual fees and substantial in-kind work by national experts. In 2019, the total cost of 4E activities is estimated to be €1.8 million, 7% lower than the previous year.

The annual fees and voluntary contributions of the 15 Members funded approximately 39% of the total expenditure.

77% of resources were directed towards research, while communication and outreach activities accounted for 16% of costs. The share of resources devoted to administration and financial management remained at only 7%.

## Allocation of 4E resources in 2019



## 4E membership fees, 2019

While Annex membership fees can vary from year to year depending upon the agreed work programme, in fact all membership fees have not altered since 2016 and are considered by existing Members to represent excellent value – often saving them money.

<b>EXECUTIVE COMMITTEE</b>	€20,000
<b>ELECTRIC MOTOR SYSTEMS ANNEX (EMSA)</b>	€15,000
<b>SOLID STATE LIGHTING ANNEX (SSL)</b>	€22,000
<b>ELECTRONIC DEVICES AND NETWORKS ANNEX (EDNA)</b>	€15,000
<b>POWER ELECTRONIC CONVERSION TECHNOLOGY ANNEX (PECTA)</b>	€20,000



## Attachments



Energy efficiency is the first fuel – the fuel you do not have to use – and in terms of supply, it is abundantly available and cheap to extract. But demand for the first fuel needs to grow, and that’s where policy action matters the most.

*Brian Motherway, IEA Head of Energy Efficiency  
Commentary – 19 December 2019*

## Attachment 1: 4E Executive Committee Delegates\*

Contracting Party	Nomination	Name & Details	Email/Telephone
AUSTRALIA	Primary	<b>Ms Catherine Zerger</b> (from 21 October 2019) Director, GEMS Policy & Legislation Department of the Environment and Energy	Catherine.Zerger@environment.gov.au Tel: +61 2 6275 9147
	Alternate	<b>Mr Ben Costelloe</b> (from 15 April 2019) Acting Director, GEMS Policy Department of the Environment and Energy	Ben.Costelloe@environment.gov.au Tel: +61 2 6275 9213
AUSTRIA	Primary	<b>Dr Adriana Diaz</b> Ecodesign Company GmbH Engineering and Management Consultancy	diaz@ecodesign-company.com Tel: +43 1 40 35 611-33
	Alternate	<b>Mr Michael Hübner</b> Federal Ministry for Transport, Innovation and Technology	michael.huebner@bmvit.gv.at Tel: +43 1 711 62 652922
CANADA	Primary	<b>Mr Jamie Hulan</b> Director, Equipment Division Office of Energy Efficiency, Natural Resources Canada	Jamie.Hulan@canada.ca Tel: +1 613 996 4359
	Alternate	<b>Ms Kimberly Curran</b> (from 4 September 2019) Chief, Standards Development, Office of Energy Efficiency, Natural Resources Canada	Kimberly.Curran@canada.ca Tel: +1 613 947 1207
CHINA	Primary	<b>Mr Lin Ling</b> Director of Resource and Environment China National Institute of Standardization	linling@cnis.gov.cn Tel: +86 10 58811737
	Alternate	<b>Mr Liu Meng</b> Associate Researcher China National Institute of Standardization	liumeng@cnis.ac.cn Tel: +86 10 58811128
DENMARK	Primary	<b>Mr Jesper Ditlefsen</b> (from 31 October 2019) Special Advisor Danish Energy Agency	jdi@ens.dk Tel: +45 33 95 58 15
	Alternate	<b>Mr Thore Stenfeldt</b> (from 31 October 2019) Advisor Danish Energy Agency	tst@ens.dk Tel: +45 33 92 77 04
EUROPEAN COMMISSION	Primary	<b>Mr Robert Nuij</b> (from 24 June 2019) Directorate-General for Energy European Commission	robert.nuij@ec.europa.eu Tel: +32 229 86183
	Alternate	<b>Mr George Paunescu</b> (from 24 June 2019) Directorate-General for Energy European Commission	mugurel-george.paunescu@ec.europa.eu Tel: +32 229 52989
FRANCE	Primary	<b>Mr Alain Anglade</b> Senior Expert, Building Department ADEME	alain.anglade@ademe.fr Tel: +33 493 957 935
	Alternate	<b>Ms Therese Kreitz</b> Responsible for International Affairs ADEME	therese.kreitz@ademe.fr Tel: +33 493 957 984
JAPAN	Primary	<b>Mr Masanori Kobayashi</b> (from 24 December 2019) Director, Head of International Project Group, Energy Conservation Technology Department, NEDO	kobayashimsn@nedo.go.jp Tel: +81 44 520 5284
	Alternate	<b>Ms Erika Minagawa</b> Chief Officer, Energy Conservation Technology Department, NEDO	minagawaerk@nedo.go.jp Tel: +81 44 520 5284

Contracting Party	Nomination	Name & Details	Email/Telephone
REPUBLIC OF KOREA	Primary	<b>Mr Hyeong-Jung Kim</b> General Manager, Korea Energy Agency	jakekim@energy.or.kr Tel: +82 31 260 4240
	Alternate	<b>Mr Kyung-Ho, Jo</b> Assistant Manager, Korea Energy Agency	jokh@energy.or.kr Tel: +82 31 260 4249
NETHERLANDS	Primary	<b>Mr Hans-Paul Siderius (Vice-Chair)</b> Senior Expert Netherlands Enterprise Agency	hans-paul.siderius@rvo.nl Tel: +31 88 602 2609
	Alternate	<b>Mr Justin Rosing</b> Ministry of Economic Affairs	j.a.rosing@minez.nl
NEW ZEALAND	Primary	<b>Mr Brian Fitzgerald</b> (from 10 April 2019) Standards and Regulations Energy Efficiency and Conservation Authority (EECA)	Brian.Fitzgerald@eece.govt.nz Tel: +64 4 470 2541
	Alternate	TBA	
SWEDEN	Primary	<b>Dr Peter Bennich</b> Policy Officer, Energy Efficiency Department The Swedish Energy Agency, Testlab	peter.bennich@energimyndigheten.se Tel: +46 73 625 6782
	Alternate	<b>Mr Carlos Lopes</b> Coordinator for Ecodesign and Energy Labelling The Swedish Energy Agency, Testlab	carlos.lopes@energimyndigheten.se Tel: +46 70 550 3430
SWITZERLAND	Primary	<b>Dr Michael Moser</b> Scientific Advisor, Energy Research Section Swiss Federal Office of Energy (SFOE)	michael.moser@bfe.admin.ch Tel: +41 58 465 36 23
	Alternates	<b>Mr Roland Brüniger</b> R. Brüniger AG Consultant, Swiss Federal Office of Energy (SFOE)	roland.brueiniger@brueiniger.swiss Tel: +41 44 760 0066
		<b>Mr Markus Bleuer</b> Appliances and Competitive Tenders Section Swiss Federal Office of Energy (SFOE)	markus.bleuer@bfe.admin.ch Tel: +41 58 462 69 24
UNITED KINGDOM	Primary	<b>Mr Sam Balch</b> Deputy Director, Home and Local Energy Department for Business, Energy and Industrial Strategy	sam.balch@beis.gov.uk Tel: +44 300 068 6661
	Alternates	<b>Ms Samuela Bassi</b> Policy Manager – Energy Using Products Department for Business, Energy and Industrial Strategy	samuella.bassi@beis.gov.uk
		<b>Mr Suleiman Faruqi</b> Senior Policy Advisor, Home and Local Energy Department for Business, Energy and Industrial Strategy	suleiman.faruqi@beis.gov.uk Tel: +44 2072 153 127
USA	Primary	<b>Mr Jeremy Dommu</b> Electronic Products Manager Building Technologies Office, US Department of Energy	jeremy.dommu@ee.doe.gov Tel: +1 202 586 9870
	Alternate	<b>Mr John Cymbalsky</b> (acting Chair) Building Technologies Office US Department of Energy	john.cymbalsky@ee.doe.gov Tel: +1 202 287 1692

\* As at December 2019

## Attachment 2: All 4E publications, 2019

Date	Source	Title
JANUARY	4E	Policy Brief: Policy Guidelines for Pumps, Fans and Compressors
MARCH	4E	4E 2018 Annual Report
	EMSA	Newsletter Report of Results of Phase 1: Round Robin of Converter Losses
APRIL	SSL	Presentations from KILT-SSL Annex International Seminar on Certification, Standards and Requirements
MAY	4E	IEA Report: Tracking Clean Energy Progress 2019 4E IEA Brochure & web page
	EDNA	Report: Intelligent Efficiency for Data Centres and Wide Area Networks
JUNE	EDNA	Report: Total Energy Model for Connected Devices Report: Getting to Zero: An Evaluation of Zero Network Standby Power
JULY	EDNA	Report: Bridging the Network Standby Gap between Mobile and Mains-Powered Products Report: Global Forecast of Energy Use for Wireless Charging
AUGUST	EDNA	Report: Test Procedures for Measuring Network Standby Power
SEPTEMBER	SSL	Report: Interlaboratory Comparison 2017 (IC 2017) Nucleus Laboratory Comparison Report
	EMSA	Launch of DTI-HydraCalc software tool
OCTOBER	SSL	Presentations from DTU-SSL Annex Seminar on Recent Research on LED Quality Metrics and Regulations
NOVEMBER	4E	IEA Energy Efficiency 2019
DECEMBER	EMSA	EMSA Newsletter

## Attachment 3: 4E workshops, presentations and meetings

Date	Source	Title	Location
JANUARY	SSL	SSL Annex Management Committee	Teleconference
	EDNA	22nd EDNA Management Committee	Teleconference
	PECTA	1st PECTA Management Committee	Teleconference
FEBRUARY	4E	4E Management Committee	Teleconference
	PECTA	2nd PECTA Management Committee	Teleconference
MARCH	PECTA	3rd PECTA Management Committee	Teleconference
		4th PECTA Management Committee	Teleconference
	4E	4E Management Committee	Teleconference
	EDNA	23rd EXCO	Beijing, China
		11th EDNA meeting	Beijing, China
APRIL	EDNA	23th EDNA Management Committee	Teleconference
	EMSA	SEAD Policy Exchange Forum - Efficient Electric Motors and Motor Systems	Webinar
	SSL	18th Experts Meeting	Seoul, KR
		The International Seminar on Certification, Standards & Requirements of Solid State Lighting Korea Institute of Lighting and ICT and IEA 4E SSL Annex	Seoul, KR
		SSL Annex Management Committee	Seoul, KR
	PECTA	5th PECTA Management Committee	Teleconference
MAY	EMSA	21st EMSA Meeting	Teleconference
	EDNA	24th EDNA Management Committee	Teleconference
	4E	4E Management Committee	Teleconference
	PECTA	6th PECTA Management Committee	Teleconference
JUNE	PECTA	7th PECTA Management Committee	Teleconference
		7th PECTA Management Committee	Teleconference
	EDNA	25th EDNA Management Committee	Teleconference
	SSL	SSL Annex Management Committee	Teleconference
	4E	4E Management Committee	Teleconference
JULY	4E	4E Management Committee	Teleconference
AUGUST	EDNA	26th EDNA Management Committee	Teleconference
	PECTA	9th PECTA Management Committee	Teleconference
	4E	4E Management Committee	Teleconference

Date	Source	Title	Location
SEPTEMBER	EMSA	EEMODS'19	Tokyo, Japan
		Five papers presented to EEMODS'19,	Tokyo, Japan
		Coordination of IEC & ISO standards on energy efficient electric motor driven systems (IEC CAISEMS)	Tokyo, Japan
	EDNA	Digitalisation Webinar #3: the Key Role of Internet-Connected Devices	Webinar
		27th EDNA Management Committee Regulations in Europe	Teleconference
	4E	4E Management Committee	Teleconference
OCTOBER	PECTA	10th PECTA Management Committee	Teleconference
		PECTA presentation at the Austrian IEA National event of 2019: IEA Vernetzungstreffen	Innsbruck, Austria
	PECTA	11th PECTA Management Committee	Teleconference
		12th PECTA Management Committee	Teleconference
	SSL	19th Expert Meeting	Copenhagen
Recent International Research on LED Quality Metrics and New Lighting Regulations in Europe		Roskilde, Denmark	
SSL Annex Management Committee		Teleconference	
4E	4E Management Committee	Teleconference	
NOVEMBER	4E	24th EXCO	Brussels, Belgium
	EMSA	ASET-EU Fan Conference	Brussels, Belgium
		22nd EMSA Meeting	Brussels, Belgium
	EDNA	Network Zero Workshop	Brussels, Belgium
		12th EDNA meeting	Brussels, Belgium
PECTA	1st Annex Meeting	Brussels, Belgium	
	2nd Expert Meeting	Brussels, Belgium	
DECEMBER	4E	4E Management Committee	Teleconference



## Attachment 4: Electric Motor Systems (EMSA) 2019 Record of Activities & Delegates

### RECORD OF ACTIVITIES

	Date	Intended Audience	Location
<b>PUBLICATIONS IN 2019</b>			
Report phase 1 Global Round Robin test program for converter losses	March	Public	
EMSA Newsflash	March	Public	
DTI-Hydracalc Tool	September	Public	
EMSA Newsletter*	December	Public	
<b>WORKSHOPS &amp; CONFERENCES IN 2019</b>			
SEAD Policy Exchange Forum - Efficient Electric Motors and Motor Systems	April	Industry, academia, policy makers, researchers	Webinar
EEMODS 2019	September	Industry, academia, policy makers, researchers	Tokyo, Japan
IEC CAISEMS workshop	September	IEC and ISO	Tokyo, Japan
ASET-EU Fan Conference	November	Fan industry, policy makers	Brussels, Belgium
Workshop: market monitoring & surveillance	May	EMSA Members and guests	Brussels, Belgium
<b>MANAGEMENT/EXPERTS MEETINGS IN 2019</b>			
21st EMSA meeting	May	EMSA Members	Utrecht, Netherlands
22nd EMSA meeting	November	EMSA Members	Brussels, Belgium
<b>WORKSHOPS &amp; CONFERENCES PLANNED FOR 2020</b>			
ECEEE 2020 - workshop on EMDS and digitalization	June	Public	Gotheborg, Sweden
Motor Summit 2020	November	Public	Zurich, Switzerland
<b>MANAGEMENT/EXPERTS MEETINGS PLANNED FOR 2020</b>			
23rd EMSA meeting	May	EMSA Members	Utrecht, Netherlands
24th EMSA meeting	November	EMSA Members	Zurich, Switzerland

\*in English, Chinese, Japanese, Spanish

### COUNTRY DELEGATES

Country	Name	Organisation	Email	Phone
AUSTRALIA	Simon Newman	Department of the Environment and Energy	simon.newman@environment.gov.au	+61 262759352
AUSTRIA	Konstantin Kulterer	Austrian Energy Agency	konstantin.kulterer@energyagency.at	+43 1 586 15 24 - 114
DENMARK	Jesper Ditlefsen Sandie B. Nielsen	Danish Energy Agency Danish Technological Institute	bjh@ens.dk sbn@teknologisk.dk	+45 33 95 58 15
NETHERLANDS	Frank Hartkamp Hans-Paul Siderius	Netherlands Enterprise Agency	frank.hartkamp@rvo.nl hans-paul.siderius@rvo.nl	+31 6 2290 7809 +31 6 1588 6304
SWEDEN	Glenn Widerström Maja Dahlgren	Swedish Energy Agency	glenn.widerstrom@energimyndigheten.se maja.dahlgren@energimyndigheten.se	+46 165 44 2062 +46 165 44 2408
SWITZERLAND	Michael Moser Roland Brüniger	Swiss Federal Office of Energy	michael.moser@bfe.admin.ch roland.brueeniger@brueniger.swiss	+41 44 760 0066 +41 44 226 20 10
USA	John Cymbalsky Jeremy Domm Sanaee Iyama	Department of Energy LBNL	john.cymbalsky@hq.doe.gov Jeremy.domm@ee.doe.gov ssiyama@lbl.gov	+510-486-6604

#### Lead Country

#### Switzerland

#### ANNEX CHAIR

**Roland Brüniger**  
Swiss Federal Office of Energy  
c/o R. Brüniger AG, Engineering & Consulting  
Zwillikerstr. 8, CH-8913 Ottenbach Switzerland  
**Email:** roland.brueeniger@r-brueniger-ag.ch  
**Tel:** +41 44 760 00 66

#### ANNEX CHAIR

**Frank Hartkamp**  
Netherlands Enterprise Agency  
Croeselaan 15, 3521 BJ Utrecht, The Netherlands  
**Email:** frank.hartkamp@rvo.nl  
**Tel:** +31 (0)88 042 42 42

#### OPERATING AGENT

**Maarten van Werkhoven**  
TPA advisors  
Generaal Winkelmanlaan 31 2111 WV Aerdenhout  
The Netherlands  
**Email:** mvanwerkhoven@tpabv.nl  
**Tel:** +31 23 536 80 90

#### EMSA COORDINATOR

**Rita Werle**  
Impact Energy Inc.  
Gessnerallee 38a, CH-8001 Zurich Switzerland  
**Email:** rita.werle@impact-energy.ch  
**Tel:** +41 44 226 20 10

## Attachment 5: Solid State Lighting (SSL) 2019 Record of Activities & Delegates

### RECORD OF ACTIVITIES

	Date	Intended Audience	Location
<b>PUBLICATIONS IN 2019</b>			
Presentations from KILT-SSL Annex International Seminar on Certification, Standards and Requirements	April	Lighting industry, policy makers, testing certification experts	
Interlaboratory Comparison 2017 (IC 2017) Nucleus Laboratory Comparison Report	September	Standardisation organisations, lighting metrologists, test laboratories, policy makers	
Presentations from DTU-SSL Annex Seminar on Recent Research on LED Quality Metrics and Regulations	October	Lighting industry manufacturers, designers, researchers	
<b>WORKSHOPS &amp; CONFERENCES IN 2019</b>			
International Seminar on Certification, Standards & Requirements of Solid State Lighting	April	Lighting industry, policymakers, testing certification	Seoul, Korea
Recent International Research on LED Quality	March	SSL Members & Experts	Toulouse, France
<b>MANAGEMENT/EXPERTS MEETINGS IN 2019</b>			
Management Committee meeting	January	SSL Annex Members	Teleconference
18th Experts Meeting	April	Invited SSL Experts	Seoul, Korea
Management Committee meeting	April	SSL Annex Members	Teleconference
Management Committee meeting	June	SSL Annex Members	Teleconference
19th Experts Meeting	October	Invited SSL Experts	Copenhagen, Denmark
Management Committee meeting	October	SSL Annex Members	Teleconference
<b>WORKSHOPS &amp; CONFERENCES PLANNED FOR 2020</b>			
Lighting & Health Workshop	April	Manufacturers, Researchers, Health Authorities	London, UK
<b>MANAGEMENT/EXPERTS MEETINGS PLANNED FOR 2020</b>			
Management Committee meeting	February	SSL Annex Members	Teleconference
20th Experts Meeting	March-April	Invited SSL Experts	London, UK
Management Committee meeting	April	SSL Annex Members	Teleconference
Management Committee meeting	June	SSL Annex Members	Teleconference
Management Committee meeting	October	SSL Annex Members	Teleconference
21st Experts Meeting	October – November	Invited SSL Experts	Canberra, Australia

### COUNTRY DELEGATES

Country	Name	Organisation	Email	Phone
AUSTRALIA	David Boughey	Department of Industry, Science, Energy and Resources	david.boughey@industry.gov.au	+61 2 6243 7014
CANADA	Jamie Hulan	Natural Resources Canada	jamie.hulan@canada.ca	+1 613-996-4359
DENMARK	Casper Kofod	Energy Piano (Acting MC for Denmark)	ck@energypiano.dk	+45 40 45 98 76
FRANCE	Bruno Lafitte	ADEME	Bruno.Lafitte@ademe.fr	+33 4 93 95 72 56
REPUBLIC OF KOREA	Ji-eun Choi	Korea Energy Agency	jjeunchoi@energy.or.kr	+82-52-920-0452
SWEDEN	Peter Bennich	Swedish Energy Agency	Peter.Bennich@energimyndigheten.se	+46 16 544 22 78
UNITED KINGDOM	Suleiman Faruqi	Department for Business, Energy & Industrial Strategy	Suleiman.faruqi@beis.gov.uk	+44 207 215 3127

#### Lead Country

<b>ACTING ANNEX CHAIR</b>	<b>David Boughey</b> Assistant Manager – Lighting Efficiency, Residential Energy Efficiency Branch Department of Industry, Science, Energy and Resources, Canberra, Australia <b>Email:</b> david.boughey@industry.gov.au <b>Tel:</b> +61 2 6243 7014
<b>OPERATING AGENT</b>	<b>Nils Borg</b> Borg & Co. AB Sveavägen 98, 4 tr, 113 50 Stockholm, Sweden. <b>Email:</b> nils@borgco.se <b>Tel:</b> +46 70 585 31 74
<b>OPERATING AGENT SUPPORT</b>	<b>Michael Scholand, LC</b> M2S2 Energy Ltd. 7 Green Bank, London, N12 8AS, United Kingdom <b>Email:</b> ssl.annex@gmail.com <b>Tel:</b> +44 7931 701 568

## Attachment 6: Electronic Devices and Networks Annex (EDNA) 2019 Record of Activities & Delegates

### RECORD OF ACTIVITIES

	Date	Intended Audience	Location
<b>PUBLICATIONS IN 2019</b>			
Intelligent Efficiency for Data Centres and Wide Area Networks	May	Public	
Getting to Zero: An Evaluation of Zero Network Standby Power	June	Public	
Total Energy Model for Connected Devices	June	Public	
Global Forecast of Energy Use for Wireless Charging	July	Public	
Bridging the Network Standby Gap between Mobile and Mains-Powered Products	July	Public	
<b>WORKSHOPS &amp; CONFERENCES IN 2019</b>			
Network Zero Workshop	November	4E Members	Brussels
<b>MANAGEMENT/EXPERTS MEETINGS HELD IN 2019</b>			
22nd Management Committee meeting	January	EDNA Members	Teleconference
23th Management Committee meeting	March	EDNA Members	Teleconference
11th Annex Meeting	March	EDNA Members	Beijing, China
24th Management Committee meeting	May	EDNA Members	Teleconference
25th Management Committee meeting	June	EDNA Members	Teleconference
26th Management Committee meeting	August	EDNA Members	Teleconference
27th Management Committee meeting	September	EDNA Members	Teleconference
12th Annex Meeting	November	EDNA Members	Brussels, Belgium
<b>MANAGEMENT/EXPERTS MEETINGS PLANNED FOR 2020</b>			
13th Annex Meeting	May	EDNA Members	Utrecht, Netherlands
14th Annex Meeting	November	EDNA Members	New Orleans, USA

### COUNTRY DELEGATES

Country	Name	Organisation	Email	Phone
<b>AUSTRALIA</b>	Catherine Zerger	Dept of Industry, Science, Energy and Resources	catherine.zerger@industry.gov.au	+61 2 6243 7123
<b>AUSTRIA</b>	Adriana Diaz	EcoDesign Company	diaz@ecodesign-company.com	+43 1 40 35 611 33
<b>CANADA</b>	Jamie Hulan	Natural Resources Canada	jamie.hulan@canada.ca	+1 613 947 1207
<b>DENMARK</b>	Thore Stenfeldt	Danish Energy Agency	tst@ens.dk	+45 3392 7704
<b>FRANCE</b>	Bruno Lafitte	ADEME	bruno.lafitte@ademe.fr	+33 4 93 95 72 56
<b>JAPAN</b>	Masanori Kobayashi	NEDO	kobayashimsn@nedo.go.jp	
<b>REPUBLIC OF KOREA</b>	Jeon Kwan Taek	Korea Energy Agency	mechcfc@energy.or.kr	+82 31 260 4249
<b>NETHERLANDS</b>	Hans-Paul Siderius	Netherlands Enterprise Agency	hans-paul.siderius@rvo.nl	+31 88 602 2609
<b>SWEDEN</b>	Peter Bennich	Swedish Energy Agency	peter.bennich@energimyndigheten.se	+46 16 544 22 78
<b>SWITZERLAND</b>	Roland Brüniger	Swiss Federal Office of Energy	roland.brueeniger@r-brueniger-ag.ch	+41 44 760 00 66
<b>UNITED KINGDOM</b>	Suleiman Faruqi	Dept for Business, Energy and Industrial Strategy	Suleiman.Faruqi@beis.gov.uk	+44 2072 153 127
<b>USA</b>	Jeremy Dommu	Dept of Energy	Jeremy.Dommu@EE.Doe.Gov	+1 202 586 9870

#### Lead Country

#### Netherlands

#### ANNEX CHAIR

**Hans-Paul Siderius**  
Netherlands Enterprise Agency  
Netherlands  
**Email:** hans-paul.siderius@rvo.nl  
**Tel:** +31 88 602 2609

#### OPERATING AGENT

**Steven Beletich**  
Beletich Associates  
PO Box 56  
Northbridge, NSW 2063, Australia  
**Email:** info@edna.iea-4e.org  
**Tel:** + 61 2 9967 5809

## Attachment 7: Power Electronics Converter Technology Annex (PECTA) 2019 Record of Activities & Delegates

### RECORD OF ACTIVITIES

	Date	Intended Audience	Location
<b>WORKSHOPS &amp; CONFERENCES IN 2019</b>			
PECTA presentation at the Austrian IEA National event of 2019: IEA Vernetzungstreffen	September	Public	Innsbruck, Austria
<b>MANAGEMENT/EXPERTS MEETINGS HELD IN 2019</b>			
1st Management Committee meeting	January	PECTA Members	Teleconference
2nd Management Committee meeting	February	PECTA Members	Teleconference
3rd Management Committee meeting	February	PECTA Members	Teleconference
4th Management Committee meeting	March	PECTA Members	Teleconference
5th Management Committee meeting	April	PECTA Members	Teleconference
6th Management Committee meeting	May	PECTA Members	Teleconference
7th Management Committee meeting	June	PECTA Members	Teleconference
8th Management Committee meeting	June	PECTA Members	Teleconference
9th Management Committee meeting	August	PECTA Members	Teleconference
10th Management Committee meeting	September	PECTA Members	Teleconference
11th Management Committee meeting	October	PECTA Members	Teleconference
12th Management Committee meeting	October	PECTA Members	Teleconference
1st Annex meeting	November	PECTA Members	Brussels, Belgium
2nd Experts meeting	November	Invited experts	Brussels, Belgium
13th Management Committee meeting	December	PECTA Members	Teleconference
14th Management Committee meeting	December	PECTA Members	Teleconference
<b>WORKSHOPS &amp; CONFERENCES PLANNED FOR 2020</b>			
Workshop	November	PECTA Members and invitees from USA	New Orleans, USA
<b>MANAGEMENT/EXPERTS MEETINGS PLANNED FOR 2020</b>			
3rd Experts Meeting	March	Invited experts	Vienna, Austria
4th Experts Meeting	September	Invited experts	Lyon, France
2nd Annex Meeting	November	PECTA Members	New Orleans, USA

### COUNTRY DELEGATES

Country	Name	Organisation	Email	Phone
AUSTRIA	Adriana Diaz	ECODESIGNcompany GmbH	diaz@ecodesign-company.com	+43 1 40 35 611 33
DENMARK	Jakob Wulff Andersen	Danish Energy Agency	jbwa@ens.dk	+1 613 947 1207
SWEDEN	Peter Bennich	Swedish Energy Agency	Peter.bennich@energimyndigheten.se	+46 16 544 22 78
SWITZERLAND	Roland Brüniger	Bundesamt für Energie	Roland.brueiniger@brueniger.swiss	+33 493 957 935

#### Lead Country

#### Switzerland

#### ANNEX CHAIR

**Roland Brüniger**  
Swiss Federal Office of Energy  
c/o R. Brüniger AG, Engineering & Consulting  
Zwillikerstr. 8, CH-8913 Ottenbach Switzerland  
**Email:** roland.brueiniger@r-brueniger-ag.ch  
**Tel:** +41 44 760 00 66

#### OPERATING AGENT

**Markus Makoschitz**  
AIT Austrian Institute of Technology GmbH  
Giefinggasse 2  
1210 Vienna  
Austria  
**Email:** markus.makoschitz@ait.ac.at  
**Tel:** +43 50550-6317

# About the IEA



The TCPs are organised under the auspices of the International Energy Agency (IEA), but the TCPs are functionally and legally autonomous.

## About the International Energy Agency (IEA)

The IEA is at the heart of global dialogue on energy, providing authoritative analysis, data, policy recommendations, and real-world solutions to help countries provide secure and sustainable energy for all.

The IEA was created in 1974 to help co-ordinate a collective response to major disruptions in the supply of oil. While oil security this remains a key aspect of our work, the IEA has evolved and expanded significantly since its foundation.

Taking an all-fuels, all-technology approach, the IEA advocates policies that enhance the reliability, affordability and sustainability of energy. It examines the full spectrum issues including renewables, oil, gas and coal supply and demand, energy efficiency, clean energy technologies, electricity systems and markets, access to energy, demand-side management, and much more.

Since 2015, the IEA has opened its doors to major emerging countries to expand its global impact, and deepen cooperation in energy security, data and statistics, energy policy analysis, energy efficiency, and the growing use of clean energy technologies.

## IEA Technology Collaboration Programmes

The Technology Collaboration Programme supports the work of independent, international groups of experts that enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues. The experts in these collaborations work to advance the research, development and commercialisation of energy technologies. The scope and strategy of each collaboration is in keeping with the IEA Shared Goals of energy security, environmental protection and economic growth, as well as engagement worldwide.

The breadth of the analytical expertise in the Technology Collaboration Programme is a unique asset to the global transition to a cleaner energy future.

These collaborations involve over 6 000 experts worldwide who represent nearly 300 public and private organisations located in 55 countries, including many from IEA Association countries such as China, India and Brazil.