

Evaluation 2011-2016

DIFFER

**Dutch Institute for Fundamental Energy
Research**

Eindhoven, October 17 2017

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1 Introduction

1.1 Scope and context of this review

This assessment concerns the research carried out at the Dutch Institute for Fundamental Energy Research (DIFFER) in the period 2011-2016. The evaluation was commissioned and organised by the Netherlands Organisation for Scientific Research (NWO) and Dialogic.

The external evaluation follows the Standard Evaluation Protocol 2015-2021 (SEP). It is the protocol for research assessment in the Netherlands as agreed upon by NWO, the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Association of Universities in the Netherlands (VSNU). The primary aim of the assessment procedure is to reveal and confirm the quality and relevance of the research to society and to improve these where necessary.

Box 1. Changes to the previous version of the SEP protocol (2009-2015)

- The institute's strategy is leading in the evaluation process
- Increased more systematic attention to relevance to society
- Extension and tightening of the assessment of PhD programmes
- Introduction of an assessment of scientific integrity policy
- Cancel productivity as an independent criterion
- Qualitative evaluation of the assessment committee supported by a category (1, 2, 3 or 4)
- Introducing a new 4-point scoring model to better distinguish the quality of research groups
- More transparency on the outcomes and follow-up of research evaluations

An Evaluation Committee was established and asked to produce a reasoned judgment of the institute and its research programmes, in accordance with the SEP. Prior to the external evaluation, DIFFER submitted a self-assessment document covering the period 2011-2016. This report was approved by the Governing Board of NWO on 5th of July 2017. The self-assessment report and addendum included a SWOT analysis and a full set of statistics at institute and programme level concerning input (finances, funding and staff) and output (refereed articles, books, PhD theses, conference papers, publications aimed at the general public, and other output) for the six years prior to the evaluation. A number of tables were to be included about research staff, main categories of research output, funding, and PhD candidates (see SEP appendix D, D3). The self-assessment report therefore offered a concise picture of the institute and research groups' work, ambitions, output and resources in accordance with the guidelines provided by the SEP. Site visits form an important part of every evaluation and include interviews with the management of the institute, the programme coordinators, other levels of staff, and site visits to laboratories and facilities.

1.2 The Evaluation Committee

The Evaluation Committee was appointed by the Governing Board of NWO. Its members were:

- Prof.dr. Sibylle Günter, IPP Garching, DE (chair)
- Prof.dr. Fraser Armstrong, Oxford, UK
- Dr. Heinz Frei, LBNL, USA
- Prof.dr. Hans Geerlings, Shell/TUD, NL
- Prof.dr. Bruce Lipschultz, York, UK
- Prof.dr. Peter Styring, Sheffield, UK

A short curriculum vitae of each of the members is included in Annex 1. The Committee was supported by NWO (Dr. Mark Boneschanscher) and Dialogic (Leonique Korlaar MSc).

Before the site visit all members of the Committee signed the NWO Code of Conduct, by means of which they declared that their assessment would be free of bias and without regard to personal interest, and that they had no personal, professional or managerial involvement with the institute or its research programmes. It was concluded that the Committee had no conflicts of interest.

1.3 Data supplied to the Committee

Six weeks prior to the site visit the Evaluation Committee received the self-assessment report of DIFFER together with the site visit programme and an accompanying letter. The documentation supplied to the Committee included all the information required by the SEP as well as by the additional questions raised by NWO.

Prior to the site visit the Committee was informed about the Dutch science policy and the organisation of scientific research in the Netherlands, about (the transition of) NWO and the governance structure of the NWO research institutes.

1.4 Procedures followed by the Committee

The Committee proceeded in accordance with the Standard Evaluation Protocol 2015-2021. The assessment was based on the DIFFER self-assessment report (2011-2016) and other documentation provided by NWO, the institute, and the interviews during the site visit (from 16-17th of October 2017). The programme of the visit is included in Annex 2.

The Committee met on the afternoon and evening preceding the site visit to discuss the topics (and specific questions) for the different interviews. Moreover, the Committee agreed on procedural matters and aspects of the assessment as described in the following paragraphs. All interviews were conducted by the entire Committee. After completing the interviews, the Committee discussed the scores and comments on the institute and its research programmes and determined the final assessment.

At the end of the site visit, a meeting was held with the DIFFER management and a representative of NWO to report the Committee's preliminary findings.

On November 20th 2017 a draft version of this report was sent to the DIFFER director for factual correction and comments. The report was subsequently submitted to the NWO Executive Board.

1.5 Aspects and assessment scale

The Standard Evaluation Protocol 2015-2021 requires the Evaluation Committee to assess three main aspects of the institute and its research. These are:

1. *Research quality.* The committee assesses the quality of the institute's research and the contribution that research makes to the body of scientific knowledge. The committee also assesses the scale of the institute's research results (scientific publications, instruments and infrastructure developed by the institute, and other contributions to science).
2. *Relevance to society.* The committee assesses the quality, scale and relevance of contributions targeting specific economic, social or cultural target groups, of advisory

reports for policy, of contributions to public debates, and so on. The point is to assess contributions in areas that the institute has itself designated as target areas.

3. *Viability*. The committee assesses the strategy that the institute intends to pursue in the years ahead and the extent to which it is capable of meeting its targets in research and society during this period. It also considers the governance and leadership skills of the institute's management.

These three main evaluation criteria were rated according to a four-category scale, as specified in the SEP. The verdict was given in qualitative form, though a quantitative figure should be added. The scale is as follows: 1. World leading/excellent; 2. Very good; 3. Good; 4. Unsatisfactory (see Annex 4).

The SEP required the Evaluation Committee to also consider three additional topics. These are:

1. *PhD programmes*. The Evaluation Committee considered the supervision and instruction of PhD candidates.
2. *Research integrity*. The Evaluation Committee considered the institute's policy on research integrity and the way in which violations of such integrity are prevented.
3. *Diversity*. The Evaluation Committee considered the diversity of the institute. It is precisely the presence of mutual differences that can act as a powerful incentive for creativity and talent development in a diverse institute.

These topics were considered in qualitative terms (instead of using the four-category scale).

In addition to the topics above NWO formulated three questions for all NWO institutes:

1. What is the institute's added value in the national context and its international position?
2. How does the institute stimulate and facilitate knowledge utilization and open access?
3. How does the institute's structure, size and financial policy contribute to its mission?

In addition, four specific questions were formulated for DIFFER:

1. Is DIFFER's programmatic approach well aligned with the international Fusion Research programme?
2. Is DIFFER's Solar Fuels programme implemented successfully and is the research focus well chosen?
3. Is DIFFER's connecting and coordinating approach well suited to create (or lead) an (inter)national fundamental energy research community?
4. Should DIFFER play an active role to involve other disciplines relevant to the Energy Transition?

2 Institutional framework of DIFFER

The Dutch Institute for Fundamental Energy Research (DIFFER), one of nine dedicated NWO research institutes, was established in 2011 as the successor to the FOM Institute for Plasma Physics 'Rijnhuizen' (founded in 1959). With DIFFER, the institute's mission was expanded from fusion energy research to fundamental, cross-disciplinary energy research.

2.1 Mission

In 2011 DIFFER's mission was stated "To perform leading fundamental research in the fields of Fusion Energy and Solar Fuels, in close partnership with (inter)national academia and industry, and to have a national coordinating role in the field of fundamental energy research." In short, DIFFER performs "Science for Future Energy".

The research focus on fusion and solar fuels followed from DIFFER's scientific and technological track record and the ambition to meet the challenges of climate change and rising energy demand.

In the evaluation period, DIFFER pursued four generic strategic goals to fulfil its mission:

1. Performing top-level fundamental energy research in fusion and solar fuels
2. Maintaining and exploiting a high-quality technical infrastructure
3. Acquiring a national coordinating role in fundamental energy research
4. Intensifying collaborations with universities and large technological institutes

For the new strategy 2017-2022, DIFFER has decided to broaden its mission: "To perform leading fundamental research on novel materials, processes and devices for a global renewable energy infrastructure, in close partnership with (inter)national academia and industry."

2.2 Research

DIFFER focuses on two research themes:

- **Fusion Energy.** This research programme contributes to the development of practically inexhaustible, clean power generation through the thermonuclear reaction of hydrogen isotopes deuterium and tritium. The research focuses on the viable realisation of nuclear fusion reactors and includes developing and using: (1) suitable materials that can withstand reactor conditions with intense heat and particle fluxes; (2) state-of-the-art sensors and diagnostics for studying the dynamics and mitigating the instabilities of the nuclear fusion plasma, and (3) tractable and accurate models for plasma scenario prediction, optimisation, and control.
- **Solar Fuels.** This research programme comprises use-inspired fundamental research on approaches to convert the building blocks carbon dioxide (CO₂), water (H₂O), and nitrogen (N₂), into CO₂-neutral chemicals and fuels, using electrons and/or photons. DIFFER focused on the following chemical pathways: (1) electrochemistry and (2) photo-electrochemistry and photo-catalysis. The common challenge in these pathways is to be able to tailor and control chemical reactions from the molecular level to the macro-scale. Therefore, the three research lines are: (a) non thermal chemical processes, (b) functional materials and interfaces, and (c) light-matter interaction.

At the moment of the site visit, both research themes comprise of several research groups as summarised in the table below.

Scientific division	Research groups
Fusion Energy	• Fusion Facilities & Instrumentation (FFI) • Plasma Material Interactions (PMI) • Plasma Edge Physics and Diagnostics (PEPD) • Computational Plasma Physics and Chemistry (CPPC) • Integrated Modelling and MHD (IMM) • Integrated Modelling and Transport (IMT)
Solar Fuels	• Atmospheric Plasma Processing of Functional Films (APPPF) • Catalytic and Electrochemical Processes for Energy Applications (CEPEA) • Electrochemical Materials and Interfaces (EMI) • Materials and Surface Science (MSS) • Nanomaterials for Energy Applications (NEA) • Non-equilibrium Fuel Conversion (NFC) • Photonics for Energy (PFE) • Plasma Solar Fuels Devices (PSFD) • Solar Fuels Facilities and Instrumentation (SFFI) • Molecular Solar Energy (TU/e-DIFFER)

2.3 Organisational structure

As a result of the implementation of the Strategic Plan 2011-2016 major changes were carried out in the research organisation. DIFFER's 16 research groups are now organised in the above-mentioned two scientific divisions: Fusion Energy and Solar Fuels. Support is organised through the Support Facilities division. See also Figure 1. The governance model features small, flexible groups with much freedom and responsibility and a small and active management team consisting of the DIFFER director (also heading the solar fuels research theme), the head of fusion research and the institute manager.

As part of the transformation from Rijnhuizen to DIFFER, two non-energy research divisions were spun out to Dutch universities in the years 2013/2014. In parallel the Solar Fuels department was established. It was kick-started by former members of the Fusion department and further expanded by means of effective hiring. There was also a reorientation of the Fusion Energy department in 2014. The two former fusion research divisions merged into a single department which focuses mainly on the plasma periphery and materials. In 2015, DIFFER relocated to the campus of Eindhoven University of Technology (TU/e).

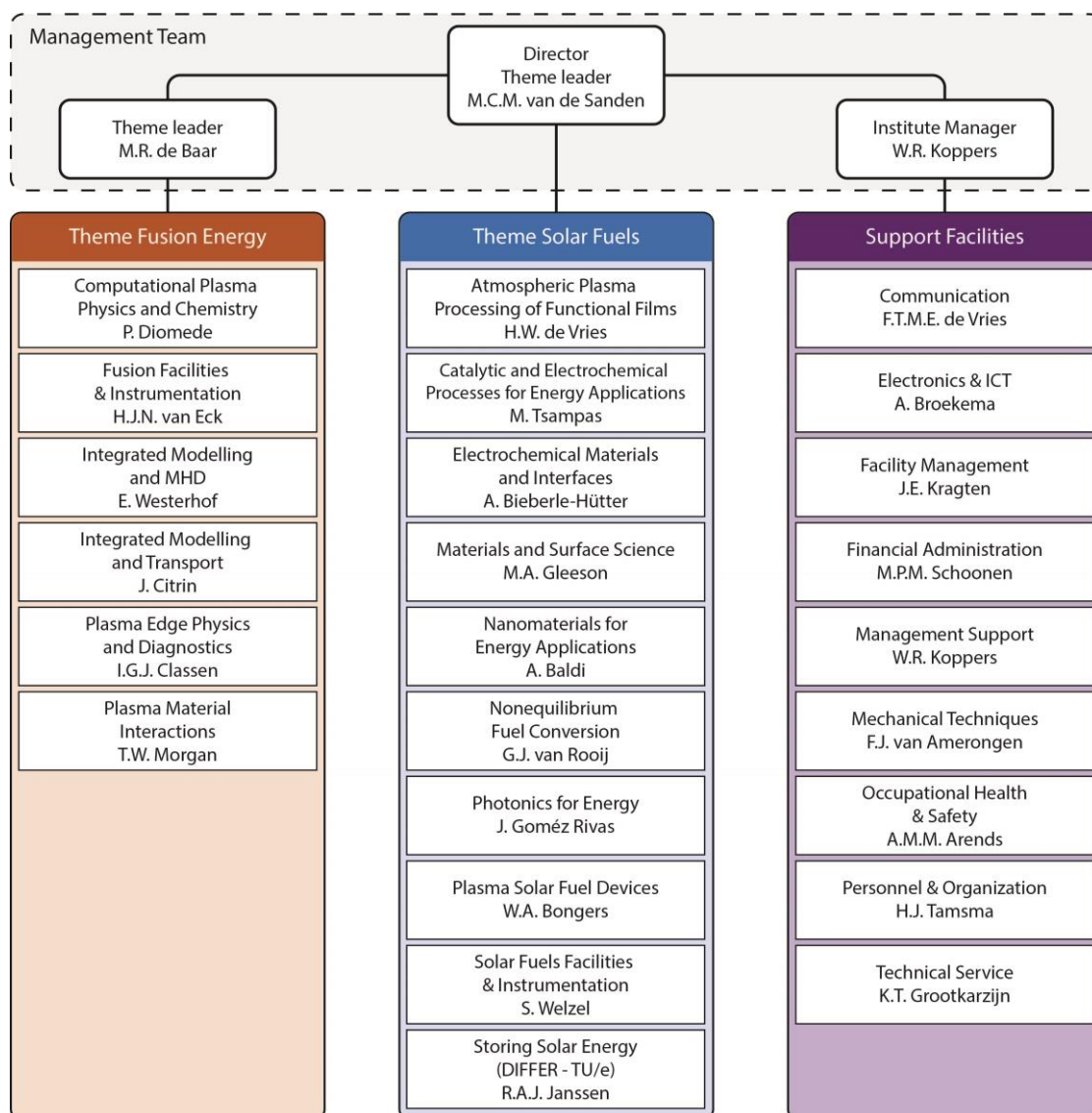


Figure 1. Organisational chart DIFFER (May 2017)

2.4 Financial matters

The running budget (2011-2016) of DIFFER is funded by four separate sources (see Figure 2): direct funding (FOM and NWO funding; 'base' funding of the institute), research grants (institutional programmes and industrial partnership programmes), contract research (European funding, industry related funding and funding agencies such as STW, RVO, M2I and NWO-personal grants), and funding for the relocation of PSI-lab (project funded by Province Noord-Brabant, Metropolitan Region Eindhoven, the City of Eindhoven, and FOM).

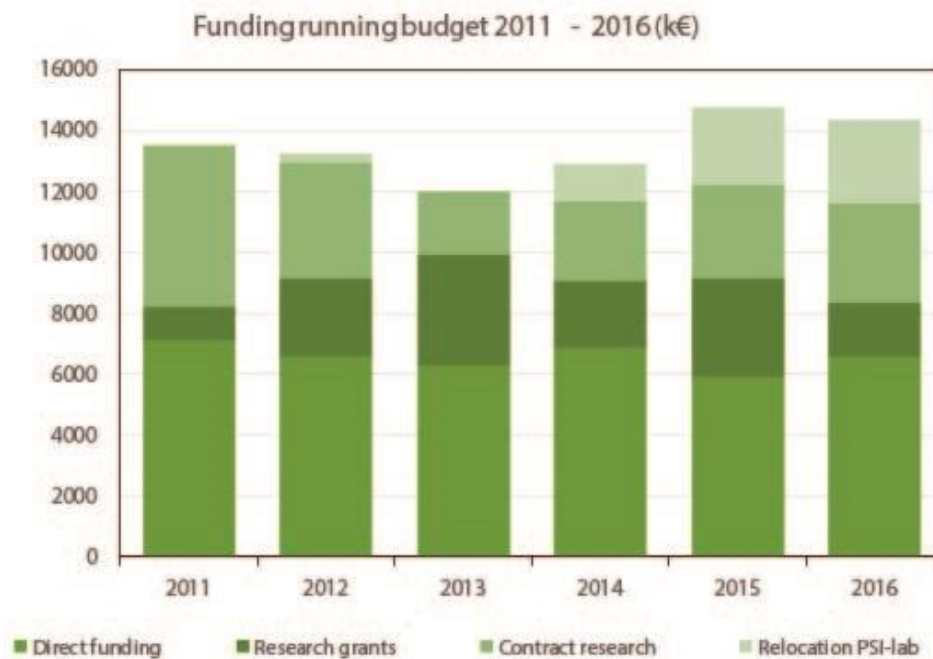


Figure 2. Funding of the running budget (k€)

In 2016, the total funding of the running budget of DIFFER was about M€ 14,3: 46% (M€ 6,6) from FOM and NWO, 13% (M€ 1,8) from research grants, 22% (M€ 3,2) from contract research, and 19% (M€ 2,7) for the relocation of PSI-lab. During the six years under review, the funding has increased by about 6%, with a dip around 2013. The latter is mostly due to the move of some of the research groups to universities.

Figure 3 gives an overview of the funding versus expenses for the evaluation period. On average the expenses have been less than the funding in this period. Two main reasons for this are that:

- The DIFFER management had to take actions to maintain a healthy balance between funding and expenses. The deficit has changes to a yearly surplus and hereby the additional funds have increased (which are kept as a buffer for future fluctuations).
- Budgets are reserved for future expenses. Material and investment budgets are often allocated to the projects to the first year, while expenses occur during the duration of the project.

In 2013 the investment expenses were more than the funding due to investments in the Industrial Partnership Program 'CP3E¹' for which funding had been realized in former years. In the period 2012-2015, the investments decreased due to the relocation of the scientific divisions GUTHz² and nSI³ to their new locations, and the relocation of DIFFER to Eindhoven. After the relocation (2016), the investments are increasing again.

¹ Controlling Photon and Plasma induced Processes at EUV optical surfaces

² Generation and Utilization of THz Radiation

³ Nanolayer Surface and Interface Physics

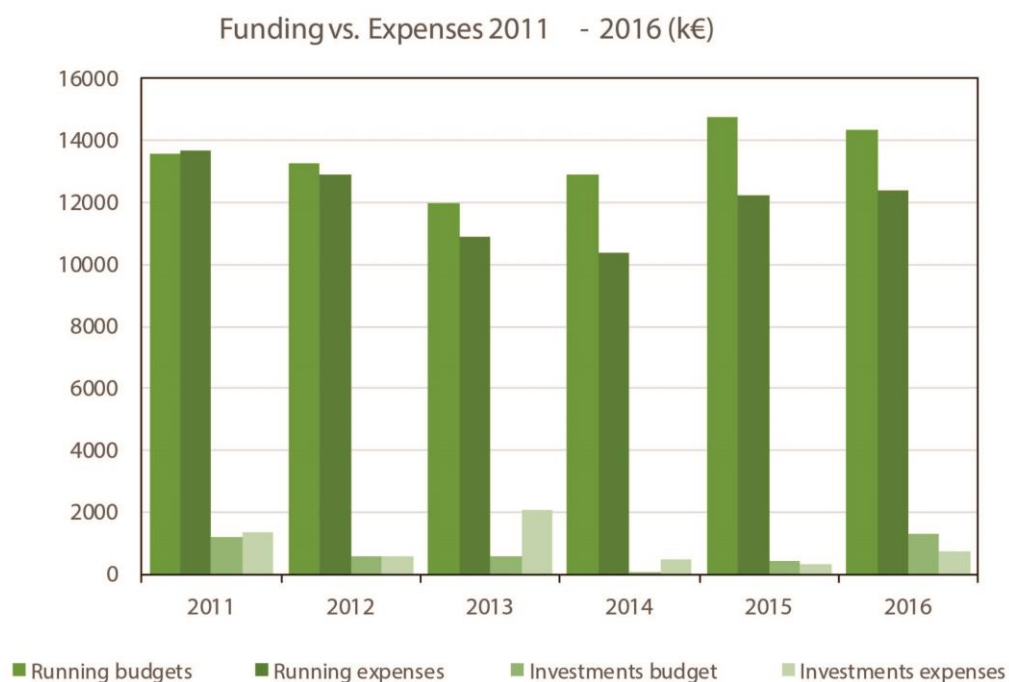


Figure 3. Funding versus expenses (k€)

2.5 Staff

In 2016 the total number of permanent and temporary personnel at DIFFER was 114.4 person per year (PPY). This number comprises a scientific staff (including PhD's and postdocs) of 69.3 and a support staff of 45.1. Figure 4 gives a more detailed overview of the development of the *scientific* staff of DIFFER.

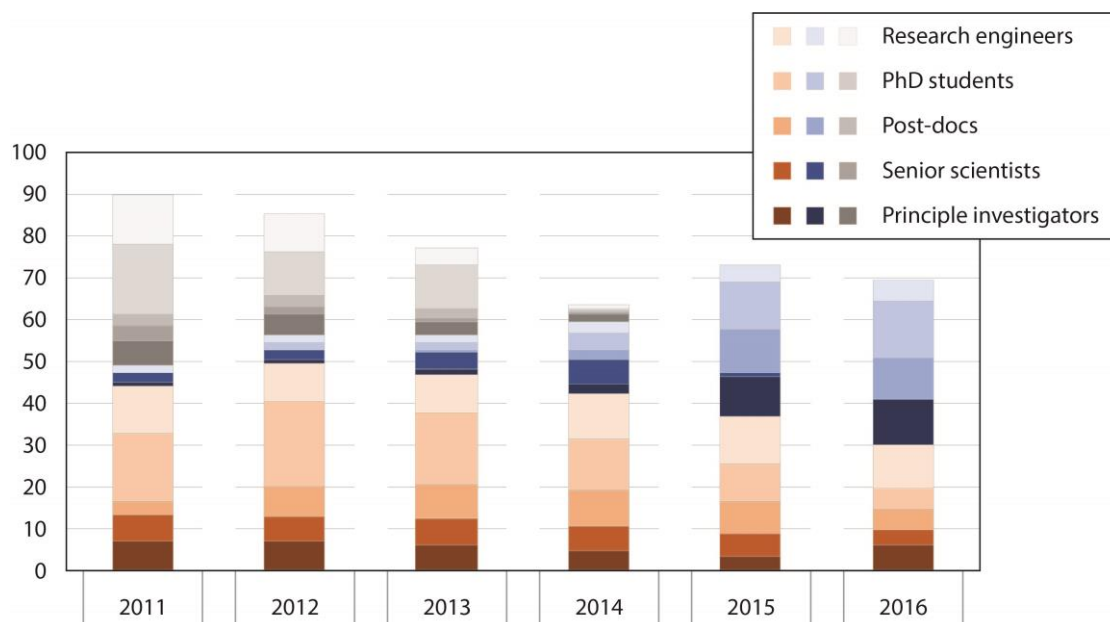


Figure 4. Development of DIFFER scientific staff

3 Assessment of the institute DIFFER

3.1 Strategy and targets DIFFER

As a consequence of the new mission in 2011, the non-energy research groups of DIFFER are spun out to Dutch universities in 2013 and 2014. DIFFER's focus is now on energy research, in particular on fusion energy and solar fuels.

In the area of **Fusion Research**, DIFFER increasingly concentrates on the problem of power exhaust in a future fusion power plant, one of the main challenges in the European Roadmap to fusion electricity. With its upgraded facility Magnum-PSI, able to generate ITER relevant plasma conditions and fluence, DIFFER has a world leading role in the area of plasma wall interaction on linear plasma devices. To close the gap to realistic magnetic fusion devices, DIFFER rightly teams up with the tokamaks that are strong in the area of power exhaust (ASDEX Upgrade, TCV) or for testing divertor solutions for ITER (WEST). To support these experimental activities, DIFFER exploits its well-known capability in the development of plasma diagnostics. Together with an increased effort in modelling of the plasma edge, DIFFER will be able to make significant contributions to the understanding of divertor physics and thus how to dissipate the power exhaust for ITER and a future power plant. These efforts are complemented by state of the art multi-scale modelling for the whole fusion plasma and developments for active plasma control.

DIFFER actively explores possible synergies between fusion energy and solar fuels research. This is particularly promising in the area of plasma chemistry and the corresponding modelling activities. DIFFER also aims at contributing to challenges in energy research outside the two main focus areas. Research on materials under extreme conditions in the fusion energy area or the development of control techniques for plasma operations could be promising candidates.

DIFFER is leading the way in investigating the opportunities for non-equilibrium plasmolysis in **Solar Fuel** conversion. This area of chemical physics is intellectually rich as well as offering (eventually) the very significant possibility of selectively converting gaseous CO₂ into CO, and N₂ into NH₃. A long term goal would be conversion of ambient CO₂. Efficiency and product separation are important challenges, in addition to understanding how microwave energy can be channelled selectively into molecules to activate particular vibrational states leading to bond scission. However, the fact that papers on plasma activation from the DIFFER scientists have so far received little attention from the established 'Solar Fuels' science community needs to be addressed. Another promising direction is the exploitation of plasmon resonance in metal nanoparticles to 'catalyse' fuel-forming reactions, again offering the promise of selectivity and efficiency. Elsewhere on the electrocatalysis side, the DIFFER approach looks more conventional and less likely to become distinguished internationally, although it is sound: i.e. improvements are being made in OER overpotential and cathode selectivity (CO₂ reduction vs H₂ evolution) all using abundant materials.

3.2 Assessment on the three criteria

3.2.1 Research quality

Fusion Research

Fusion research at DIFFER is world leading with a particular strength in the area of plasma material interaction. This is not only a very exciting and demanding research field, but it is also of extremely high relevance for fusion research. Handling the power exhaust in ITER and in a future fusion power plant is one of the great technological challenges for fusion research. Magnum-PSI coming into full operation places DIFFER in a unique position worldwide as it allows the study of ITER-like divertor conditions. Furthermore, DIFFER has an excellent track record in the development of diagnostics and advanced control techniques. With all this expertise, DIFFER significantly contributed to the scientific output at several European tokamaks. In the following, specific comments on the various research groups are given:

- **Fusion Facilities & Instrumentation (FFI):** The combination of Magnum-, Pilot- and Nano-PSI facilities is unique worldwide for the study of plasma surface interactions. Such facilities allow a large range of studies, from ITER technology tests to the details of plasma surface interactions and materials properties/physics. The transfer and rebuilding of these facilities at Eindhoven was excellently organized and essential for continued scientific output by the DIFFER group throughout the transition. The technology and physics of sources appears to be having a large overlap with that needed for Solar fuels studies – a key strength of the DIFFER programme.
- **Plasma Material Interactions (PMI):** The combination of facilities provided by the FFI group has enabled a uniquely large range of high-quality studies from large scale through to a micro-scale – all excellent work. In addition the group has developed and pursued studies in multiple materials from tungsten to liquid metals to carbon all of which tie in extremely well with the solar part of the DIFFER programme. Together with a strong ethos of collaboration (internal and external) the research performed on these facilities is very important for the national, EU and international fusion programmes.
- **Plasma Edge Physics and Diagnostics (PEPD):** The research of this group has, from the start, included an excellent programme on near-surface plasma studies at Magnum-PSI. While the initial work focused on the physics of detachment, the focus is now more general in trying to understand the role of the plasma, impurities and neutrals in affecting the divertor plasma state which is planned to ultimately tie into their control programme. The work has recently expanded to the TCV tokamak divertor plasma. In principle, we applaud this growth and direction of the programme, but so far there is not much experience in this specific topic.
- **Computational Plasma Physics and Chemistry (CPPC):** The work of this group supports both fusion and solar activities through modelling of both plasma physics and chemistry. The goal is to build a comprehensive model of vibrationally-excited states of CO₂ molecules. Such a chemical-plasma modelling capability ties in well with multiple solar research areas as well as the work of the PEPD group in terms of N effects on near surface divertor plasmas which have similar temperatures and densities. The quality of the staff and the scientific plans are excellent. It is however too early for an in depth evaluation of this group as it started its work only recently.

- **Integrated Modelling and MHD (IMM):** Very good results have been achieved in the modelling of the stabilization of neoclassical tearing modes (NTMs) and the modelling of energetic ion confinement and redistribution of energetic ions by MHD instabilities. Recently the activities regarding the modelling of fusion plasmas have been extended to the plasma edge. This move is very adequate as (1) the modelling of the plasma edge still involves many challenges to be addressed before reliable predictions for ITER/DEMO can be made and (2) it would perfectly fit in with DIFFER's strategy as important synergies with the work on Magnum-PSI and the related plasma wall interaction and divertor physics are to be expected.
- **Integrated Modelling and Transport (IMT):** The group performs excellent work on turbulent transport in the plasma core of tokamaks. Non-linear modelling using the state-of-the-art GENE code is accompanied by using reduced models that have a significantly lower computation time, thus allowing for real-time control. By exploiting synergies with university groups, the group uses novel approaches such as machine learning algorithms and system identification techniques. The plans to continue these activities are supported. The proposal to extend the research towards the plasma edge is very appropriate as this activity could be the link to the other groups in DIFFER (and given the importance of the pedestal for the overall confinement).

Solar Fuels Research

The Solar Fuels theme at DIFFER was established in 2011 and recently with the first groups starting in 2013 and three groups starting only in 2015. Therefore, the current review can only have a mid-term character. Fortunately, parts of the programme are already well established today and the institute conducts overall very good and internationally recognised research. DIFFER has implemented a governance model which features relatively small, flexible groups that allow for coverage of a broad range of fields making up fundamental solar fuels research. This model also enables fast adjustments of the programme if necessary. The complete solar fuels research field is too large for DIFFER to cover fully and therefore programmatic choices must be made. Also, working with small relatively independent groups requires effective embedding through both external and internal collaboration. Fortunately, all ingredients are present today to enable further growth into a unique world-leading institute, albeit some further focussing of the programme could be necessary. Below, some detailed comments regarding the research groups are given.

- **Atmospheric Plasma Processing of Functional Films (APPF):** The group does good scientific work with important applications in the renewable energy area. The synthesis of ultra-smooth organosilicone thin films on polymers using a plasma is directly relevant for the protection of PV polymers by forming a moisture barrier. The work of this group has stopped and no programme for the next period was offered.
- **Catalytic and Electrochemical Processes for Energy Applications (CEPEA):** This is a new area of research for DIFFER, with an interesting approach to break unwanted scaling relations in catalysis through application of suitable ion conducting membranes. This approach to use ion conducting membranes in dedicated device architectures that are coupled with light (photochemistry) or vibrational excitation (plasma chemistry) with the objective to produce solar fuels is unique. The CEPEA group started only recently. Already at this stage, devising a plan to attract additional funding is useful. A robust publication strategy should form an integral part of this plan as it allows the quality of the work to be established internationally.

- **Electrochemical Materials and Interfaces (EMI):** The EMI-group was established in 2014 and is still very much in the start-up phase. The group focusses on understanding the properties of electrochemical materials and interfaces, the goal being to identify factors that limit the performance of a photo-electrochemical conversion of interest. To this end, theoretical and experimental lines of research were started. The theoretical work focusses on multi-scale modelling of photo-electrochemical interfaces; the experimental programme is concerned with the preparation of well-defined nanostructured materials for photo-electrochemical application. The group is on the way to evolve into a research unit of very good quality provided a healthy balance between experimental and theoretical programme is maintained. A further embedding of the group through internal and external collaborations is essential.
- **Materials and Surface Science (MSS):** This is very good fundamental surface science, and there is good evidence for choice of relevant and challenging projects. For example, the work on Eley-Rideal reactions is certainly of fundamental interest. However, overall, the key publications are a little dated. It is felt that the current research is stalling a little, so it is appropriate that the group is going to focus on more creative and important directions, i.e. the chemistry underpinning plasma activation of CO₂ and H₂O at surfaces. The commissioning of new experimental capabilities is a welcome development.
- **Nanomaterials for Energy Applications (NEA):** The Nanomaterials for Energy Applications group started at DIFFER in 2015 and made a flying start. This is partly due to the activities of the principal investigator during his postdoc at Stanford University (USA). As a result, several papers in high-impact journals have already been published. The group is well embedded through national and international collaborations. The main lines of research involve 'storage of hydrogen in single nanoparticles' and 'plasmonic excitations as sensors for electron transfer processes or as initiators/drivers of chemical reactions'. Overall, the group already has an excellent track record and the research plans for the coming years are promising.
- **Non-equilibrium Fuel Conversion (NFC)** This group studies the production of solar fuels using non-equilibrium conditions as provided by a suitable plasma environment. An example is the plasma-driven dissociation of CO₂ into CO and O₂, but many other reactions can be conceived. The approach of the group is unique in the world and the results obtained are extremely promising. The panel advises NFC to publish more often in journals acknowledged to be excellent by the general solar fuel community.
- **Photonics for Energy (PFE)** The Photonics for Energy group has delivered outstanding contributions to the broad photonics field, some of which are highly relevant for the energy field. The group leader has decided to move to the Technical University Eindhoven. Further exploration of the concept of 'cavity enhanced chemistry' is recommended.
- **Plasma Solar Fuels Devices (PSFD)** This group and the 'Non-equilibrium Fuel Conversion' group form a natural combination. Non-thermal plasmolysis could offer an interesting alternative to electrochemical CO₂ and H₂O activation. The group has extensively studied plasma driven CO₂ dissociation to CO and O₂, which defines a potential starting point for the synthesis of solar fuels. The work delivered by the group is unique and potentially world leading.

- **Solar Fuels Facilities and Instrumentation (SFFI)** The SFFI group plays an essential role in supporting the various research groups by providing shared diagnostic techniques as well as plasma creation facilities. Such sharing of knowledge and common equipment enhances both the diagnostic and plasma capabilities of all solar research, and also maximizes the 'online' time of such studies and cross-fertilization of diagnostic techniques (e.g. x-ray diffraction) and research. The latter also includes the current development of surface characterization equipment. The proximity of the TU Eindhoven adds to the strength of the group.

Overall conclusion

Over the evaluation period Fusion research quality and output, which already was strong, has further strengthened. In the midst of the movement of laboratory and facilities Magnum-PSI has not only been reinstalled and is fully working, but has made a strong impact at an international level with unique contributions to ITER and near surface plasma studies. The Integrated modelling areas have continued to mature and, together with improved diagnostics and control capabilities, have attained direct forward predictability of the core plasma but also control of instabilities. A new research area in computational physics and chemistry, while being less than a year old, has shown good promise in attacking the physics of nitrogen species (atoms, ions, radical molecules) in the divertor region. Overall, the fusion programme is judged excellent.

The Solar Fuels programme was started only very recently. Therefore, the current evaluation has the character of a mid-term review. The programme is arranged along three research lines (non-thermal chemical processes, functional materials and interfaces, light-matter interaction), which are in different stages of development and therefore differ in quality delivered. Overall, the solar fuels programme is already of very good quality with the prospect of reaching excellence in the coming evaluation period.

Given that the Solar Fuels programme of DIFFER is not yet mature enough to be world-leading, the committee assess the overall research quality of DIFFER as very good (score 2).

3.2.2 Relevance to society

As indicated in the self-assessment, research into sustainable energy options in itself is of societal relevance. Though this is true, it is not sufficient to guarantee optimal relevance of DIFFER to society. Therefore, DIFFER actively pursues an agenda-setting role in connecting society, industry and academia (including polytechnical schools) around fundamental energy research. This aspect is recognized and has resulted in e.g., a leading role in the Dutch Science Agenda (NWA) route for the energy transition, a position as chair of the NERA Scientific Board and as chair of the advisory committee for electrochemical conversion & materials (ECCM) advising the ministry of economic affairs. DIFFER furthermore has an in-house start-up company Syngaschem, with which it has extensive collaborations.

DIFFER also fulfills several very important and essential roles as the representative for fusion energy in the Netherlands. A large amount of effort is put into working with industry/SMEs where DIFFER serves as the conduit for information about Fusion and commercial opportunities. The latter includes the potential for contracts with ITER as well as the joint development of techniques or knowledge with industry (knowledge transfer and sharing). The second very important role DIFFER is fulfilling is that of education about Fusion and encouraging young people to go into science (in particular fusion-related activities). Such outreach activities range from bringing students/politicians to DIFFER and the participation of DIFFER personnel in outreach (e.g. 'Fusion Road Show'). The range and penetration into society of activities in the above areas is excellent.

Overall, the panel judges the relevance to society as excellent (score 1).

3.2.3 Viability

The DIFFER research programme focuses on two main themes: (i) Fusion Energy and (ii) Solar Fuels. Both are key areas if a low-carbon future is to be achieved.

The future DIFFER Fusion Energy research will continue to be anchored in the world-leading linear plasma facilities with added surface and plasma in-situ and in-operando diagnostic as well as modelling capabilities. A significant, riskier, changeover of core to divertor research is being pursued through a combination of collaborations at EU tokamaks and internal development of knowledge capabilities with a goal of controlling the divertor plasma condition.

The Solar Fuels theme, introduced in 2011 and its research programme becoming effective from 2013 onwards, has shown considerable progress over a short period of time. Solar Fuels are becoming increasingly important and this is reflected in increased funding. The European Commission is launching a Horizon Prize in Artificial Photosynthesis together with proposed calls under Horizon 2020 and beyond. DIFFER is therefore ideally placed to benefit from such funding activities. Activities are tailored to technological needs and a structure is in place to encourage evolution of ideas and technologies at a fundamental level. Alongside Solar Fuels, the work on Fusion offers opportunities in both energy generation on a modular scale as well as coupling in to energy storage. DIFFER provides a fairly unique combination of plasma physics and chemical knowledge which provides a potentially important niche to profit from in the Solar Fuels area.

The focus now needs to be on demonstrating excellence in its strategy development. Current research is addressing targets that can be regarded as state of the art, for example the production of synthetic hydrocarbons using RWGS-FT and wax hydrocracking technologies. What is actually needed is the development of disruptive technologies that will give DIFFER a leading role.

As indicated by the SWOT analysis and confirmed by the director, the greatest risk for the financial viability of DIFFER lies in its funding mechanism. This panel is concerned about the low level of base funding compared to funds that need to be obtained in competition. Furthermore, with the changeover to NWO-I, the possibilities for strategic funding from NWO seem to be minimized. This is another reason for concern, given that DIFFER benefitted greatly from strategic funding in the past. As big science research conforms to an international roadmap with a long horizon, this typically does not match well with the short-term oriented free competition – making especially the fusion research at DIFFER vulnerable in this respect. This panel therefore urges both the DIFFER management team as well as NWO to develop strategies from both sides to address this challenge.

Governance and Leadership are such that the institute can respond to external stimuli. Staff recruitment and development are high priorities and good plans are in place to manage this. In particular, there is shown to be good monitoring of Tenure Track appointees to accelerate them towards tenured Group Leader positions within five years. While there is good senior leadership and experience at present, it has been identified that there is a potential threat in that there have been a considerable number of younger researchers appointed recently which is shifting the age-experience balance; a good spectrum of ages assists in providing a range in knowledge and expertise as well as continued capability to bring in new people.

The current Solar Fuels group has a diverse knowledge base, focused in particular areas. A need has been identified to appoint a visionary Senior Leader who can help drive the overall vision and strategy of the group. This person should demonstrate maturity and international standing in the field of Solar Fuels and CO₂ conversion. Whilst this could be an internal

appointment, success is more likely with an external appointment who is already an expert in the field. Strategies should also be put in place for succession planning and leadership in order to mitigate risks and ensure a smooth future transition.

There is good integration of the research activities with outside companies and with academia. The move to the TU/e campus has obvious benefits and the facilities are world-leading. The fact that these facilities are available to outside organisations is essential in promoting activities local, nationally and internationally. External relations help to position the institute in the mind of the public and should hopefully avoid any negative public perceptions.

Given the concerns about the funding mechanism, but on the other hand the strong positioning of the fusion research towards the future, and with the assurance of the plan to select a senior leader who can further position the solar fuels research, the overall viability of DIFFER is assessed to be very good (score 2).

3.3 Considerations regarding organisation, management policies and staffing

3.3.1 PhD programmes

DIFFER has a very successful and well-structured PhD programme. The number of PhD students supervised by DIFFER is impressive (38 DIFFER PhD students in 2011-2016 plus 14 external students, seconded to DIFFER), given the number of staff involved.

A strict hiring procedure accompanied by a well thought supervision procedure, involving not only promotor and supervisor, but also an independent mentor, has proven very successful. DIFFER's awareness of the need to finish theses in time has obviously increased. The time for completion (from start until PhD defence) decreased from 2011 (56 months) to 52 months in 2016. The job opportunities for the PhD students are excellent, probably also thanks to the courses offered in soft skills and other topics relevant for jobs, including those also outside academia. The PhD students are obviously very satisfied with their situation as proven in the discussions during the evaluation as well as in the employees survey in 2016 (average rate: 7.9/10).

3.3.2 Research integrity policy

Research Integrity is taken very seriously. Each researcher is issued with a copy of the book, "On Being a Scientist: A Guide to Responsible conduct in Research". Regular staff meetings discuss policy and actions, and there is an open policy in discussing integrity within groups. Group Leaders are responsible for checking scientific results in manuscripts before they are submitted for publication. DIFFER has also coordinated its crisis communication plan with that of NWO, which details the procedure of how to act if scientific fraud or misconduct occurs. During the evaluation period there have been no cases of misconduct or fraud at DIFFER nor other issues relating to research integrity.

3.3.3 Diversity

DIFFER has adopted a policy regarding diversity in gender, age and ethnicity. Currently the staff represents 20 different nationalities (making up 1/3 of the staff), and the age profile of the institute reflects the age distribution of the working population of the Netherlands. The Institute hired 2 employees with disability in the past 2 years within the framework of the 'Participation Law'.

The goal regarding gender diversity is to fulfil the “20 in 2020” strategy of NWO for top positions (pay scale band 12 and above). As of the end of 2016, 11% of the Institute’s staff is in this category. While it will be a challenge to achieve the goal of 20% within the three years to which DIFFER has committed itself, important practical steps that were implemented are: (1) DIFFER will give preference to female candidates given equal qualifications for future hires in this category; (2) participation of at least one female member on the hiring committee (on occasion drawn from outside of the Institute); (3) mandatory staff attendance of courses on unconscious bias choices in the candidate selection process; (4) DIFFER has participated in the FOM mentoring programme for women; (5) Implemented bias-rejection selection procedures for new positions; (6) DIFFER will instate in the near future a diversity task force for recommending further steps to advance diversity among its staff.

3.4 Supplementary questions by the NWO board

3.4.1 Generic questions for all NWO institutes

1. What is the institute’s added value in the national context and its international position?

DIFFER is the clear centre of gravity for the development of fusion energy generation and expertise for the Netherlands. DIFFER thus enables the Netherlands to participate at the EU and international levels, which is of tremendous value to the country. While the Dutch Fusion programme cannot and does not cover the full range of fusion physics and technology, it has developed niche expertise. The Magnum- and Pilot-PSI facilities are internationally unique and recognised as the ‘go to’ facility to perform plasma-material interaction experiments as evidenced by the number of collaborative activities. Magnum/Pilot-PSI research into plasma surface interactions and modification of surfaces in fusion devices competes equally on the world stage. The capabilities in control techniques are excellent and have been applied to core plasma instabilities at the ASDEX-Upgraded tokamak.

As for the Solar Fuels research, this panel advises to further strengthen the national coordinating role of DIFFER where possible, by making explicit that DIFFER is more than the institute in Eindhoven. With its governance model of small, flexible groups, DIFFER should be able to connect to the other solar fuels research initiatives within the Netherlands in order to guarantee good coverage of the field. Given the identified lack of coordination in (fundamental) energy research in the Netherlands, other energy related research initiatives in the Netherlands would benefit significantly from DIFFER picking up this role.

Finally, it is clear that the status of being a national institute has helped to raise the reputation of the work being carried out. Bringing together a number of aspects of fundamental energy research into one institute has helped to strengthen activities by giving a concerted focus. The move to the TU/e campus has given greater visibility of the institute on a local level and allowed for greater interactions with the university. The new building is outstanding in design and function. The fact that Dutch energy research is concentrated in this centre has given more exposure to activities on a national level. If major progress is to be made in this area then consolidating major research efforts is key. The range of national collaborations exemplifies this. However, it is on the international stage where the greatest impacts are being observed. This is reflected in the number of international partners (e.g. Fujifilm) and the growing reputation of DIFFER on the international research and legislative stage, including representation of the Dutch government at the recent Mission Innovation Workshop in the US (Dr. Michael Gleeson was invited to be a Lead Writer on one of the CO₂ Utilization panels).

2. How does the institute stimulate and facilitate knowledge utilization and open access?

DIFFER provides for its scientists a Green route (publication of a post- or preprint in its online repository) in addition to support for the Gold route of direct publication in an open access journal. In 2016, DIFFER already published 61% of its publications from previous programmes via open access, meeting the 2018 goal of the Dutch State Secretary of Education, Culture and Science for publications funded by public money. The self-assessment report of DIFFER also points to the activity of the Industrial Liaison Officer, and to student and public outreach efforts. There is an impressive list of activities.

3. How does the institute's structure, size and financial policy contribute to its mission?

Current structure, size and financial policy are well balanced in DIFFER. The fundamental question is whether today's structure, size and budget would enable a decisive role in facilitating the energy transition, unarguably the most fundamental problem of mankind today.

We are, however, concerned about the low level of base funding compared to the large requirement to obtain competitive funding. The application for project funds already now covers a significant percentage of the time of the newly appointed group leaders. Furthermore, continuity of the work on the new topics requires sufficient base funds.

3.4.2 Specific questions

1. Is DIFFER's programmatic approach well aligned with the international Fusion Research programme?

As discussed above (3.2.1) DIFFER's main emphasis is on power exhaust, one of the most important topics as identified in Mission 2 of Europe's research roadmap towards fusion electricity. With its worldwide unique set of PSI facilities DIFFER significantly contributes to this mission, in concert with the exhaust programmes at the European and worldwide tokamak facilities. With its additional emphasis on the development of liquid metal divertor targets, DIFFER recently entered a new high risk/high gain topic of very high relevance. The very good alignment with the European and international fusion programmes is also obvious for the work on plasma diagnostics, modeling and control.

2. Is DIFFER's Solar Fuels programme implemented successfully and is the research focus well chosen?

Comments to Mission 2011-2016: "Perform leading fundamental research in the fields of fusion research and solar fuels research".

The focus for Solar Fuels research of DIFFER for this period has been "Convert renewable energy (photons directly or via electrons) into CO₂ neutral fuels and chemicals, gaining international distinction and recognition in the field of solar fuels research". Doing so, DIFFER identified three research lines (1) non-thermal chemical processes; (2) functional materials and interfaces; (3) light-matter interactions.

The evaluation committee is of the opinion that this has been a good, cohesive choice of approach, because it uses non-equilibrium plasma and plasmon-assisted catalysis using nanostructured materials to exploit non-thermal, far-from equilibrium effects in novel approaches for high efficiency and high selectivity of CO₂ reduction, H₂O splitting, and N₂ reduction (a recognized challenge in fundamental energy science). This is an excellent fundamental scientific niche of DIFFER that underlies 'Grand Challenge' goals, with examples suggested below.

Regarding the stated goal for DIFFER to gain a distinctive position internationally in the field of Solar Fuels research, the potential to do so is there and DIFFER is on the way, but there is still some way to go. To this end, what is missing is a commitment to one or two 'Grand Challenges' in the field of Solar Fuels that are viewed as critical by the Solar Fuels community. Leading in solving a 'Grand Challenge' problem in the field would be an effective approach for DIFFER to gain profile in the Solar Fuels community. Importantly, it would serve to focus the creative energies of the PIs of the Institute on a common 'Grand Challenge', creating the necessary cohesion and synergy among the groups to accelerate progress towards solving a critical problem. Focusing on a Grand Challenge that only an Institute or Center (as opposed to small university teams) can solve is essential for justifying the long-term funding sources for the Institute. Examples for 'Grand Challenges' might be: "Conversion of dilute atmospheric CO₂ to fuel, which requires integration of the CO₂ to CO conversion by renewable electricity-powered plasma chemistry with atmospheric CO₂ capture and concentration", or "Plasma assisted heterogeneous catalysis of the N₂ to ammonia conversion reaction". Both subjects are well aligned with proposed future research presented at the site visit and described in the review documents.

Comments to the proposed mission 2017-2022: "Perform leading fundamental research on novel materials, processes and systems for global sustainable energy infrastructure".

In the committee's opinion, there is a real danger in directing resources for diversifying the institute's research portfolio outside fusion and solar fuels. A main reason is that this new mission gives no rallying point for research groups, and allows PIs to pursue diverse, possibly diverging topics that may not help furthering synergy within DIFFER because the mission is too broad. Creative energies of PIs are not focused on a common hard problem that only a center can tackle. Breaking down a challenging scientific barrier would help lift DIFFER to international prominence in the Solar Fuels field.

The three cross-cutting themes proposed are well chosen, as is the intent to use them to provide unique capabilities to the Dutch research community.

3. Is DIFFER's connecting and coordinating approach well suited to create (or lead) an (inter)national fundamental energy research community?

The areas of Fusion Energy and Solar Fuels are at different levels of maturity and this is reflected in their positions within their communities. The two areas are out of phase with each other so it is difficult to draw direct comparisons at this point in time. The Fusion section has plans to initiate a National Nuclear Research Programme. Initial discussions have taken place (particularly with TUDelft) and workshops are being organised. Funding in the order of 20M€ would be required to establish such a programme which would make facilities and infrastructure accessible to the nuclear energy research community, particularly in the area of molten salts for Gen IV systems. The Solar Fuels area is relatively new, so just starting to make an impact. While they are present at a number of CO₂-use related meetings, it is disappointing that there were no speakers from DIFFER at the 2nd International Conference on Solar Fuels in 2017. DIFFER needs to establish a profile globally and within Europe. Stronger links are needed in this area through contacts outside the Netherlands and Europe. Greater effort is needed to drive the agenda of DIFFER within the research communities.

In respect of esteem, there is good engagement at a national level, however international visibility seems limited in Solar Fuels research. There are plans to run national conferences but there needs to be a greater lead in international activities, including organising international meetings and workshops. A more challenging publication strategy should be considered that result in articles in high impact journals that do not address niche markets. DIFFER needs to be seen to advise on national and European policies. While it is recognised that DIFFER focuses on fundamental research it is bound by science and engineering. When

considering global recognition, social aspects of the work need to be considered. By positioning the institute within an additional political framework, they may be able to develop greater influence. Within Solar Fuels, membership of organisations such as CO₂ Value Europe should be considered as an entry point.

4. Should DIFFER play an active role to involve other disciplines relevant to the Energy Transition?

In many fields of science/technology a significant gap exists between fundamental and applied research. Very often, ideas generated within fundamental research are not picked up easily in applied R&D and vice versa. For energy research this is very undesirable and could, for instance, hamper development of solar fuels technology. DIFFER could play a role to alleviate this problem through involvement of other disciplines relevant to further development of a certain technology. It could be imagined that DIFFER takes up responsibility for certain development programmes executed outside the institute in Eindhoven. In this way, a seamless connection between fundamental and applied research is warranted. More social and economic interactions and collaborations should be considered, especially life cycle assessment when developing innovative low carbon processes.

4 Conclusions and recommendations

4.1 Conclusions

During the previous 6 years, DIFFER underwent a complete restructuring process with the spin-out of the non-energy research groups and the start of a completely new research field: Solar Fuels. In parallel, the institute has been relocated to its new building on the TU/e campus in Eindhoven. All these changes have been managed extremely well. The institute is now in very good shape to continue with the research in its two main topics: Fusion Research and Solar Fuels.

Over the evaluation period, Fusion Research quality and output, which already was strong, has further strengthened. With its world-leading Magnum-PSI facility, DIFFER is very well equipped to continue to play a major role within the EUROfusion consortium and worldwide. The plasma-materials interactions have strongly strengthened with Magnum-PSI coming online and taking up the challenge of liquid metals as first-wall components. The integrated modelling areas have continued to mature and, together with improved diagnostics and control capabilities, have attained direct forward predictability of the core plasma and control of instabilities. The new research area in computational physics and chemistry, although less than a year old, has shown bright promise in attacking the physics of N species (atoms, ions, radical molecules) in the divertor region. The quality of research in this area is excellent.

For the new research field on Solar Fuels, this evaluation should be regarded more as a mid-term evaluation, as DIFFER has only recently started corresponding activities. As a particular promising and unique activity at DIFFER, the solar fuel generation by non-equilibrium plasmas stands out. The overall quality of the research on solar fuels is very good. It is not yet mature enough to be internationally leading.

DIFFER's research has an outstanding relevance to society. Not only is the research on sustainable energy options very relevant to society in general, DIFFER actively pursues an agenda setting role in connecting society, industry and academia around fundamental energy research.

With its two major research fields DIFFER is ideally placed to benefit from funding activities both in the Netherlands and in the European Union. There is good integration of the research activities with outside companies and with academia. The panel is however concerned about the low level of base funding compared to funds that need to be obtained in competition. The overall assessment of DIFFER's viability is very good.

DIFFER has a very successful and well-structured PhD programme. The number of PhD students supervised by DIFFER is impressive, given the number of staff involved.

Research Integrity is taken very seriously. During the evaluation period there have been no cases of misconduct or fraud at DIFFER nor other issues relating to research integrity.

DIFFER has adopted a very ambitious policy regarding diversity in gender, age and ethnicity.

4.2 Recommendations

- In general, we applaud the change in the mission statement. We do consider the new mission statement as being, in principle, adequate for an institute performing

fundamental research. It does however seem to be too broad compared to the research capabilities and topics dealt with in DIFFER. We recommend a more focused mission statement is prepared.

- We recommend that a Grand Challenge be defined that will allow the DIFFER Solar Fuels programme to become world leading.
- We recommend the appointment of a Senior Research Leader in Solar Fuels, with sufficient maturity and international standing.
- DIFFER should develop a strategy towards control in the area of plasma edge and divertor parameters in collaboration with other groups. It should be determined how DIFFER can become world leading in this research field.
- The DIFFER management team should continue to exploit further synergies between Fusion Energy and Solar Fuels, in particular in modelling of activated species.
- Efforts should be made by DIFFER to increase the international visibility of their solar fuels research through publishing important results in highly regarded general chemistry and material science journals. Participation and presence at the most relevant internationally leading conferences should be increased by DIFFER. Approaches should be made directly to conference organisers to secure oral (particularly Invited, Keynote and Plenary) presentations.

Annex 1. Curricula Vitae of Evaluation Committee Members

Sibylle Günter (chair) studied physics in Rostock, where she received her PhD degree in 1990, and her habilitation in 1996. She then moved to the Max-Planck Institute for Plasma Physics, where she was appointed in 1997 as a group leader. In 2000 she was appointed as scientific member of the Max-Planck society and director at the Max-Planck Institute for Plasma Physics. In 2001 she was appointed as adjunct professor at Rostock university and in 2006 as honorary professor at the Technical University of Munich. In 2011 she became the scientific director of the Max-Planck Institute for Plasma Physics, chair of the directorate and of the Board of Scientific Directors. Her research interests are plasma spectroscopy, theory of magnetized plasmas, experimental tokamak physics, and numerical methods to describe transport in strongly anisotropy systems.

Fraser Armstrong obtained his PhD at the University of Leeds in 1978, and then carried out research at the University of Konstanz as a Royal Society European Exchange Fellow. Following studies with Helmut Beinert (Enzyme Institute Madison) and Allen Hill (Oxford), he was awarded a Royal Society University Research Fellowship which he held in Oxford until 1989 when he joined the Chemistry Faculty at the University of California, Irvine. He moved to his present position in Oxford in 1993. In 2008, he was elected a Fellow of the Royal Society- the national academy of sciences of Great Britain and the Commonwealth. He has developed new applications of dynamic electrochemical techniques for studying complex electron transfer and catalytic reactions in redox proteins. These efforts have provided new insight into the perfection of enzymes as catalysts and the design of optimal electrocatalysts for the future, both in detail and horizon ('almost-perfect' catalysts do exist). He coauthors an internationally leading textbook on Inorganic Chemistry.

Heinz Frei studied chemistry at the ETH Zurich, where he received his PhD degree in 1977. After a postdoctoral stay at the Chemistry Department of the University of California at Berkeley, he started a research group in solar photochemistry at LBNL with focus on chemistry with near infrared light. He served as a Deputy Director of LBNL's Physical Biosciences Division (1998-2007) and the Helios Solar Energy Research Center (2008-2011), and was one of the founding scientists of the Joint Center for Artificial Photosynthesis (JCAP, the U.S. Dept. of Energy Innovation Hub for Fuels from Sunlight), Leader of the Center's Interface Project 2010-2015, and Acting Dept. Head of JCAP at LBNL in 2012. Currently, his research effort focuses on the scientific challenges of the direct conversion of carbon dioxide and water to a liquid fuel by artificial photosynthesis. He was elected Fellow of the AAAS in 2014.

Hans Geerlings studied experimental physics in Amsterdam, where he received his PhD degree in 1987. In that year, he moved to Shell, where he worked in research on a number of topics including synthesis gas generation and conversion, hydrogen storage and CO₂ capture and sequestration. In 2007, he was appointed as a part-time professor of chemical engineering at the Delft University of Technology. His current research interests include fundamental and engineering aspects of solar fuel synthesis.

Bruce Lipschultz obtained his PhD in Plasma Physics related to fusion plasmas from the University of Wisconsin, USA, in 1979. He then took a position at the Massachusetts Institute of Technology, leading the research in Fusion plasmas near the surfaces of tokamak devices. Since 2013 he has been a Professor at the University of York, UK, continuing the study of plasmas as well as the development of new tokamak magnetic configurations for controlling plasma surface interactions. He carries out experiments at EU facilities in the UK, Germany

and Switzerland. His research has generally focussed on the understanding and development of the use of atomic processes to remove energy and momentum from the tokamak exhaust plasma before it reaches so-called 'divertor' surfaces.

Peter Styring studied Chemistry in Sheffield, where he received his PhD degree in 1989. After a postdoctoral stay at Stony Brook, he became Lecturer in Organic Chemistry at the University of Hull, where he stayed until 2000. That year he returned to the University of Sheffield, in the Department of Chemical & Biological Engineering where he became Professor of Chemical Engineering & Chemistry in 2007. He was appointed as Departmental Director of Research & Innovation in 2015, and in 2017 became Head of the Department of Chemistry. His research focusses on the capture and utilization of CO₂ and covers areas as diverse as organic and polymer synthesis, catalysis, reactor design and policy (including Life Cycle and Techno-economic Analyses). He is Director of the UK Centre for Carbon Dioxide Utilisation and International Scientific Advisory Board member of the Carbon XPRIZE, the Global CO₂ Initiative and the ICCDU. He is Chair and Director of the EPSRC CO₂Chem Grand Challenge Network which has over 1,200 members globally.

Annex 2. Programme of the Site Visit

15 – 17 October 2017

Sunday, 15 October 2017

Location: Hotel Pullman, Vestdijk 47, Eindhoven

- 17.30 – 17.40 Welcome, introduction and installation by member of NWO Executive Board
- 17.40 – 17.50 Introduction of NWO in Dutch context by member of NWO Executive Board
- 17.50 – 18.20 Discussion with NWO Executive Board on institute specific issues
- 18.20 – 18.30 Introduction of Dutch knowledge landscape and SEP (external secretary)
- 18.30 – 19.00 General introduction to DIFFER (past and future) by Prof. dr. ir. Richard van de Sanden (also present members DIFFER MT Prof. dr. Marco de Baar and Dr. Wim Koppers)
- 19.00 – 19.30 Internal discussion of panel, division of tasks (closed session)
- 19.30 Dinner at hotel (closed session)

Monday, 16 October 2017

- 08.15 – 08.45 Transport from the hotel to the institute
- 08.45 – 09.00 Welcome at the institute

DAY 1: PAST PERFORMANCE

FUSION ENERGY

- 09.00 – 09.15 Introduction by panel discussion leader: Prof. dr. S. Günter (closed)
- 09.15 – 09.30 Introduction by division head – Prof. dr. Marco de Baar
- Presentations *10 min + 10 min discussion (panel and presenter, excl. division head)*
- 09.30 – 09.50 Dr. Thomas Morgan – Plasma Material Interactions
- 09.50 – 10.10 Dr. Ivo Classen – Plasma Edge Physics and Diagnostics
- 10.10 – 10.25 *Coffee break*
- 10.25 – 10.45 Dr. Paola Diomede – Computational Plasma Physics and Chemistry
- 10.45 – 11.05 Dr. Egbert Westerhof – Integrated Modelling and MHD
- 11.05 – 11.25 Dr. Jonathan Citrin – Integrated Modelling and Transport

DIFFER RESEARCH FACILITIES & INSTRUMENTATION

Presentations *10 min + 5 min discussion (panel and presenter)*

11.25 – 11.40 Dr. Hans van Eck – Facilities & Instrumentation for Fusion research

11.40 – 11.55 Dr. Stefan Welzel – Facilities & Instrumentation for Solar Fuels research

11.55 – 13.00 Tour of the premises

13.00 – 14.00 *Lunch (incl. poster session/interview of PhD students, excl. MT DIFFER)*

SOLAR FUELS

14.00 – 14.15 Introduction by panel discussion leader: Prof. dr. F. A. Armstrong (closed)

14.15 – 14.30 Introduction by division head – Prof.dr.ir. Richard van de Sanden

Presentations *10 min + 10 min discussion (panel and presenter, excl. division head)*

14.30 – 14.50 Dr. Andrea Baldi – Nanomaterials for Energy Applications

14.50 – 15.10 Prof. dr. Jaime Gómez-Rivas – Photonics for Energy

15.10 – 15.30 Dr. Anja Bieberle-Hütter – Electrochemical Materials and Interfaces

15.30 – 15.50 Dr. Mihalís Tsampas – Catalytic and Electrochemical Processes for Energy Applications

15.50 – 16.05 *Coffee break*

16.05 – 16.25 Dr. Hindrik de Vries – Atmospheric Plasma Processing of Functional Films

16.25 – 16.45 Dr. Michael Gleeson – Materials and Surface Science

16.45 – 17.05 Dr. Gerard van Rooij – Non-equilibrium Fuel Conversion

17.05 – 17.25 Dr. Waldo Bongers – Plasma Solar Fuels Devices

17.25 – 18:15 Free discussion with all presenters from morning/afternoon session

Presentation *30 min + 15 min discussion*

18.15 – 19.00 Dr. Wim Koppers

DIFFER 2011–2016: Diversity, Integrity policy and PhD programme

DIFFER 2011–2016: Organisation, Governance and Finance

19.00 Transport to restaurant/hotel and working dinner (closed session)

Tuesday, 17 October 2017

07.30 - 08.30 Closed breakfast session panel

08.30 - 09.00 Transport from the hotel to the institute

DAY 2: STRATEGIC PLAN DIFFER AND FUTURE RESEARCH

09.00 – 09.15 Presentation of panel questions to DIFFER MT in preparation of working lunch

Presentation *30 min + 15 min discussion*

09.15 – 10.00 Prof.dr.ir. Richard van de Sanden (also present Prof. dr. Marco de Baar and Dr. Wim Koppers) - New mission and strategic plan DIFFER 2017 – 2022

Presentation *15 min + 15 min discussion*

10.00 – 10.30 Dr. Wim Koppers

DIFFER 2017–2022: Diversity, Integrity policy and PhD programme

DIFFER 2017–2022: Organisation, Governance and Finance

10.30 – 11.00 *Coffee break*

11.00 – 12.30 Closed session panel (*discussion, formulating further questions, writing report*)

12.30 – 13.30 *Working lunch (incl. the MT DIFFER if there is need for additional questions)*

Presentation by chairman *10 min + 20 min discussion*

13.30 – 14.00 Meeting/interview with the chairman of the SAC-DIFFER (*panel and chair SAC by video*)

14.00 – 17.30 Closed session panel (*writing report*)

17.30 - 18.15 Closure with director and NWO representative, presentation of draft assessment (*including snack*)

18.15 – 18.45 Transport to restaurant

19.00 Closing dinner (with the MT DIFFER if the report is finished by evaluation commission otherwise working dinner without MT DIFFER), followed by transport to the hotel

Annex 3. Quantitative data composition and financing

Funding

Funding of running budget (k€)	2011	2012	2013	2014	2015	2016
Funding						
Direct funding	7103	6547	6308	6832	5892	6562
Research grants	1112	2649	3615	2223	3260	1808
Fusion Energy	1472	1472	1452	1655	1040	680
Solar Fuels	0	0	1763	870	2220	1128
Former Research	-360	1177	400	-302	0	0
Contract research	5320	3784	2092	2632	3080	3256
Fusion Energy	1864	2144	1769	2295	2171	1982
Solar Fuels	17	17	17	527	909	1274
Former Research	3439	1623	306	-190	0	0
Relocation PSI-lab	30	303	-53	1210	2540	2739
Total funding	13565	13283	11962	12897	14772	14365
Expenditure						
Personnel costs	11478	10163	8487	8257	8668	8386
Other costs	2212	2740	2390	2103	3542	3986
Investments	1357	602	2102	463	311	724

Staff

Staff (ppy)	2011	2012	2013	2014	2015	2016
Research staff	90	85.2	77.3	63.7	73.0	69.3
Principal Investigators	13.9	12.8	10.3	7.9	13.0	16.8
Fusion Energy	7.0	7.0	5.9	4.5	3.2	6.0
Solar Fuels	1.0	1.0	1.4	1.9	9.8	10.8
Former research	5.9	4.8	3.0	1.5	0.0	0.0
Senior scientists	11.9	10.1	11.3	12.9	6.2	3.3
Fusion Energy	6.1	5.6	6.2	6.1	5.6	3.3
Solar Fuels	2.0	2.5	4.1	6.3	0.6	0.0
Former research	3.8	2.0	1.0	0.5	0.0	0.0
Post-docs	5.7	10.0	11.1	10.7	18.0	15.0
Fusion Energy	3.2	7.5	8.4	8.3	7.6	4.9
Solar Fuels	0.0	0.0	0.6	1.9	10.4	10.1
Former research	2.5	2.5	2.1	0.5	0.0	0.0
PhD students	33.6	32.3	29.5	17.1	20.7	18.7
Fusion Energy	16.5	20.2	17.1	12.4	9.1	5.1
Solar Fuels	0.2	1.6	1.7	4.2	11.6	13.6
Former research	16.9	10.5	10.7	0.5	0.0	0.0
Research engineers	24.9	20.0	15.1	15.1	15.1	15.4
Fusion Energy	11.1	8.9	9.1	11.1	11.3	10.7
Solar Fuels	2.0	2.0	2.0	3.0	3.8	4.7
Former research	11.8	9.1	4.0	1.0	0.0	0.0
Support staff	55.4	51.1	48.7	46.2	45.3	45.1
Administrative and general support	24.8	23.2	23.9	23.3	22.9	22.7
Technical support	30.6	27.9	24.8	22.9	22.4	22.4
Total staff	145.4	136.3	126.0	109.9	118.3	114.4

Research output

Research output by theme	2011	2012	2013	2014	2015	2016
Refereed articles	214	143	129	99	114	103
Fusion Energy	135	73	102	71	76	64
Solar Fuels	0	0	0	14	38	39
Former research	79	70	27	14	0	0
Refereed articles by FELIX users (1)	54	44	0	0	0	0
PhD Theses	13	8	8	9	6	8
Fusion Energy	10	4	4	8	3	4
Solar Fuels	0	0	0	0	3	4
Former research	3	4	4	1	0	0
Seminars	20	10	7	18	15	24
Fusion Energy	19	7	4	13	3	11
Solar Fuels	0	0	3	5	12	13
Former research	1	3	0	0	0	0
Invited conference presentations	47	37	40	40	49	58
Fusion Energy	25	17	24	19	13	20
Solar Fuels	0	7	9	20	36	38
Former research	22	13	7	1	0	0
Other conference contributions (2)	251	266	248	187	189	180
Fusion Energy	182	175	154	113	99	86
Solar Fuels	0	2	42	59	90	94
Former research	69	89	52	15	0	0
Total	599	508	432	353	373	373

Note 1: Output which does not include a DIFFER co-author by external users of the FELIX user facility (spun out to Radboud University Nijmegen).

Note 2: regular conference presentations, posters and papers

Bibliometric analysis		2011	2012	2013	2014
DIFFER	Publications	194	136	127	97
	MNCS (1)	1.44	1.30	1.42	1.75
	PP (top 10%) (2)	15%	15%	17%	23%
Fusion Energy	Publications	108	69	100	70
	MNCS	1.30	1.20	1.44	1.85
	PP (top 10%)	14%	10%	19%	25%
Solar Fuels	Publications	27	2	4	15
	MNCS	2.28	-	-	1.81
	PP (top 10%)	26%	-	-	23%

Note 1: MNCS - Mean Normalized Citation Score, with 1 as the world average.

Note 2: Proportion of papers that achieve the top 10% of their field in terms of citation impact.

Research facilities

Use of facilities by peers		2014	2015	2016	2017
Magnum-PSI	Experimental days	50	Relocation shutdown		61
	EUROfusion funding covered	31	Relocation shutdown		33
Pilot-PSI	Experimental days	97	96	Relocation shutdown	
	EUROfusion funding covered	95	79	Relocation shutdown	

PhD candidates

Enrollment				Success rates: graduated in year of PhD period					
Start-ing year	Male	Fe-male	To-tal	4 or ear-lier	5 of ear-lier	6 or earlier	7 or ear-lier	Not yet finished	Discon-tinued
2008	5+1	1+1	8	4/50%	2/25%	2/25%			
2009	7	1	8	3/37.5%	4/50%		1/12.5%		
2010	5	2	7		7/100%				
2011	9+1	1	11		8/73%	2/18%			1/9%
2012	1+1	0	2		2/100%				
2013	2+2	0	4					4/100%	
2014	8+1	1+1	11					11/100%	
2015	5+1	1	7					7/100%	
2016	4+2	0	6					6/100%	
Total	46+9	7+2	64	7/11%	23/36%	4/6%	1/2%	28/44%	1/2%

Note: PhD candidates conduct research with the primary aim/obligation of graduating, based on an 0.8-1.0 FTE contract. This includes PhD candidates with employee status and externally funded candidates (indicated as "+X") without employee status who are conducting research under the authority of the research unit.

Research output at the institutional and thematic level

	2011	2012	2013	2014	2015	2016
Publications with industrial partners	8	7	15	6	4	6
Fusion Energy	3	3	10	5	2	1
Solar Fuels	0	0	0	0	2	5
Former research	5	4	5	1	0	0
Patents and licenses registered	0	3	0	2	0	1
Active co-patents in portfolio	45	29	32	33	2	2
Co-patents applied for	2	7	0	0	0	0

Annex 4. Explanation of the categories

The committee assesses the institute on the three assessment criteria: research quality, relevance to society and viability. These criteria are assessed both in qualitative terms (with arguments) and quantitative terms (in one of the four categories, see the table below).

Table 1. Meaning of categories in SEP 2015-2021

Category	Meaning	Research quality	Relevance to society	Viability
1	World leading / excellent	The institute has been shown to be one of the few most influential research groups in the world in its particular field.	The institute makes an outstanding contribution to society.	The institute is excellently equipped for the future.
2	Very good	The institute conducts very good, internationally recognised research.	The institute makes a very good contribution to society.	The institute is very well equipped for the future.
3	Good	The institute conducts good research.	The institute makes a good contribution to society.	The institute makes responsible strategic decisions and is therefore well equipped for the future.
4	Unsatisfactory	The institute does not achieve satisfactory results in its field.	The institute does not make a satisfactory contribution to society	The institute is not adequately equipped for the future.

In addition to the three criteria, every assessment also considers at least three further aspects: PhD programmes, research integrity, and diversity. These aspects are only assessed in qualitative terms.