Integrating Energy Recovery into Solid Waste Management Systems

Task 36 Final Proposal for Task Prolongation for the New Triennium 2016-2018

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Endorsement by ExCo Member of participating country
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Objective

To collect, analyse, share, and disseminate best practice technical and strategic non-technical information on integration of energy recovery into solid waste management, leading to improved availability of information to decision makers and to increased acceptance and performance in terms of environment, costs, and reliability.

Work scope

The proposed integration of energy into solid waste management Task is a prolongation of Task 36, with continued emphasis on dissemination of information aimed at policy and decision makers.

The program of activities defined in this proposal builds upon the work done in the current Task 36 triennium and addresses key challenges in the integration of energy into solid waste management solutions and decisions. It includes actions that look at the role that energy recovery can play in a transition to a circular economy, waste to energy in developing economies and the influence of the varying international policy and legislative factors, including fiscal measures on energy recovery. Further work will involve an updated assessment of the technologies, markets and legislation relating to the management of residues from energy recovery from waste. The proposed scope of work also focuses on future development of energy recovery from waste, specifically at the growing trend of converting solid waste to liquid fuels and other commodities. The Task is intending to collaborate with Task 33 in this area. We are also considering a seminar on challenging biomass fuels which will include waste derived fuels, in collaboration with Task 32; and we have agreed to work in collaboration with Task 40 on the trade of EfW fuels in Europe. The Task will also continue to work closely with trade organisations, operating industry and with research organisations. The structure of work will generally consist of a workshop exploring each theme, associated summary reports and technical site tours.

Work programme

- Task meetings to exchange results from relevant national R&D programmes and participant country updates and developments, and best practice.
- Field trips associated with the Task meetings, including visits to state of the art facilities to view new developments in conversion of solid waste to liquid fuels and other commodities, and residues treatment facilities. Presentation of information from these visits will be made available on the Task 36 website.
- International workshops in conjunction with the Task meetings, to cover new developments in energy recovery; advanced treatment technologies and conversion of waste feedstocks to liquid fuels; the role of energy recovery in a circular economy; legislative and policy drivers; and factors influencing the development of waste to energy internationally.

- Specific actions resulting in discussion of concepts for improved integration of energy from waste into resource value chains[1], including:
    - Recent and future trends to convert **solid waste into liquid fuels** and other commodities, including examination of waste feedstocks, technologies, applications and drivers. This work will be done in collaboration with Task 33.
    - Examination of the role that EfW has to play in a **circular economy**, including the recovery of materials and by-products from waste. This will examine how energy recovery can be included in a fully integrated waste management system to close the resources circle and how waste refineries might be developed.
    - **Transboundary shipments** of waste to be used in energy recovery. This work will be done with Task 40.
    - Latest developments in waste derived fuels, including **solid recovered fuel** (SRF), with the intention of providing information for decision makers; this topic will also cover current trends in the use of commercial and industrial waste as alternative feedstock to MSW.
- Information exchange with IEA Bioenergy Task 33 as indicated above. This would facilitate discussion on a range of aspects impacting on conversion of solid waste to liquid fuels, including technologies, markets, feedstocks, policy etc. The Task is in discussion with Task 33 on the potential to do a joint project in this area.
- A joint seminar with Task 32 on the topic of challenging biomass fuels is under discussion. Task 36 will contribute to presentations on waste derived fuels and solid recovered fuels for this seminar.
- A joint project and workshop with Task 40 on the trade of EfW fuels.
- Strategic project – see outline below
- Information exchange with other IEA Bioenergy Tasks and other international networks on relevant energy from waste technologies worldwide;
- Closer links to the **International Solid Waste Association** (ISWA). ISWA are working in related areas and have asked Task 36 to participate in their Task Force on Resource Management. We are currently discussing this with them.
- Closer links to European Recovered Fuels Organisation (ERFO) (we are currently discussing this with them).
- ExCo interaction and support

Strategic Projects

Task 36 will be part of the proposed strategic topic on fuel pre-treatment for thermal conversion. We will provide best practice information on energy recovery from solid waste for this work, including a joint case study with Task 33 on pre-treatment for gasification of solid recovered fuel.

Potential additional work

Due to the limited budget in Task 36 the work programme have been limited to the tasks described above for the next triennium. However there are also some additional areas that are of large interest that might be subject to specific actions during the period. If more nations become members during the period and thus the budget increases these topics will be considered:

- Review of international policy, legislative and fiscal drivers impacting on energy recovery (for example, there are moves to limit municipal solid waste to energy in some countries to no

[1] For example there are proposals for Smart Management of waste, which takes into account the technical, environmental and economic factors influencing waste management. See, for example: http://www.navigantresearch.com/research/smart-waste. Alternative proposals include the development of a circular economy. This represents an alternative to a traditional linear economy, in which commodities are produced, used and thrown away. A circular economy keeps resources in use for as long as possible, allowing the extraction of maximum value from them whilst in use, then recovery and regeneration of products and materials at the end of each service life

more than 30%; and there are incentives to make advanced conversion more viable).

- Challenges to the integration of energy from waste into waste management in **developing economies**;
- Update on the status of treatment technologies, legislation and markets for residues of energy recovery, including bottom ash and air pollution control residues

Deliverables and Target Groups

The following deliverables will be primarily aimed at decision makers who impact the development and delivery of energy from waste, and will include:

- A summary report on conversion of solid waste to liquid fuels;
- A workshop and summary report on transboundary shipments of waste (in particular refuse derived fuels) for energy recovery (with Task 40);
- An update report on the situation regarding solid recovered fuels; and
- A review of the web site and the way it is used (budget permitting).

All reports and workshop proceedings will be disseminated in the following way:

- Publication on the Task 36 website;
- Summary articles in appropriate trade publications, which will signpost to relevant content on website;
- Conference papers targets at relevant international waste management conferences, for example ISWA (International Solid Waste Association), IWWG (International Waste Working Group) – International Symposium on Energy from Biomass and Waste, International Symposium on Waste Management and Landfill Symposium; and
- Biannual newsletter – highlighting recent workshop proceedings and published reports.

The following deliverables will also provide information to the Executive Committee on the progress of the work:

- Two Task meetings each year, including site visits and workshops, reported on the web site and via appropriate trade press;
- Updated web site and web visit numbers; and
- Progress reports, financial reports and audited accounts for the Executive Committee.

Management of the Task

Task Leader: The Task Leader for this work will be Inge Johansson.

Task Assistant: Inge will be assisted by Pat Howes and Kathryn Warren as Task Assistants for the first six months of the project, to ensure smooth handover of the work.

Further information on their experience is provided in Section 4.1 of this proposal.

Annual Budget US$15,400; **Budget per participant**; US$61600, assuming 4 countries participate.

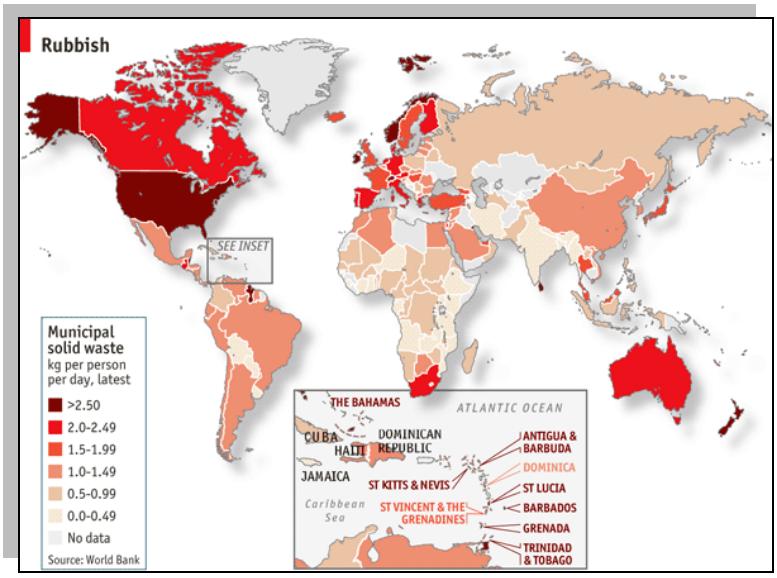
Contents

1. Background

1.1 Why do we need to examine energy from waste?

Figure 1 shows their World Bank figures for waste arisings per person worldwide and shows how waste production is currently highest in OECD countries. In 2012 the World Bank estimated that there is around 1.3 billion tonnes of waste produced per annum globally. However, it also estimated that this will grow to 2.2 billion tonnes/year by 2025 and attributed this rise to increased urbanisation in developing and emerging economies and the associated increase in per capita production of waste.

Figure 1: Production of MSW worldwide (Source: the Economist based on the World Bank, 2012)



In addition to these global trends there are important regional trends:

- In Europe, for example, a legislative framework has been developed to address the impact of waste generation and encourage adherence to a waste management hierarchy in which waste reduction is of primary importance, followed by reuse, recycling and recovery before final disposal. This has resulted increasingly sophisticated waste management in some European countries, which is stabilising municipal waste production and improving reuse, recycling and recovery, as well as increasing the importance of and efficiency of energy recovery[2]. The European Commission has also proposed a new Directive on waste management that includes targets to 'better reflect the needs of the circular economy'[3].
- In North American the principle of the waste hierarchy is also important and there has been an increase in recycling[4]. However, the potential integration of energy from waste (EfW) plants is undermined by the availability of abundant cheap landfill in many areas. There are signs of change in the more densely populated Eastern States and there are trends to increase materials recovery and consider the value in converting waste to fuels, chemicals and other commodities as opposed to conventional combustion. In the emerging economies of Asia, waste composition is changing to reflect increasing urbanisation and improved incomes, resulting in challenges in waste collection. In these countries there is increased interest in the treatment of waste and associated energy recovery, but because of the high organic content of the waste

[2] For statistics on waste management, see: http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/main_tables
[3] EC Proposal for a Directive of the European Parliament and of the council COM(2014)397 final
[4] See, for example, US EPA statistics on municipal solid waste (http://www.epa.gov/solidwaste/nonhaz/municipal/msw99.htm) and Giroux Environmental consulting (2014) State of waste management in Canada, prepared for the Canadian Council of Ministers of Environment

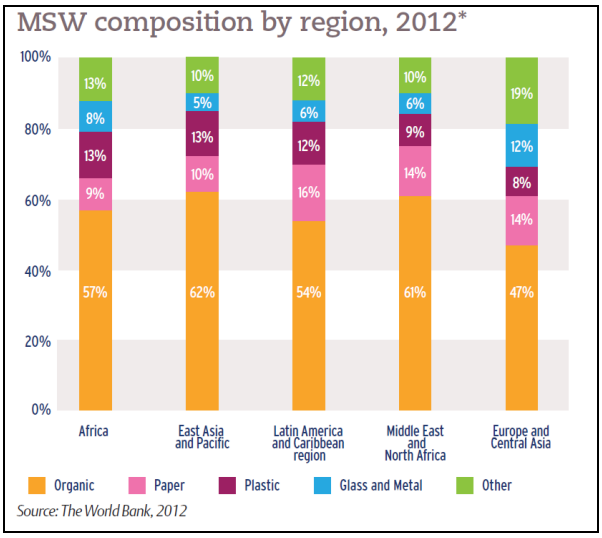
produced interest in anaerobic digestion is greater than that in combustion technologies.

- Per capita production of waste in Africa is still comparatively low, but as economies and urbanisation increase Africa will face the same challenges as Asia – and is already in some urban areas.

Figure 2 demonstrates some of these regional differences. It shows the composition of municipal solid waste generated in different region. This shows that organic waste dominates in most regions, but that the proportion varies and there are other important differences. In regions with high organic waste production the waste will have a high moisture content and low calorific value (CV). As other fractions begin to increase in proportion the CV may increase to a level where EfW is feasible.

Figure 2 provides data averaged over a region, which masks differences within the region. For example, Japan and Singapore both have commercially operating energy from waste plants, although these are only now becoming important to other regions in East Asia.

Figure 2: MSW composition worldwide by region



There is are economic consequences to the growth of solid waste production, represented in the cost of managing the waste. World Bank estimates of these costs are presented in Table 1, showing forecast increases in the cost of waste management for all world regions by 2025.

Table 1: Cost of waste management in 2010 and 2015 (World Bank, 2012)

Estimated Solid Waste Management Costs 2010 and 2025

Country Income Group	2010 Cost[6]	2025 Cost
Low Income Countries[7]	$1.5 billion	$7.7 billion
Lower Middle Income Countries[8]	$20.1 billion	$84.1 billion
Upper Middle Income Countries[9]	$24.5 billion	$63.5 billion
High Income Countries[10]	$159.3 billion	$220.2 billion
Total Global Cost (US$)	**$205.4 billion**	**$375 billion**

Source: Authors' calculations with input from *What a Waste* report (Hoornweg and Thomas 1999) and the World Bank Solid Waste Thematic Group and Carl Bartone.

In 2012 UNEP estimated that 120 million tonnes of waste was treated by EfW worldwide, representing a capacity of 54GW and demonstrating the commercial nature of energy from waste. Their analysis estimated that this will grow to around 0.5 billion tonnes of waste/year by 2050, in plants of capacity equal to 200GW. This is a significant increase and it presents an opportunity as well as a cost for local authorities and municipalities, in that EfW can play an important role in local energy provision, offsetting the costs of waste treatment and providing baseline generation to support

other forms of renewable electricity generation.

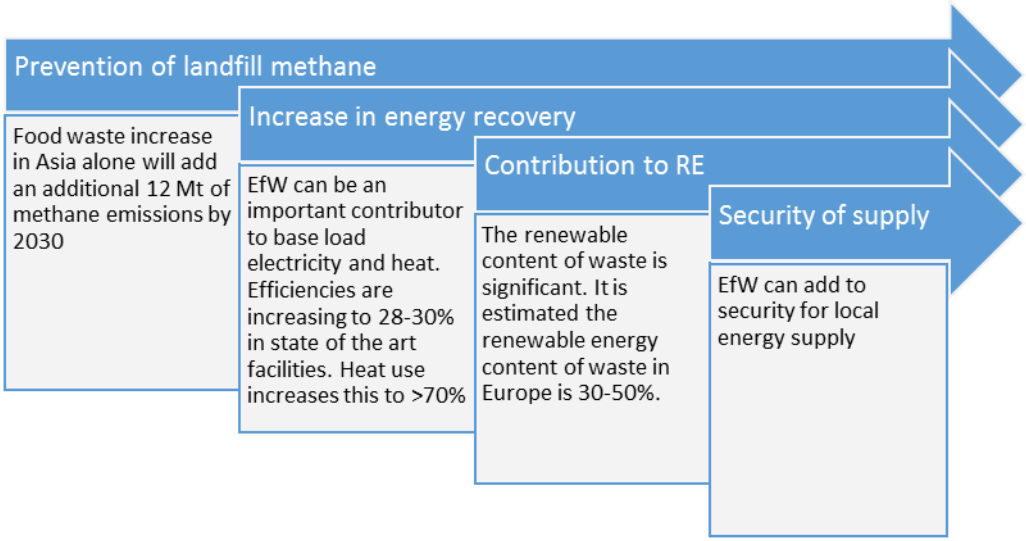
1.2 Why is this relevant to IEA Bioenergy?

Waste is the one biomass resource that is routinely produced in urban environments. It can be used to provide bioenergy that is integrated into the lives of the population. As we have shown above, its management and use is very relevant to growing cities; and its management changes as the needs of the local population evolve. In addition waste is generally regarded as a sustainable biomass source. It can therefore play an integral role in security of sustainable energy supply.

1.3 How is waste management likely to evolve?

Changes in waste management are often linked to other challenges, such as rising resource and energy costs and demands. This has led to the development of new types of waste management systems aimed predominantly at resource management and integrating different waste management technologies more closely. An example of this is the movement to "Smart" Waste Management, which links waste management to other needs, such as improvement in the use of material and energy resources contained within the waste. The costs of not improving waste/resource management and use could be high. Poor waste management is likely to result in higher methane emissions globally and both environmental and health consequences from landfilling or dumping of waste. For example, ISWA[5] estimated that increases in food waste production in Asia alone could increase landfill methane production from 31 to 43 million tonnes/year. Figure 3 summarises some of the reasons why EfW can be important globally and locally.

Figure 3: The importance of energy from waste to sustainable energy



In European countries and other medium to high income countries solid waste contains a considerable energy value, even when the recyclates have been removed. This residual fraction includes significant renewable content that can be exploited in modern EfW systems that can be integrated with materials recovery and efficient energy recovery[6]. There are additional opportunities:

- In Europe there are increasing trends towards the development of **solid recovered fuels** from waste that can be used to decrease carbon emissions from industrial high energy users, such as lime and cement kilns.

[5] Antonis Mavropoulos of ISWA, writing in Waste Management World: http://www.waste-management-world.com/articles/print/volume-11/issue-2/features/waste-management-2030.html

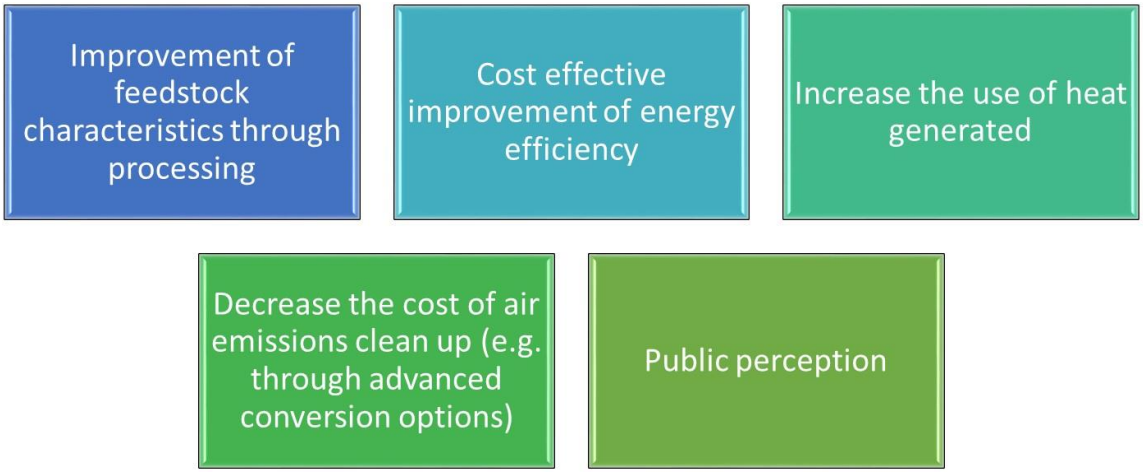
[6] See, for example, the Task 36 report on the management of residues from energy recovery by thermal waste to energy systems (2012): http://www.ieabioenergytask36.org/vbulletin/showthread.php?31-Final-Reports-for-2010-2012&p=31#post31

- There is worldwide interest in making EfW more flexible through the development of advanced thermal conversion treatment, which may allow biofuels production or even the production of high value chemicals.

1.4 Challenges faced by EfW

Most current energy from waste plants have energy efficiencies between 21-28% (electricity generation) or >70% (heat generation). However, in some regions (such as the UK), finding heat users to maximise energy efficiency has proved difficult. As we have noted above, fuel moisture contents are relatively high (particularly in developing and emerging economies) and the energy content of the unprocessed feedstock is relatively low. Air emission clean-up costs are high. All these factors added together make EfW expensive. However, EfW can contribute to sustainable greenhouse gas emission savings[7]. These common challenges to optimising the benefits of EfW are shown in Figure 4.

Figure 4: Common challenges for EfW



In addition operators and policy makers face other challenges:

1. The variable composition of waste both regionally and with time: in most parts of the world waste is changing in composition as reuse, recycling and recovery increase. EfW plants need to be able to cope with this variability and any future changes
2. Poor public perception of EfW because of the industrial scale of development and concerns about emissions from combustion and the impact on human health
3. The changing demands of waste management and the need to integrate energy with these demands
4. In OECD countries: the increasing demands for tailored fuels from waste and how these can be produced without threatening the waste hierarchy
5. In emerging and developing economies: the rapid increase in waste generation in urban environments and the need to develop appropriate waste management strategies that may include integration of energy into solid waste management. To plant this there is a need for data on waste arising, composition and calorific values; there is a need to develop skills and understanding through appropriate training; and there is a need for information provision so that decision makers understand their options and choose the solution appropriate to their needs.

1.5 The role of energy from waste in the circular economy

One important trend in OECD countries is the interest in the circular economy. In EU the proposed Directive (see footnote 3) reflects this interest.

[7] See, for example, analysis done by Task 36 in Environmental Impacts of managing residual municipal solid waste http://www.ieabioenergytask36.org/Publications/2007-2009/Chapter_3_Final.pdf

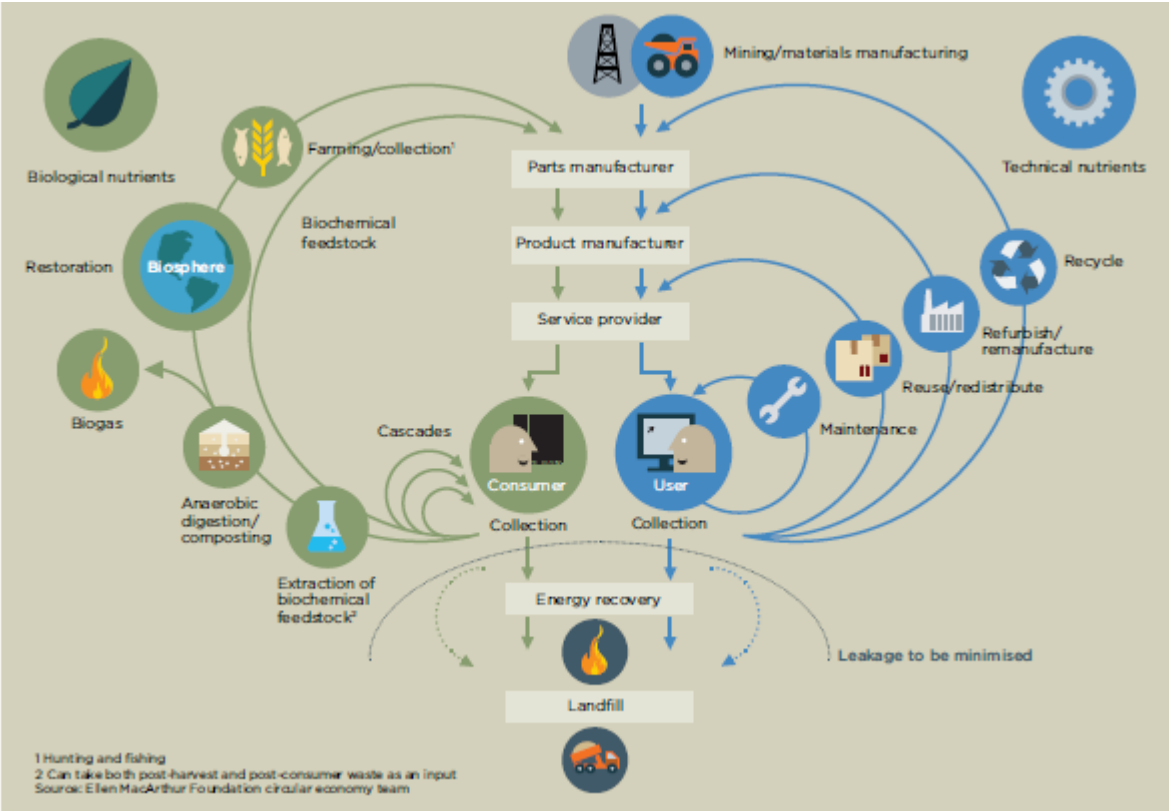
What is the circular economy?

The following definition is taken from the Ellen MacArthur Foundation 2013

"A circular economy is an industrial system that is restorative or regenerative by design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."

This is illustrated in Figure 5.

Figure 5: The circular economy (Ellen MacArthur Foundation, 2013)



1.5.1 How does energy fit with the circular economy?

It has not yet proved possible for circular use of all of the resources in waste; and to process waste there is a need for energy. The niche for energy from waste is currently at the point of treating those fractions of waste that cannot be recycled or recovered; and the fact that it can provide energy to ensure the processing required for reuse, refurbishment or recycling is available. This shows that even in a fully functioning circular economy there is a need for energy.

This means that there will be a need to adopt EfW, so that a solution to dealing with residual waste is provided, whilst at the same time providing some of the energy that will be needed for further processing of materials and resources within a circular economy. One of the challenges facing Task 36 is to follow the development of circular economy concepts over the next triennium and to understand the role that EfW has within these concepts.

2. Role of Task 36

The core role of Task 36 is as a forum for discussion, information dissemination and knowledge flow on the integration of energy into solid waste management and on the challenges facing policy makers involved in solid waste management decisions. Task 36 has an important role in enabling the exchange of ideas, discussion of challenges and exchange of information on current practice.

The proposed work programme presented here is aimed at facilitating exchange of information on strategic, technical and non-technical issues related to the integration of energy into solid waste management. The programme of work has been developed by the current Task 36 participants and through consultation with ExCo members from countries outside of the Task. It has been developed taking into account challenges and trends with waste management and policy considerations in OECD countries.

To be successful at exchange of information we have refined and optimised the use of tools available to us over the 2013-15 triennium and propose to continue this development in the 2016-18 period, through:

- Development of Task meetings, to ensure that each is associated with a workshop relevant to the objectives of the Task and includes a relevant site visit;
- Working with other Tasks to take advantage of synergy between the Tasks and optimise the use of Task budgets by sharing Task deliverables;
- Production of a newsletter twice a year;
- Production of papers to be presented at conferences to publicise and disseminate the work of the Task;
- Production of topic reports on key issues; and
- Development of the use of electronic/Internet communication tools to publicise and disseminate the work of the Task (e.g. by the use of platforms such as linked in and tools such as Twitter).

At the end of the triennium we will review the success of these different dissemination techniques in a cost benefit analysis.

2.1 Priorities for 2016-18

Priorities for 2016-18 have been developed taking the global trends discussed above in to account and also local trends of importance to participating countries.

The key issues of interest to Task 36 participants include:

A. Trends on different waste streams as feedstock, including (1) the processing of waste into specific fuels (‘solid recovered fuels’ and/or ‘refuse derived fuels’), and (2) the use of industrial and commercial waste for energy recovery
B. Developments in the circular economy and smart waste management and the way these impact energy recovery from waste, including the recovery of materials and by-products from waste.
C. Trends on the conversion of waste into chemicals or liquid fuels as part of the thermal conversion process
D. Trends in transboundary shipment of waste
E. Contribution to strategic report on the pre-treatment of fuel for thermal conversion.

Each of these is examined in more detail below.

2.1.1 Trends in different waste streams as feedstock for Waste-to-Energy plants

A1: Production of waste derived fuels

Production of refuse derived fuels and solid recovered fuel (SRF) has increased in Europe in line with developments in waste management and in carbon accounting. Waste fuels are currently classed as renewable for the purpose of the EU Emissions Trading Scheme, which means that many energy intensive industries (such as cement and lime manufacture) are interested in the substitution of fossil energy with specifically developed solid recovered fuels. Task 36 has followed the growth of these fuels, supporting a conference in 2011 and a workshop in 2013. We propose to build on this work by holding a joint seminar with Task 32 (B1) on the topic of co-firing of challenging biomass fuels, including solid recovered fuels from waste. We will then produce a summary report (B2) of the trends in solid recovered fuels aimed at policy makers who need to understand their potential and use.

A2 Most work on energy recovery from waste is relevant to municipal solid waste only, but there are increasing trends in the use of commercial and industrial waste for energy. These trends will be considered in the knowledge exchange at the task meetings. This topic will also be considered in the workshop on challenging biomass fuels to be held with Task 32.

Alignment with Strategic Plan Objectives and Actions: This task is aligned with Objective 1, and will promote the market deployment of technologies and systems for sustainable energy production from a range of waste derived fuels. Our focus on waste derived fuels will encompass a range of bioenergy fuel sources. The outputs of this task are aligned with the Strategic Plan Action of Providing an integrated technologies approach (synergy) with regard to the use of biomass for energy purposes – looking at specifically at waste derived fuels.

2.1.2 B: The Circular economy and smart waste management

As discussed above trends in the circular economy could have significant impacts on waste management practices. It is not clear how these will impact energy recovery from waste nor the role of energy recovery from waste in the circular economy but obvious impacts will come from changing residual waste composition. We will examine these issues by holding a workshop (A1) with leading advocates of the circular economy and smart waste management. The theme of this workshop will be to examine the role that EfW has to play in a circular economy, including the recovery of materials and by-products from waste. This will examine how energy recovery can be included in a fully integrated waste management system to close the resources circle and how waste refineries might be developed.

To assist with this task we will draw on our links with the International Solid Waste Association (ISWA), which has asked Task 36 to participate in their Task Force on Resource Management. The Task also aims to engage a wide range of stakeholders as part of this task. The task has received interest in this area from regions outside of the current task membership. For example, Singapore's National Environment Agency have expressed an interest in this area as they implement a waste-to-energy RD&D program aiming to improve energy recovery and materials recovery. The Task will encourage these links as far as possible, with the aim of opening up further engagement in South East Asia via links in Singapore.

Alignment with Strategic Plan Objectives and Actions: This task is aligned with the strategic objective to 'Encourage and promote the sustainable deployment of technologies with important local, regional, and global socio-economic and environmental benefits that will contribute to a secure energy supply and job creation'. This will be achieved by exploring the role that energy from waste has to play in a circular economy, ensuring materials are kept in use for longer, and maximising resource recovery.

2.1.3 C: Advanced thermal conversion of waste

One interesting development in energy recovery from waste is the increase in interest in advanced thermal conversion of waste. This is related to the potential for greater flexibility in the way the

process is used. For example advanced conversion options can result in the production of gaseous fuel for use in turbines or injection to the grid or the production of other chemicals from the thermal conversion process, such as liquid fuels. There is also a potential for the development of other higher value chemicals, although this is not being realised at present. To examine the progress in the application of these technologies, the challenges that are being faced and the status of the technologies we propose to hold a joint workshop (C1) with IEA Bioenergy Task 33. The aim of this workshop will be to examine recent and future trends (including drivers) and to encourage discussion of a number of key issues, such as feedstock preparation, technologies, the importance of policy support, the commercialisation of the technology and how the technology is being applied.

The work shop, together with other information gathered by Tasks 36 and 33, will be used to produce a report (C2) on the topic, to be written jointly with Task 33.

Alignment with Strategic Plan Objectives and Actions: Amongst others, the output of this topic will meet the objective to ***'****Provide a realistic overview of the readiness level of different conversion technologies as well as potential benefits and impacts on the market'.* This is of particular importance as the emergence of alternative thermal technologies for the conversion of waste is a growing area of interest for both developers and policy makers.

2.1.4 D: Transboundary shipment of waste

D1 Report on transboundary shipment of waste with Task 40.

The production of increased amounts of refuse derived fuel (RDF) through mechanical and biological treatment in Europe has been accompanied by a trend to ship this fraction around Europe. The incentives for this shipment are multiple: including a desire to generate heat locally to feed district heating systems in the Nordic countries or a need to find waste for the current over-deployment of EfW plants in central-western Europe. We will work with Task 40 (D1) to uncover how much waste feedstock is being transported for energy purposes around Europe and the drivers, incentives and implications of this trend. The work will in first instance focus mainly on ongoing trade in the member countries in Tasks 36 and 40. It will cover different types of solid waste beyond RDF, including municipal solid waste, RDF, solid recovered fuel (SRF) and recovered or recycled wood classified as waste. Used cooking oil and other liquid waste streams will not be included.

The study will cover:

- Traded quantities and flows in Europe, together with the drivers for this trade and future trends to 2025
- The impact of this trade on the use of non-waste biomass in the countries importing the waste.
- The fuel properties of various waste streams compared to clean solid biomass streams (Task 36 will provide this).
- Task 40 will also aim to provide a global overview of main waste-to-energy trade flows
- An optional element that could be included is the environmental impact of waste trade compared to other alternatives (e.g. landfilling or construction of domestic combustion facilities). This analysis would mainly focus on GHG balances of waste trade. We are exploring the potential for this analysis to be done in a number of ways, including by Task 38 (the interest/participation of Task 38 is currently explored). An alternative possibility is that this could be covered by an MSc student from Utrecht University with an Internship at Ricardo Energy & Environment.

2.1.5 E: Contribution to the Strategic report on Fuel Pre-treatment of biomass residues in the supply chain for thermal conversion.

EI Chapter for report

Task 36 has committed to the production of a chapter for the proposed report on fuel pre-treatment of biomass residues. This chapter will explore the pre-treatment required for gasification of solid recovered fuels or refuse derived fuels.

2. Review of international policy, legislative and fiscal drivers impacting energy recovery in solid waste management

Task 36 has routine reports on policy and other legislative matters from each participant at its Task meetings. We have recently noted that there are a number of issues that are common to participating countries; and that are of interest to non-participating countries. Due to the budget limitations, this issue will continue to be monitored at the Task meetings. However if there will be an increase in participating countries (and thus budget), we propose to produce a summary report (D2) of trends that impact energy recovery from waste (for example, there are moves to limit municipal solid waste to energy in some countries to no more than 30%; and there are incentives to make advanced conversion more viable).

Alignment with Strategic Plan Objectives and Actions: These tasks are clearly aligned with the specific strategic actions to 'Provide scientifically sound and politically and commercially independent data and information for policy makers, industry and IEA bodies in a format appropriate to the specific audience' and by 'Take a leading role in the discussion of current topics in the field of biomass energy'. The dissemination of information on topics of transboundary shipment of waste and the international policy, legislative and fiscal drivers are key to encouraging other sectors of the bio-based economy to apply the same stringent rules of sustainability and to implement the most appropriate policies relevant to the local situation.

2.2 ExCo interaction and support

This Task will continue to support the Bioenergy Agreement in its work. To do this the Task leader will attend ExCo meetings as necessary and provide annual reports and accounts as required.

To strengthen the involvement of the ExCo with the Task, the ExCo member for the host country will be invited to participate in the Task meeting held in their country.

All ExCo members will be provided with access to all parts of the Task 36 web site, including member only sections.

2.3 Information dissemination and knowledge flow

Task 36 generates information through its Task meetings, topic reports prepared from projects funded by the Task and from presentations at workshops and conferences. Communication of this information is normally through its web site and through workshops and presentations at conferences. The web site has proved to be an efficient means of dissemination of knowledge. The web site received an average of 7000 visits per month, over 84000 visits in 2014, with more than 235,000 page visits. While Europe and North America topped these visits, there were also a number of site visits from Asia and Russia.

We will examine our budget to look at the potential to extend this through:

- Setting up a linked in group to publicise the work (past and present) of the Task.
- Increasing publicity through presentations at relevant conferences and in relevant journals
- Increasing networking with other international groups, such as the International Solid Waste Association
- Updating the web site to improve its hit rate.

Country representatives are also responsible for dissemination within their country. These participants are usually well-known national experts who are linked into their countries research and development and industry networks. They are participants in their country's national programmes and report on work on-going at national level. In addition the Task has been linked, through its participants, with the CEN Standards work on biogenic content of waste and solid recovered fuel; and with EU funded work

in the past.

3. Deliverables

The following technical deliverables are proposed for Task 36 in the Triennium 2016 – 18:

- A **workshop** and **summary update report** on the use of solid recovered fuels.
- A **workshop** on the integration of energy into the circular economy
- A **workshop** and **summary report** on the use of advanced thermal conversion of waste for energy and the production of other chemicals, such as liquid fuels
- A **workshop** on transboundary shipments of waste for energy recovery.

Provided that the task succeed in attracting more members during the triennium (re-entry of UK and Norway to begin with, but hopefully also new members) the following additional deliverables are proposed

- A **summary report** on international policy, legislation and fiscal drivers impacting on energy recovery in solid waste management
- A **topic report** on the challenges in the integration of energy into solid waste management in developing economies.

All deliverables are outlined in detail in Table 2, together with proposed leads and preliminary budgets.

We will also produce:

- Progress and annual reports as requested by the ExCo
- Annual audit reports

In addition to these deliverables we will look for opportunities to promote the work of the Task in articles in leading journals and at relevant conferences, workshops etc.

Table 2: Summary of deliverables

Ref	Deliverable Type	Detail	Partner/Collaborator	Time	Lead	Budget	Information Dissemination
M1	**Task Meeting**	Meeting timed to coincide with A1		Q1 2016	Italy	$2000	
A1	**Workshop**	Co-firing of challenging biomass fuels, including SRF from waste	Task 32	Q1 2016	Italy	$2000	Workshop proceedings on Task 36 and Task 32 websites
A2	**Summary Report**	Trends on use of solid recovered fuels		Q1 2016	Italy	$4000	Website report on Task 36 website
M2	**Task Meeting**	Meeting timed to coincide with B1		Q3 2016	Germany	$2000	
B1	**Workshop**	Workshop on role of EfW in Circular Economy	ISWA Resource Task Group	Q3 2016	Sweden	$2000	Workshop proceedings on Task 36 and ISWA websites
		Report of workshop on the role of circular economy		Q4 2016		$2000	
M3	**Task Meeting**	Meeting timed to coincide with C1		Q1 2017	Sweden	$2000	
C1	**Workshop**	Advanced thermal conversion of waste	Task 33	Q1 2017	Germany	$2000	
C2	**Summary report**	Recent and future trends and drivers relating to Advanced Thermal Conversion of Waste	Task 33	Q2 2017	Germany	$5147	Workshop proceedings and summary report on Task 36 and Task 33 websites
M4	**Task Meeting**	Meeting timed to coincide with D1		Q3 2017	France	$2000	
D1	**Workshop**	Transboundary shipment of waste	Task 40	Q3 2017	Sweden	$2000	Workshop proceedings on Task 36 and Task 40 websites
D2	**Summary report**	Summary report on transboundary shipment of waste	Task 40	Q4 2017	Sweden	$6000	
E1	**Chapter**	Contribution to the strategic project on fuel pre-treatment for biomass residues	Tasks 32, 33, 34, 40 and 43	Q2 2018	Sweden	$5253	Strategic report
M5	**Task Meeting**			Q1 2018	TBC		
M6	**Task Meeting**	Task meeting at end of Triennium Conference		Q3 2018		$5000	
	End of Task Report				Sweden	$4000	

3.1 Schedules and milestones

The schedule for 2016-18 is shown in Figure 6.This shows the schedule for the workshops and the time taken for lead into the workshop (organisation and preparation).

Figure 6 Task 36 Proposed schedule for 2016-18

Deliverable	2016				2017				2018			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WS Co-firing challenging fuels (A1)WS	*											
SR Use of Solid recovered fuels (A2)			*									
EfW in the Circular economy (B1)												
WS Advanced thermal conversion (C1)					*							
SR Trends in Advanced conversion (C2)												
WS Transboundary shipment of waste (D1)							*					
SR International policy & other drivers (D2)												
TR EfW in developing countries (E1)												
CP EfW in developing countries (E2)												
End of Triennium conference (M6)												
End of Task report												⊗
Task meetings (M1-5)	⊗		⊗		⊗		⊗		⊗			⊗
ExCo meetings		⊗		⊗		⊗		⊗		⊗		⊗
Task administration												

Key	
WS	Workshop
SR	Summary report
TR	Topic report
CP	Conference presentation
M	Meeting

4. Task membership and budget

There are currently six members of the Task. We have set a budget at: US$ 15,400 per country per year. For four participants this means that the budget will be US$ 61600/year.

Table 3 Indication of main areas of interest for each (current) participating country.

Participant	Areas of interest
France	EfW in the move to 'Smart' waste management Energy recovery in the circular economy Solid recovered and refuse derived fuels Contribution of EfW to renewable energy EfW in developing economies
Germany	Co-firing of SRF in industrial applications
Italy	Transition to an integrated waste management system (Smart waste management; the circular economy etc.) Refuse Derived Fuels/Solid Recovered Fuels Energy recovery from non-Municipal Solid Waste streams
Sweden	Status of EfW policy in different countries, including impact of EfW caps The management of residues (fly ash/APC residues and bottom ash) Incentives for gasification and other Advanced Thermal Technologies Trans-boundary shipment of waste for energy recovery Energy recovery in the circular economy and smart/integrated waste management EfW in developing economies Waste to liquid biofuels

Indicative breakdown of Task budget

(a) Annual budget by main task, assuming four participating countries

Item	Annual US $
10% ExCo retention	6160
Administration	18480
Consultancy	15800
Travel, subsistence and meetings	16160
Web site	3000
Audit	2000
Total	61600

Note: The cost of the End of Triennium meeting is including in Task Administration (1333/year).

(b) Triennium budget (2016-18), assuming 4 participating countries

Category	Sub-categories	No hrs/year	Rate [$/hr]	Budget YYYY	Spent as of YY/MM/DD
Administration					
Task Managment	Salaries TL (Inge Johansson)	96.5	170	49230	
	Co-TL (Pat Howes)	22.5	186	4185	
	Co-TL (Kathryn Warren)	15	135	2025	
Support Services	Accounting				
	Overhead cost				
	Banking fees				
	Auditing			6000	
	ExCo retention			18480	
Other expenditure	Postal Fees				
	etc.				
Travel cost	TL			21000	
	Co-TL			1000	
	Secretary				
	NTL				
Meeting cost	Room rent, meals, etc			26,480	
Newsletter					
Website				9000	
Projects	Title			47400	
TOTAL				184800	

4.1 Task management

The proposed Task leader for this prolongation is Inge Johansson of SP Technical Research Institute of Sweden. He will be assisted by Kathryn Warren and Pat Howes of Ricardo Energy & Environment, for the first six months of the Triennium, who will provide assistance in organising and facilitating the Task and helping set up the Triennium work.

Inge Johansson

Inge has been working with waste and bioenergy for the last 15 years both nationally in Sweden as well as internationally. The last four years, Inge has held a position as a Researcher at SP Technical Research Institute of Sweden working mostly with projects related to Waste to Energy, but also more general waste management projects including EU FW7 projects in that area. Inge is coordinating a Swedish strategic network "Waste Refinery" within the field of thermal treatment, biological treatment and system analysis. Inge has been a member of the ISWA working group on Energy

recovery since 2006 and has previously worked at Avfall Sverige – the Swedish Waste Management association. At Avfall Sverige, Inge worked with all aspects of Energy recovery from waste, education, technical aspects, policy and legislation, economics, environmental impact and networking both nationally and within EU. Inge has a comprehensive network within the Waste-to-Energy Industry. For the last three years Inge has also been the NTL in task 36.
Inge will be responsible for the technical direction of the Task, which will be undertaken through planning and co-ordination of the Task. He will undertake this role in consultation with the Task participants, in order to ensure all participating countries achieve their aims in participating in the Task. Pat will be the lead contact person for the ExCo and will provide the progress reports as required and the annual financial statements.

In addition Inge, with the assistance of the Pat Howes and Kathryn Warren of Ricardo Energy & Environment for the first six months of the Triennium in order to ensure a smooth handover of work. Pat and Kathryn will also provide assistance in the following:

- Planning and organising of the first Task meeting
- Transfer of contact details and information on planned work, including strategic projects
- Transfer of information on operating the Task.

Dr Pat Howes of Ricardo Energy & Environment will be assistant Task Leader for the first 6 months of the Triennium. Pat was Task Leader until 2015. She is an international authority on waste management and bioenergy. She has worked in the waste and bioenergy area for 25 years, authoring many reports on the subject. She has been involved in EfW networks for the IEA and European Commission, including work on landfill gas and anaerobic digestion, as well as EfW. She has been involved in advising the UK Government and Environment Agency on technical and policy issues relating to energy from waste, including review of legislation and regulation on waste and biomass, a Fact Base for Energy from Waste and work on the management of waste wood. Pat has considerable experience of working on international projects and co-ordinating multinational teams.

Mrs Kathryn Warren of Ricardo Energy & Environment will be available to assist Pat and Inge as necessary. Kathryn is a Senior Consultant and a Chartered Waste manager with over 10 years' experience in waste management in the UK. Kathryn has been a Senior Consultant at Ricardo Energy & Environment for five years, where she specialises in waste derived fuels, waste treatment technologies and renewable heat. Kathryn is a core member of Ricardo Energy & Environment's waste procurement team, and provides technical support to private waste management companies and local authorities on EfW projects. Kathryn recently led a project reviewing current waste to energy technologies, and quantifying investment profiles for each major technology group, and identifying drivers, opportunities and barriers to the development of waste to energy solutions on behalf of Zero Waste South Australia. Kathryn has been involved in Task 36 for the past three years, providing support and assistance to Pat Howes. Her active involvement has included work on a collaborative project with Task 37 (biogas) and organisation of workshops and Task meetings. She has also been supporting Pat in the preparation of Task meeting minutes and other routine work. Kathryn is an experienced project manager, managing work including multi-partner projects of values up to £250,000.

5. Links with other IEA Bioenergy Tasks and external organisations

In this triennium we are proposing to work with other tasks in the following areas:

- We are proposing to organised a joint work shop with **Task 32** on the co-combustion of challenging fuels, including solid recovered fuel and refuse derived fuel.
- We are proposing to produce a report on advanced thermal conversion of waste with **Task 33**. This will update the report we are producing for the 2013-15 triennium and will be associated with a workshop.
- We will examine the issue of transboundary shipment of waste for energy use with **Task 40**.
- We are proposing to participate in the proposed Strategic project on fuel pre-treatment for thermal conversion.

6. References

World Bank (2012) What a Waste: a global review of solid waste management. Urban Development Series Knowledge Papers No 15

Ellen MacArthur Foundation (2013) Towards the circular economy.

Task 36 prolongation proposal

Identify the actions in the Strategic Plan 2015-2020 that would be addressed by the proposed Task by inserting an X in the 'Tick' column for each relevant row.

OBJECTIVE	ACTION	TICK
Objective 1: To promote the market deployment of technologies and systems for sustainable energy production from biomass.	Provide a realistic overview of the readiness level of different conversion technologies as well as potential benefits and impacts on the market.	X
	Provide an integrated technologies approach (synergy) with regard to the use of biomass for energy purposes as well as the use of co-products (chemicals, fodder, fibre, mechanical wood / biomass products)	X
	Identify and characterise the R&D priorities for bioenergy, including the scientific and technical innovations needed for new and growing market. Encourage joint actions on technological innovation in the area of bioenergy including energy driven biorefineries and job creation.	
	Identify the most promising bioenergy technologies and most efficient public policies and investigate technical and non-technical barriers and incentives to the market deployment of these technologies in the context of the scenarios of the 2020-2050 low carbon society (IEA, 2011) and investigate the emerging technologies for this	
	Encourage and promote the sustainable deployment of technologies with important local, regional, and global socio-economic and environmental benefits that will contribute to a secure energy supply and job creation	X
	Show the potential of bioenergy to contribute to a sustainable environmental footprint e.g. by GHG reductions, soil improvement and nutrient balance, water footprint, material recycling, resource sufficiency	
Objective 2: To raise public awareness through communication with key stakeholders for the use of biomass as an energy source and to provide clear and verified information on bioenergy	Provide scientifically sound and politically and commercially independent data and information for policy makers, industry and IEA bodies in a format appropriate to the specific audience	X
	Take a leading role in the discussion of current topics in the field of biomass energy	X
	Ensure communication on different levels and with different means, e.g. scientific and easy to read policy oriented reports, strategy papers, website, newsletters etc.	X
	Develop mechanisms for exchanging feedback with the relevant target groups, to gauge visibility and impact	X
	Encourage other sectors of the bio-based economy to apply the same stringent rules of sustainability in using biomass as in the case of biofuels and bioenergy	
Objective 3: To strengthen the outreach efforts of the Implementing Agreement to involve interested new member countries, industry and multilateral organisations	Actively involve relevant industry players by organising topical workshops with panel discussions at both the ExCo and the Task level	X
	Continually adjust the Task work programmes to reflect industry's needs and to promote cooperation with industry	X
	Actively seek new member countries. Educate possible participants about the benefits of IEA Bioenergy through invitations to observe Executive Committee meetings and Task events such as workshops, study tours, and seminars	X
	Encourage industry associations to contribute to Task work where appropriate	X
	Initiate new tasks where new topics emerge that are in accordance with the needs of the members, and close completed tasks	X
	Strengthen the exchange of information and technology transfer with multilateral organisations (e.g. FAO, GBEP, etc.) within the biomass sector to develop global energy and environmental policies with regard to the use of biomass	
	Encourage the information exchange and possible joint research projects at ExCo and at Task level with other IEA Implementing Agreements which are topically close to IEA Bioenergy (see Figure 2)	X
	Support the development of global, sustainable, bioenergy policies by designing mechanisms that enable the involvement of countries with less developed bioenergy infrastructure and expertise, while maintaining a collaboration which is attractive to internationally leading countries and experts	
	Identify strategies that encourage existing Contracting Parties to expand their Task participation	
Objective 4: To increase the dissemination of information	Keep the website of IEA Bioenergy and the Tasks' websites up-to-date and work towards their increased integration	X
	Encourage member countries to create a national distribution list and take responsibility for periodically providing information on relevant IEA Bioenergy publications, newsletters, events etc. by the national delegate	X
	Encourage members who have an expert's presentation at international conferences also to briefly mention the work of IEA Bioenergy (where appropriate)	X
	Strengthen the exchange with IEA Headquarters and get actively involved in the development of road maps, ETPs etc.	X
	Improve interaction with other IEA Implementing agreements through information exchange (see Figure 2)	X
	Present IEA Bioenergy and its results at national and international meetings	X