IEA Bioenergy

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Task 34

Direct Thermochemical Liquefaction

Task Prolongation Proposal for the new triennium 2016-2018

20 January 2016

Prepared by:
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And
National Team Leaders

Task Period 2016-2018
Task 34 Proposal Summary Sheet

Task Title: Direct Thermochemical Liquefaction **Proposer:** Alan Zacher

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Endorsement by ExCo Member of participating country
Country: United States **Name:** Jim Spaeth **Signature:**

Objective

The objectives will be to consider the field of direct thermochemical liquefaction technologies for biomass (both fast pyrolysis and hydrothermal liquefaction) and the upgrading of the products to liquid fuels in order to identify both technical and non-technical barriers to more rapid and wider spread implementation of the technologies. The activities of the Task will focus on information exchange, technology review and technology implementation issues and opportunities. There has been considerable success in interaction between group participants in technoeconomic assessments and in Round Robins; these will play leading roles in the continuing Task.

Work Scope

The Task will be expanded in scope to include the ongoing activities of the current Pyrolysis Task and to include also hydrothermal liquefaction of biomass with a focus on implementation and the market opportunities. The scope of the Task will include production and utilization of liquid fuels derived from biomass for heat and power; upgrading of bio-oil and biocrude to liquid transportation fuels; and chemical products, where there is an energetic or economic contribution. In order to meet these objectives every effort will be made to actively involve industry and decision-makers in the Task, and interactions with other Tasks will continue to be exploited.

Table 1: Priority Topics for Task 34 (2016-2018)

Support commercialization through standards development
Validate applicable analytical methods for bio-oil product evaluation
Facilitate information exchange with stakeholders
Support technoeconomic assessment of liquefaction technologies

Work Program

The program of work will be based on the traditional approach of IEA Bioenergy with a well-defined technical and non-technical work program in which small groups of participants will contribute.
wp1 Contribution to bio-oil standards development (CEN and ASTM)
wp2a Round robin for bio-oil analysis method validation (bio-oil REACH registration or CEN standard analytes)
wp2b Seminar on advanced methods of bio-oil/biocrude chemical analysis
wp3 Stakeholder seminars
wp4 Technoeconomic assessment
wp5 Workshop on pretreatment of biomass for thermal conversion (collaboration with Task 32 and Task 33)
wp6 Regular semi-annual meetings (to include stakeholder seminars, workshops, and technical tours)
wp7 Publications

Deliverables and Target Groups

The deliverables will include:
d1 Task 34 website maintenance; t2 research and industrial stakeholders
d2 Newsletter, twice a year; t1 research and industrial stakeholders
d3 Organization and reporting of an international round robin on bio-oil/biocrude analysis; t5 round robin participants, research and industrial stakeholders
d4 Topical report on advanced methods of bio-oil/biocrude analysis (outcome of seminar); t4 seminar participants, research and industrial stakeholders
d5 Progress, annual reports, and a final report; t3 ExCo

Management Qualifications

Task Leader: Alan H. Zacher, United States, Pacific Northwest National Laboratory (a Department of Energy national laboratory) .
Annual Budget US$144,000; **Budget per participant**; US$18,000, assuming 8 countries participate. US, Germany, Finland, Netherlands, Sweden, New Zealand, Canada, and UK.

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BACKGROUND

The Pyrolysis Task 34 is widely acknowledged as having made a major contribution to the science, technology and understanding of biomass fast pyrolysis to liquids through the PyNe Newsletter, the website, publications and the many meetings and activities over the past 20 years.

This proposal is to continue Task 34 for a further three years from January 2016 to December 2018. It will continue to emphasize fast pyrolysis of biomass focusing on markets and technology implementation, including upgrading, in order to support those involved in commercializing and utilizing fast pyrolysis for production of fuel oil and transportation fuels. In addition, the more recent developments in hydrothermal liquefaction, an alternative biomass liquefaction technology, will also be included in the information exchange.

CHALLENGES FOR FURTHER MARKET DEPLOYMENT

The overall objective of the continuing Task is to facilitate commercialization of liquid fuels from biomass and particularly fast pyrolysis and hydrothermal processing to maximize liquid product yield and production of renewable fuel oil and transportation fuels. The Task will contribute to the resolution of critical technical areas and disseminating relevant information particularly to industry and policy makers. The scope of the Task will be to monitor, review, and contribute to the resolution of issues that will permit more successful and more rapid implementation of biomass liquefaction technology, including identification of opportunities to provide a substantial contribution to bioenergy. This will be achieved by all the activities described in Work Program below.

The Task scope includes all steps in a process of liquid fuels production from biomass extending from reception of biomass in a raw harvested form to delivery of a marketable product as liquid fuel, heat and/or power, chemicals and char byproduct. The technology review may focus on the thermal conversion and applications steps, but implementation requires the complete process to be considered. Process components as well as the total process are therefore included in the scope of the Task, which will cover optimization, alternatives, economics, and market assessment.

The work of the Task will address the concerns and expectations of the following:

- Conversion technology developers
- Equipment manufacturers
- Chemical producers
- Policy makers
- Investors
- Researchers
- Bio-oil/biocrude application developers
- Bio-oil users
- Utilities providers
- Decision makers
- Planners

Industry will be actively encouraged to be involved as Task participants, as contributors to Workshops or Seminars, as Consultants, or as technical reviewers of Task outputs to ensure that the orientation and activities of the Task match or meet their requirements.

THE ROLE OF A SPECIFIC TASK ON LIQUEFACTION OF BIOMASS

A continuation of the existing task within the IEA Bioenergy Agreement on Direct Thermochemical Liquefaction of biomass is proposed to strengthen the existing momentum in market introduction of fast pyrolysis systems in its member countries, as well as the export position of OECD-based manufacturers to non-OECD member countries.

The proposed task will facilitate effective exchange of strategic technical and non-technical information. The main stakeholders of the Task are equipment suppliers, research organizations, technology and process developers, and government agencies. Knowledge transfer to these target groups is done directly through involvement in Task-organized events and direct access to Task-generated information.

The Task will cover issues related to biomass liquefaction technologies to be (potentially) used in its member countries. As the key technical and non-technical issues for the different applications and application scales for fast pyrolysis and hydrothermal liquefaction are similar, current Task members strongly support a Task in which direct thermochemical liquefaction issues are specifically addressed. As hydrothermal liquefaction has seen a resurgence of interest in recent years, expansion of the Task scope to include the technology issues related to the high-pressure liquefaction and biocrude product upgrading are also of interest.

The Task is aware that certain aspects of pyrolysis are relevant for further expansion of all forms of biomass thermochemical conversion technologies. In such cases, effective collaboration and information exchange is anticipated with Task 32 for Combustion and Task 33 for Gasification. One important issue of specific collaboration is pretreatment systems, where information exchange has been agreed between Tasks 32, 33, and 34. In fact, pyrolysis itself may be considered as a biomass feedstock pretreatment to both combustion and gasification.

Direct thermochemical liquefaction can also play an important role in biorefinery concepts. Therefore, a continuing collaboration with Task 42 is foreseen. The effort will likely include review of Fact Sheets as was done in the previous triennium but also other technical input on direct thermochemical liquefaction technology to the biorefinery development efforts.

PRIORITIES FOR THE WORK PROGRAM 2016-2018

The existing use of Topic Priorities has proved very successful in promoting a very high level of member participation, attracting a high proportion of industrialists to meetings, and providing a stimulating and lively forum. The potential topics to be included in the Task for the new triennium are shown in Table 1. These were derived from a list originally identified from task discussions and refined by iterative polling of the Task participants and potential participants. This final list was reviewed and confirmed at the Task meeting in May 2015.

Table 1: Priority Topics for Task 34 Prolongation

Support commercialization through standards development
Validate applicable analytical methods for product evaluation
Facilitate information exchange with stakeholders
Support technoeconomic assessment of liquefaction technologies

A more detailed overview of these topics is provided below:

WORK PROGRAM

A more detailed description of each of the above topics, with proposed actions and deliverables, is provided below.

1. Support commercialization through standards development

The task will seek to support the implementation of standard methods for the use of bio-oil. Specific efforts will include the establishment of CEN standards as required for use of bio-oil as a burner fuel, both heavy and light grades, internal combustion engine fuel, as well as feedstock to gasification and refinery co-processing, as specified in the recent Mandate from EC. Task activities will include providing input to the Working Group (WG) deliberations through the joint membership of NTLs in the WG (currently there are 2 NTLs who are also members of the WG). An effort will be made to facilitate transfer of the EU developed standards to the ASTM process in order to coordinate standards. Also, technical assistance will be provided to companies in the bio-oil market through data collection/processing and drafting a new MSDS and chemical safety report.

2. Validate applicable analytical methods for product evaluation

This element of the Work Program will have several elements. A round robin has been proposed, a seminar on advanced analytical methods also, and expansion of the analytical methods developed for bio-oil to the biocrude product from hydrothermal liquefaction and the upgraded products from each.

The Round robin process has provided useful feedback on bio-oil analytical methods in previous efforts by Task 34 and its predecessors. In the coming triennium a round robin will be organized to further evaluate analytical methods. Suggested candidate methods include those required in the REACH registration or for the CEN effort, such as sulphur analysis and chlorine analysis.

A solid basis for analysis of bio-oil has been developed over recent years, much through the efforts of the Task members. As the fast pyrolysis technology moves into the marketplace there is expanded interest in the details of the composition and properties of this complex fuel. Several countries have efforts underway in developing advanced analytical methods for bio-oil. Task 34 proposes to organize a seminar for interested participants to present and exchange new information on these advanced methods.

As the task scope expands there is an expanded need for analysis of the biocrude product from hydrothermal liquefaction. Bio-oil and biocrude have many qualitative similarities, yet many quantitative differences. The Task will seek to elucidate these similarities and differences and provide the information to the stakeholders.

The products of upgrading bio-oil or biocrude are considered to be longer term products. Their evaluation particularly in light of their similarities and differences with currently marketed petroleum products is of interest. Including such products in the round robin will facilitate their development.

The proposed round robin should address both fast pyrolysis bio-oil as well as hydrothermal liquefaction biocrude. In addition, products from upgrading the initial liquefaction products should also be included in an attempt to validate the improvements in product properties. Also, as available, the round robin could include products from advanced liquefaction processes such as catalytic pyrolysis, hydropyrolysis or algae liquefaction.

3. Facilitate information exchange with stakeholders

Fast pyrolysis is a new technology that offers the unique advantage of producing a liquid fuel directly from biomass in high yield. Though much of the recent activity in this area has been at a research level, more companies are becoming interested in the potential of producing and using a bio-oil is at an early stage of market penetration. To date, there has been extensive interest by industrialists in the Task organized workshops, and this interest will be developed and more workshops and seminars will be held to meet the identified requirements of companies involved in producing and using bio-oil and in producing and using equipment for these purposes.

To achieve this objective, the Task will work with pyrolysis technology developers and providers to help identify and define their problems and help to provide solutions both from within the group and externally. Similarly the Task will co-operate with applications developers and equipment manufacturers to help them understand more about bio-oil and its properties and requirements. This close co-operation is considered the most effective way of identifying and promoting opportunities for bio-oil to make a significant impact on renewable energy supplies.

4. Support technoeconomic assessment of liquefaction technologies

The participating countries have expressed an interest in performance of technoeconomic assessments as a part of the Task Work Program. This activity could include a comparative technology assessment. The details of such an effort will be dependent on the specific members that agree to participate in the Task.

5. Cooperation with other Tasks

The topic area of pretreatment has been identified for cooperation with Tasks 32 and 33. Specifically, feedstock requirements will be addressed in collaboration with the two other thermochemical conversion tasks. In addition Tasks 36, 40 and 43 are also joining this intertask collaboration.

The other area of inter-task collaboration, which has been identified, is with Task 42, Biorefineries. Direct thermochemical liquefaction can play an important role in biorefinery concepts. The collaborative effort with Task 42 will likely include review of Fact Sheets developed by Task 42 members, but also other technical input on direct thermochemical liquefaction technology to the biorefinery development efforts.

6. Meetings

Meetings will be held at approximately 6 month intervals and will typically comprise a regular Task meeting with a Seminar or Workshop and/or a Technical Visit. Seminar/Workshops will feature invited speakers with an emphasis on industrial and commercial organizations. This approach has proved very successful in the past Task and has resulted in an excellent two-way interaction between participants of the Task and external organizations. Each meeting will devote a portion of the session to country reports to facilitate exchange of research developments among the participants. The meetings will be open to external participation from those countries participating in the Task.

7. Publications

The newsletter will continue to be published at approximately 6-month intervals in electronic format to reduce costs and improve timeliness. Information will be gathered from the Task participants and their contacts throughout the world.

In addition, the Website will be maintained and regularly updated. An additional feature on the website beginning in 2015 is a database of demonstration plants in the fast pyrolysis area that will be contributed to and used by the participants in the field. It is planned that the Website will continuously evolve through the duration of the Task to satisfy the requirements of the Task participants as well as those organisations the Task is trying to serve.

ACTIVITY STRUCTURE

The work in Task 34 will consist of Task meetings with workshops and Task projects, in addition to the Task management and ExCo support actions. A more detailed description follows below.

Task meetings

Twice every year a formal Task meeting will be held to discuss progress in the various Task projects, plan new actions, provide feedback from ExCo meetings and exchange news from national R&D programs in individual member countries. These meetings are often held in combination with a workshop, as subjects are identified, and/or stakeholder seminars. Meetings will typically include field trips to research facilities and process demonstration sites relevant to biomass fast pyrolysis and hydrothermal liquefaction along with bio-oil and biocrude upgrading. Organization of the contributions to the Task newsletter is also an element of the task meeting.

Task activities

The following specific Task activities are foreseen:

- Support commercialization through standards development
- Validate applicable analytical methods for product evaluation
- Facilitate information exchange with stakeholders
- Support technoeconomic assessment of liquefaction technologies

A good part of the success of Task 34 is due to the fact that Task projects are not covered in existing national R&D programs but provide strategic support to reach the aims of the participating countries. Immediately after the start of the next triennium, more specific agreements will be made with individual Task members that have suggested Task projects listed above. Depending on available budget, this action list can hopefully be expanded further.

ExCo interaction and support

In order to promote effective communication between the ExCo and the Task, the Task will be represented at all ExCo meetings. At these meetings the Task Leader or the Operating Agent can clarify information provided in the submitted progress reports and effectively receive feedback.

To strengthen the relationship between individual Task members and ExCo, the ExCo member representing the host country will be invited to participate in the Task meeting to be held in their country.

From the Task budget, 10% of the funds will be reserved at the ExCo level to support specific ExCo initiated strategic projects and other actions, including the Technology Coordinator.

Task management

The Task Leader will facilitate effective implementation of the different Task activities, mainly by:

- Planning, organizing and minuting Task meetings;

- Facilitating specific Task projects;
- Dissemination of knowledge through conferences, in magazines and on the Task internet site;
- Providing interaction with the ExCo.

In addition to his management role, the Task Leader will be responsible for the technical direction of the Task. He will plan and co-ordinate all work for the entire Task. The technical results of the deliverables will become available in draft, after which they will be reviewed by the Task Leader before being finalized.

The Task Leader is also the contact person for the ExCo. Twice a year a Task progress report will be produced for the ExCo, containing information of the progress achieved in the various activities, potential delays, unresolved issues, and so on. This information will be communicated with all Task members and presented at ExCo meetings. The Task input to the IEA Bioenergy Annual Report will also be prepared by the Task Leader.

INFORMATION DISSEMINATION AND KNOWLEDGE FLOW

Within the proposed Biomass Liquefaction Task, key information is generated and compiled in the following manner:

- By obtaining results from national R&D programs from national team leaders
- Through Task organised workshops in which (invited) speakers present latest insights;
- Through strategic Task-initiated projects/studies.

The knowledge generated will be digested and summarised by either the Task Leader or a Task member responsible for a specific activity (usually both in easily readable summaries and detailed reports) and disseminated either directly to the member countries or indirectly through the ExCo. The internet site has proven to be an efficient aid in knowledge transfer.

Country Representatives

The Task members (National Team Leaders) in this proposed Task are responsible for effective dissemination of the knowledge generated through the Task in their home countries. The Task initiated actions are complementary to national programs and projects but can strategically add on to these results.

ExCo

The Task Leader will attend ExCo meetings, at least once per year, to provide interaction between the Task and the ExCo. In return, the ExCo member of the country where Task meetings are held will be invited for every Task meeting. Progress and Annual reports from the Task to the ExCo will be prepared and presented at the ExCo meetings. Input to the IEA Bioenergy Annual Report will be provided. Key outputs generated by the proposed Task will be published in IEA Bioenergy News.

Task Website

The existing website for Task 34 (http://www.pyne.co.uk/) has a long history of providing information to the growing biomass pyrolysis community worldwide. It has proven to be a key vehicle to disseminate information to the target groups. In the coming triennium, the existing website will be kept up-to-date with news items, reports etc. The scope of the website information will be expanded to include hydrothermal liquefaction as well.

Newsletter

An electronic version of the task newsletter will be produced and distributed twice every year to provide information on recent developments related to the work of this Task and biomass liquefaction in general. Interested stakeholders can subscribe to the newsletter through the website. The newsletter was published in its 38th issue at the end of 2015 with an electronic distribution of almost 1800. It is recognized worldwide as an important source of creditable information on direct thermal liquefaction of biomass.

Journal Publications

Another key means to disseminate the information generated by the Task is by technical journal articles. Examples of recent Task derived publications include: *Results of the IEA Round Robin on Fast Pyrolysis Bio-oil Production,* which will be prepared for publication in the **Energy & Fuels** in 2015. A publication of the *Norms, Standards & Legislation for Fast Pyrolysis Bio-Oils,* describing efforts in the countries participating in the Task, has also been published in **Energy & Fuels** in 2015. Titles projected for the next Triennium include *Pretreatment of Biomass for Fuels, Developments in Advanced Analytical Methods for Bio-oil and Biocrude,* and *Results of the Round Robin on Liquid Fuels from Biomass*.

DELIVERABLES

The following deliverables are planned:

- Electronic newsletter twice a year,
- Regularly updated website,
- Progress reports and Annual reports to ExCo,
- Bio-oil Advanced Analytical Seminar and report out,
- Journal publication of Round Robin results,
- Country Reports from each participating country,
- Final report, containing the output of the Task participants as well as any commissioned work.

SCHEDULE AND MILESTONES

The provisional schedule and milestones are summarised in the table below:

Item	Date	Milestone
Task meeting— Sweden	June 2016	technical visit and development update
Task meeting—New Zealand	October 2016	technical visit and development update
1st Annual Report	December 2016	Annual Report
Task meeting—Finland	2nd qrtr 2017	development update and stakeholder seminar
Task meeting—USA	4th qrtr 2017	development update and conference participation
2nd Annual Report	December 2017	Annual Report
Task meeting—Canada	2nd qrtr 2018	development update and stakeholder seminar
Task meeting—Netherlands	4th qrtr 2018	technical visit and end of triennium activities
Final Report	December 2018	Submission of Final Report with all Technical Reports and Commissioned Reports.

LINKAGES WITH OTHER IEA BIOENERGY TASKS

The thermochemical conversion tasks, #32 Combustion, #33 Gasification and #34 Liquefaction have many overlapping interests. However, the specific issues addressed by each task have different context for each Task. Linkage of Tasks 32, 33, and 34 is planned to occur, specifically in a review of feedstock pretreatment as described above. Within this pretreatment study Tasks 46, 40 and 43 also intend to participate.

In addition, direct thermochemical liquefaction of biomass can play an important role in biorefineries. Therefore, the ongoing collaboration with Task 42 will continue in order to assure that the best process information is used in biorefinery concept development.

TASK MEMBERSHIP AND BUDGET

Key Partners

Currently, seven IEA Bioenergy members (indicated in the table below) are participating in Task 34. Because of their expertise, potential for pyrolysis technologies and/or interest in the indicated areas, five of these existing member countries, along with a new participant, have already indicated at ExCo75 their interest to participate in the next triennium. Another five countries have made indications of their varying levels of consideration of participating. The other five member countries of IEA Bioenergy shown in the table also have active research and development or demonstration programs in biomass pyrolysis or hydrothermal liquefaction.

	Member now?	Declared interest to participate	Considering participation in next triennium	Active R&D
Australia	No			X
Belgium	No			X
Brazil	No			X
Canada	No	X		X
Denmark	No		X	X
Finland	Yes	X		X
Germany	Yes	X		X
Italy	No		X	X
Korea	No			X
Netherlands	Yes	X		X
New Zealand	No	X		X
Norway	Yes		X	X
South Africa	No			X
Sweden	Yes	X		X
United Kingdom	Yes	X		X
U.S.A.	Yes	X		X

Annual Budget

The work program described above is based on the assumption that an annual budget of 144,000 US$ is available, funded by 8 member countries. This is equivalent to an annual contribution per country of 18,000 US$.

The figure of 18,000 US$ is a fixed contribution per country per year. In case more or less than 8 countries participate, the task budget will increase or decrease accordingly and the set of activities might expand (or contract).

Triennium Proposed Budget, Task 34

Category	***Sub-categories***	***No hrs/year***	***Rate [$/hr]***	***Budget 2016-2018***
Administration				
Task Management	*Salaries TL*	*201*	*262*	*158,000*
Support Services	*Accounting*	*34*	*147*	*15,000*
	Auditing	*3*	*111*	*1,000*
Other expenditure	*materials*			*500*
Travel cost	*TL*			*46,000*
Meeting cost	*Room rent, meals, etc*			*25,000*
Newsletter and website				*69,000*
Projects				
Inter-task Pretreatment study				*20,300*
Advanced Analytical seminar				*32,000*
Publications				*17,000*
Biorefinery Inter-task collaboration				*5,000*
ExCo Strategic Fund				*43,200*
Total				*432,000*

Budget Justification
From the detailed budget above, the proposed Task expenditures in total and by work-scope area can be identified.

Labor: One of the primary cost categories associated with running the Task will be in labor (including benefits and overheads per Laboratory accounting practices) paid to dedicated personnel. Included are Task Leader costs as well as funds to support a part-time staff member for bookkeeping activities, who also tracks invoices and payments.

Materials and supplies: A small sum is requested for materials and supplies related to the administration of the Task, in order to cover the cost of incidentals (paper, binding, mailings, etc.).

Travel: Travel costs are related to Task Leadership participation in the Task 34 meetings and one ExCo meeting per year.

Task Meetings and Workshops: Funds are set aside for Task meetings and workshops designed for the task participants. The Task Leader will organize two task meetings per year. Invited expert contributors are also provided, as needed, through these funds. An item for costs of a seminar on analytical methods is also included.

Website maintenance and newsletter publishing: Maintenance of the Task 34 website is part of a subcontract which also includes editing and publication of the newsletter and some minimal support in minuting the task meetings.

Deliverables: Costs are broken out for the Task Activities and inter-task collaborations.

ExCo Strategic funds: 10% of the Task's annual budget is set aside for ExCo specified work.

Proposal for Prolongation – Task 34 – Pyrolysis of biomass

This Gantt chart provides an overview of task activities for the coordination of the effort and tracking of progress.

Activity No.	Priority Topic from Proposal	Status	2016				2017				2018			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Bio-oil standardization	Planning	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
		Actual												
2	Validation of Analytical	Planning	x	x	xxx	xxx	xxx	xxx	xxx	xxx	xxx	x	x	x
		Actual												
2.1	Round Robin	Planning		x	x	x	xxx	xxx	xxx	xxx	xxx	x	x	Y
		Actual												
2.2	Advanced analytical workshop	Planning	x	x	xxx	xxx	xxY	x						
		Actual												
3	Facilitate information exchange	Planning	x	xxx	xxx	x	x	xxx	x	xxx	x	xxx	x	xxx
		Actual												
4	Technoeconomic assessments	Planning	x	x	x	x	x	x	x	x	x	x	x	x
		Actual												
5	Inter task collaborations	Planning	x	x	x	xxx	x	x	x	xxx	x	x	x	
		Actual												
5.1	Pretreatment study with 32, 33, 40, 43	Planning	x	x	x	xxx	x	x	x	xxx				
		Actual												
5.2	Biorefinery development with 42	Planning		x	x	x	x	x	x	x	x	x	x	
		Actual												
	Newsletter	Planning	x	xxY	x	xxY	x	xxY	x	xxY	x	xxY	x	xxY
		Actual												
	Task meetings	Planning		x	x			x		x		x		x
		Actual												

TASK MANAGEMENT

The proposed Pyrolysis Task will be co-ordinated by Alan Zacher of the Pacific Northwest National Laboratory. The Operating Agent for the proposed Task is the U.S. Department of Energy, represented by Jim Spaeth.

Qualifications of individual leading the Task

Alan Zacher has 23 years of research experience and project management at Pacific Northwest National Laboratory (PNNL). A significant portion of his work has focused on thermal conversion of biomass, biomass derived compounds, and waste to for the production of chemicals, fuels, and environmental stewardship. His experience is in both gas and liquid phase thermal conversion reactor systems at bench and pilot scale in catalytic and non-catalytic processes. Examples of Mr. Zacher's work in this area include:

Biomass Conversion and Liquefaction Research. Starting in 1996, Mr. Zacher worked recurrently on various bench and pilot scale systems as an operator and shift engineer in the laboratory and in the field, including hydrothermal gasification and hydrothermal biomass liquefaction among others. Additionally, his focus through the years of 1996 to 2010 consisted of catalytic conversion of biomass derived materials to chemical product with high pressure batch and continuous, trickle-bed systems. Of his 28 patents, 27 of these were generated in this field, eventually leading to commercial implementation of the PGRS process by Archer Daniels Midland for the industrial scale production of propylene glycol from biomass derived sources, one of the largest commercial efforts to produce PG from a route other than petroleum.

From 2009 to 2011, Mr. Zacher shifted research thrust towards thermochemical and catalytic fuels conversion, serving as the lead engineer on the PNNL continuous fluid bed pyrolysis research task under the core pyrolysis and upgrading R&D project. In 2012, he took over management of the core pyrolysis/upgrading R&D project, and led the research thrust towards improving process and catalyst lifetime to meet national targets set by DOE. In 2011, he started and led a industry/academic project to develop first-of-its-kind bio-oil hydrotreating in an ebullated bed reactor. In 2013, he started and led an applied industry/academic project working to co-process bio-oil into FCC pilot scale reactors by stabilizing the bio-oil to partially hydrotreated intermediates. Partners for these projects included industrial partners in refining as well as academics and both U.S. and European research institutes. In 2014, he became program manager of combined efforts that oversaw a range of upgrading research and catalysis.

International Activities in Bioenergy Processes. Mr. Zacher leads DOE funded bioenergy work all of which has included international collaboration, on both a formal and informal basis. For the 2009 US-Canada Clean Energy Dialogue, he led the US efforts on the joint work in pyrolysis of woody biomass including mountain pine beetle killed trees and hog fuel residues. As part of managing the core DOE pyrolysis R&D, he worked with researchers at Natural Resources Canada, VTT Technical Research Centre in Finland, and other members of Task 34 to share design and operational experience to aid in design and improvements of new and existing pyrolysis systems at various locations. His management of core pyrolysis/upgrading R&D projects included participation in the IEA Bioenergy Task 34 round robins and cooperative research with Natural Resources Canada, but also leading the link between industrial partners in the US with Aston University and VTT in projects in novel hydrotreater design and refinery co-injection of bio-oil intermediates with petroleum into FCC pilot scale reactors. From 2013 to 2015 he shadowed the Task 34 leader, represented the U.S. NTL at some European workshops, worked directly with the other Task 34 members to accomplish the round robins, and was appointed as the U.S. representative to the task.