

# KANE FINAL PROJECT REPORT

## Annex C Final Reporting Template

# FINAL PROJECT REPORT

Please use Arial 10 or Times New Roman 12 font

Project Title	Kalundborg Next
Acronym	KANE
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Date	29/1-2016

### 1. What were the main activities and achievements of the project?

The KANE project was aimed at developing a sustainable and competitive lignocellulose based microbial oil technology for production of renewable biofuels. The project was to demonstrate the production of microbial oil from lignocellulosic sugars produced from straw and would provide the necessary techno-economic data for scale-up to commercial scale.

The project was to use and develop technologies from two leading industrial companies and combine the knowledge and the operating facilities in Denmark and Finland to achieve the project objectives. In the project, lignocellulose based microbial oil technology was optimized and demonstrated by combining knowhow in Inbicon's pre-treatment technology and Neste Oil's Microbial Oil Technology. Inbicon's pre-treatment technology was to be optimized to produce lignocellulosic sugars to feed the microorganisms in Neste Oil's Microbial Oil process, and the new Inbicon Version II ethanol process was to be run as a reference. As a part of the project, Inbicon's Kalundborg demonstration plant was to be retrofitted for the sugar platform for this purpose. The sugar streams produced were characterized and delivered to Neste Oil for conversion to oil by microorganisms. The performance of the microorganisms to produce oil from the lignocellulosic sugars was to be optimized. Microbial oil was further to be refined to high quality drop-in paraffinic biofuels, renewable diesel and jet-fuel, using Neste Oil's proprietary NExBTL technology.

The KANE project was kicked off in March 2014 and was to continue through Medio 2017. Unfortunately the process of converting lignocellulosic sugars to microbialoil proved to be less cost effective than anticipated, why the project was effectively put on hold in the autumn of 2014.

Efforts to re-scope and resuscitate the project proved unsuccessful why the project was effectively terminated.

**2. How did you collaborate? e.g. share of facilities within the consortium, exchange of personnel**

During the project, steering group meetings were held in both companies corporate headquarters in Helsinki and Copenhagen.

The research facilities were generally not shared, but rather kept to the companies themselves in order to keep confidential information and practices secret.

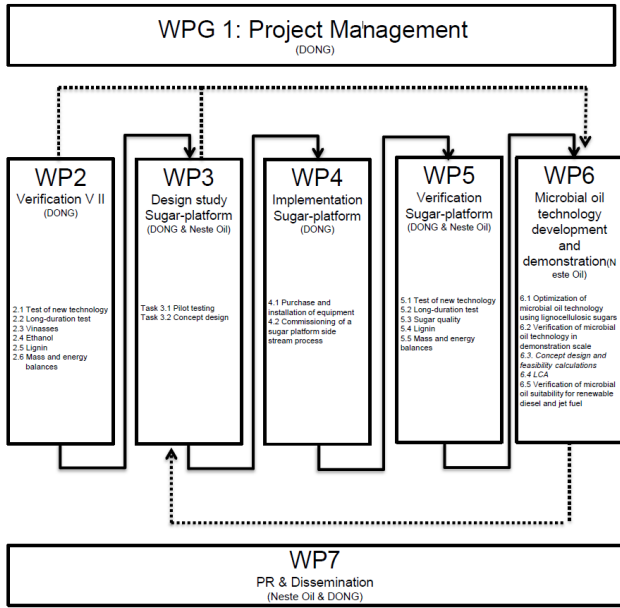
Collaboration was otherwise open and excellent.

**3. Compared with the original work plan (Stage 2 proposal), did you meet your milestones and objectives, and did you stick to your financial plan?**

During the course of the project, DONG Energy initiated the two work packages WP2 and WP3. Naturally, WP1, Project Management, was also initiated, but as this was not a results generating work package, discussion on this WP will be omitted here.

WP2 served to verify the production of lignocellulosic sugars from the Inbicon demonstration plant in Kalundborg, Denmark (IKA). Based on the analysis of the lignocellulosic sugar produced in WP1 (analysis conducted by Neste Oil in WP6) a design study was commenced in WP2 in order to make ready for the industrial scale production of acceptable grade lignocellulosic sugars for the Neste Oil microbial oil process. The general project outlay and the flow between WP 1, WP2 and WP6 is displayed in Figure 1.

Financial plans were followed, but due to the early closure of the project, many workstreams were never initiated.



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    graph TD
      WPG1[WPG 1: Project Management (DONG)]
      WP2[WP2: Verification V II (DONG)]
      WP3[WP3: Design study Sugar-platform (DONG & Neste Oil)]
      WP4[WP4: Implementation Sugar-platform (DONG)]
      WP5[WP5: Verification Sugar-platform (DONG & Neste Oil)]
      WP6[WP6: Microbial oil technology development and demonstration (Neste Oil)]
      WP7[WP7: PR & Dissemination (Neste Oil & DONG)]

      WPG1 -.-> WP2
      WPG1 -.-> WP3
      WPG1 -.-> WP4
      WPG1 -.-> WP5
      WPG1 -.-> WP6
      WP2 -.-> WP3
      WP3 -.-> WP4
      WP4 -.-> WP5
      WP5 -.-> WP6
      WP6 -.-> WP7
  
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**WP2: Verification V II (DONG)**

- 2.1 Test of new technology
- 2.2 Long-duration test
- 2.3 Visesses
- 2.4 Ethanol
- 2.5 Lignin
- 2.6 Mass and energy balances

**WP3: Design study Sugar-platform (DONG & Neste Oil)**

- Task 3.1 Pilot testing
- Task 3.2 Concept design

**WP4: Implementation Sugar-platform (DONG)**

- 4.1 Purchase and installation of equipment
- 4.2 Commissioning of a sugar platform side stream process

**WP5: Verification Sugar-platform (DONG & Neste Oil)**

- 5.1 Test of new technology
- 5.2 Long-duration test
- 5.3 Sugar quality
- 5.4 Lignin
- 5.5 Mass and energy balances

**WP6: Microbial oil technology development and demonstration (Neste Oil)**

- 6.1 Optimization of microbial oil technology using lignocellulosic sugars
- 6.2 Long-duration test
- 6.2 Verification of microbial oil technology in demonstration scale
- 6.3 Concept design and feasibility calculations
- 6.4 LCA
- 6.5 Verification of microbial oil suitability for renewable diesel and jet fuel

**WP7: PR & Dissemination (Neste Oil & DONG)**

#### 4. What were the main problems encountered and changes made?

Unfortunately, the process of converting lignocellulosic sugars to microbial oil proved to be less cost effective than anticipated, why the project was effectively put on hold in the autumn of 2014. Efforts to re-scope and resuscitate the project proved unsuccessful why the project was effectively terminated.

#### 5. How do you propose to exploit the outcomes of the work? E.g. commercialisation of process/product, patents, presentations, publications, further research? How do you rate the economic potential of your concept now?

Although the KANE project was just in its infancy, with all of the difficulties of starting up, when the project was terminated, it is safe to conclude that a process building on the Inbicon platform to produce cellulosic sugars for microbial oil production could have been perfected. None of the difficulties that were encountered during the project would have been impossible to overcome, and the refined sugar streams which was to be the outcome of workpackage 5 would have succeeded. However, the downstream processing and refining of the lignocellulosic sugar at the given sugar and coproduct prices all made for a non-feasible combined process looking at the current market price for paraffinic fuels. This may well change in the future with possible innovations made by either Neste Oil, DONG Energy or with a third party.

Regardless of the unsuccessful attempts to finish the project, the outcomes have been of high value to DONG Energy, Inbicon, in strengthening the internal knowledge of the sugar platform components and their operation. All something that can, and will, be put into future work.

In addition, the collaboration with Neste Oil during, and after, the project has been of high value to DONG Energy. From the outset, Neste Oil was an excellent partner in all regards. In concluding on the parts of WP2 and WP3 that was conducted, it can be said that regardless of the mechanical process issues encountered during the four campaigns, the sugar streams produced, purified and send to Neste Oil for further processing was of acceptable grade – a major achievement for the project. The large scale issues within purification in WP3 was close to be overcome at the time of termination of the project. All in all the project, although sadly only running six month, was a good project to DONG Energy, Inbicon yielding ample value creation and hopes for future resuscitation at the appropriate timing.

## 6. Other comments e.g. feedback to the funding organisations

The collaboration with TEKES and EUDP was excellent.

The entire process – although not yielding the desired results have been a pleasant one for DONG Energy and Neste Oil.

## 7. Publishable non-confidential executive summary of the project and its outcomes

The KANE project was aimed at developing a sustainable and competitive lignocellulose based microbial oil technology for production of renewable biofuels. The project was to demonstrate the production of microbial oil from lignocellulosic sugars produced from straw and would provide the necessary techno-economic data for scale-up to commercial scale.

The project was to use and develop technologies from two leading industrial companies and combine the knowledge and the operating facilities in Denmark and Finland to achieve the project objectives. In the project, lignocellulose based microbial oil technology was optimized and demonstrated by combining knowhow in Inbicon's pre-treatment technology and Neste Oil's Microbial Oil Technology. Inbicon's pre-treatment technology was to be optimized to produce lignocellulosic sugars to feed the microorganisms in Neste Oil's Microbial Oil process, and the new Inbicon Version II ethanol process was to be run as a reference. As a part of the project, Inbicon's Kalundborg demonstration plant was to be retrofitted for the sugar platform for this purpose. The sugar streams produced were characterized and delivered to Neste Oil for conversion to oil by microorganisms. The performance of the microorganisms to produce oil from the lignocellulosic sugars was to be optimized. Microbial oil was further to be refined to high quality drop-in paraffinic biofuels, renewable diesel and jet-fuel, using Neste Oil's proprietary NExBTL technology.

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**8. Finances** Please see amended budget below

Budget		
Total participant expenses	Total	Total
	Kr.	Hours
1. Research salaries	4.173.000	9.750
2. Tech/admin salaries	19.100.000	73.500
<b>Total salaries (1-2)</b>	<b>23.273.000</b>	<b>83.250</b>
3. Equipment over 40 000 kr.	10.000.000	
4. Materials	25.352.014	
5. Travel, meetings	1.961.852	
6. External services	1.200.000	
7. Reporting/communication		
8. Plants (Constructions)	42.000.000	
9. Other ( <i>specify below</i> )	0	
<b>Total other expenses (3-9)</b>	<b>80.513.866</b>	
10. Overhead *)	20.685.042	
<b>Total expenses (1-10)</b>	<b>124.471.908</b>	
- Grant	32.727.351	
- Project participant	74.683.145	
- Other financing ( <i>specify below</i> )	17.061.413	
Must be zero	0	

\*) calculation of overhead rate must be presented on request by EUDP

Key figures	Budget
Researchers hour kr.	428
TAP hour kr.	260
Other expenses %	64,7%
Overhead (university research )	-
Overhead (private companies)	88,88%
Grant as % of total budget	26,29%
No. of employees in company	
Annual turnover (mio. DKK)	
Assets (mio. DKK)	
Company size according to EU definition**): S-M-L Small-Medium-Large	
If research is parts of the project - state pct. of total budget	

\*\*) The classification of company size also depends on whether your company is autonomous, please see EU document The new SME definition, cf. Call for propo

**Please comment on budget items above**

(Budget items "6. External services", "8. Plants (construction)", "9. Other expenditures", "Other financing" MUST be commented)

(for large budget items more detailed budget information should be attached in appendix)

Other financing: This item covers expected turnover from sales of ethanol and lignin.

Accumulated expenses			
Accumulated expenses (1)	Total	Accum. expenses (2)	Accum. expenses accord. to budgetted wages
(Kr./øre)	Hours	(Kr./øre)	
590.866,69	1.283	549.158,24	549.158,24
4.525.062,61	13.273	3.449.127,37	3.449.127,37
5.115.929,30	14.555,90	3.998.285,61	
0,00		0,00	
20.828.895,16		20.828.895,16	
96.028,87		96.028,87	
40.855,20		40.855,20	
0,00		0,00	
0,00		0,00	
0,00		0,00	
20.965.779,23		20.965.779,23	
4.547.037,96		3.553.676,25	3.553.676,25
30.628.746,48		28.517.741,10	

Estimated grant	7.498.158,66
Previous grant	0,00
To be paid	7.498.158,66

Expenses (1)	Expenses (2)
460,51	428,00
340,93	259,86
68,5%	73,5%
14,2%	14,2%
88,9%	88,9%