

Project Overview and Status

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Residue2Heat Objective



A long-term objective of *Residue2Heat* is to use agricultural or forest residue streams that are unsuitable for food or feed production and have low ILUC values for residential heating

<u>Challenges</u> on residential heating systems

High ash contents

One aim of *Residue2Heat* is to idenfify potential bottlenecks for future implementation of new fuels.

ILUC = Indirect Land Use Change FPBO = Fast Pyrolysis Bio-Oil Solution Pyrolysis-oil (FPBO) ?













Within Residue2Heat a
burner is modified to build
up a reliable combustion
system in which FPBO can be
used as single fuel. Up till
now the utilization of FPBO in
residential-scale systems has
never been done.





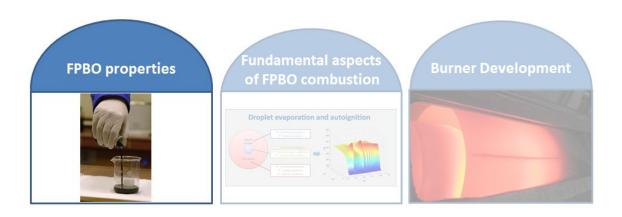


http://www.residue2heat.eu

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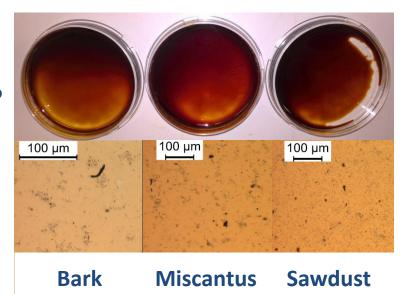


Main topics – FPBO Properties



FPBO Properties

- Homogeneous FPBO using different feedstock
- Allowed as fuel in residential heating systems?
 - Currently no norm available
 - Standardisation activities, CEN TC19.
- Handling: Production, transport, storage, handling
- Properties differ completely from Heating Oil



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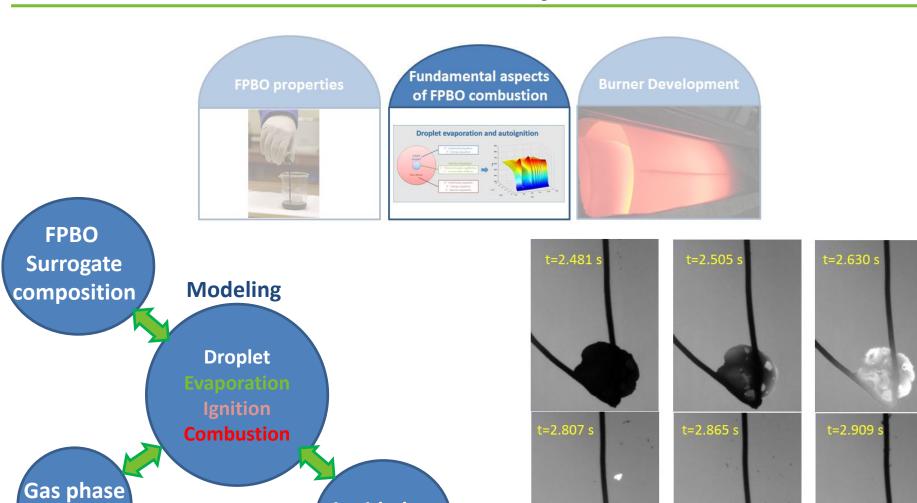
- FPBO production from ash-rich biomass successful.
- FPBO produced from different feedstock
 - Clean wood (reference FPBO);
 - ☐ Forest residue;
 - Wheat straw;
 - Bark;
 - Miscanthus;
 - Sawdust



- FPBO quality can be improved by conditioning
- Data produced for standardization efforts.



Main topic – FPBO Fundamentals

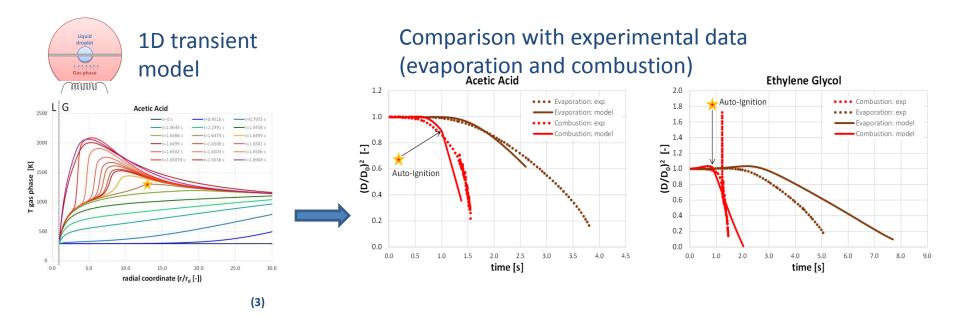


Liquid phase

chemistry

chemisty





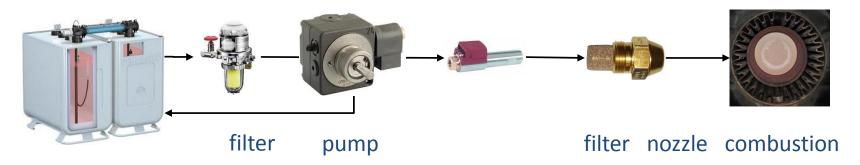
- Updated kinetic mechanism and droplet 1D model. (First results of a 2D model).
- Thermo-physical characterization of the FPBOs and surrogate composition. This surrogate contains 9 components including the heavy lignin component to represent the Heavy Molecular Mass (HMM) fraction of the FPBO. This component plays a relevant role in the formation of carbonaceous solid residue.
- Validation of the approach using experimental results from *Residue2Heat* project (WP3, WP4).



Main topic – FPBO Burner



Fuel - Component interaction



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Burner Component Tests

FPBO 20% **FPBO** 80% **FPBO** 100% **Ethanol 20% Ethanol 80% Ethanol 0%**

Standard components:

- Without any modifications no stable operation with pure FPBO
- Good results with admixture of ethanol
- Corrosion and deposit formation noticeable
- More detailed investigations needed







Main focus

- Stable combustion
- Emission control

Steps taken recently

- ☐ Redesign burner
- ☐ Different type of injectors

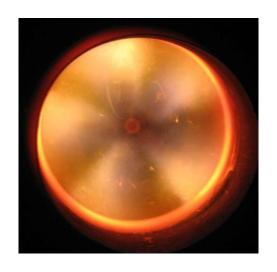
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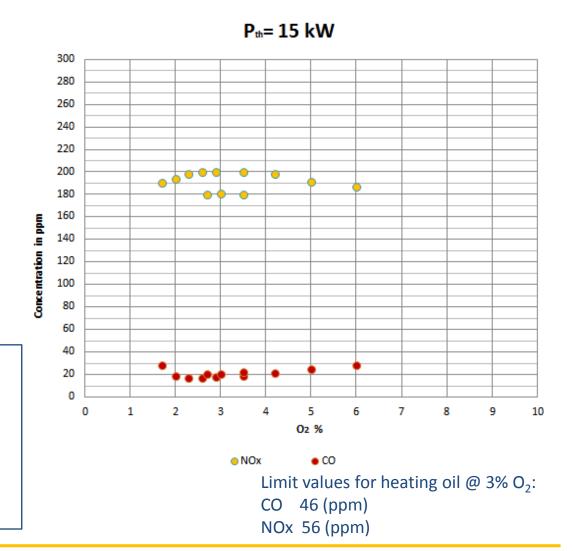
Development of a lab scale demonstrator

FPBO 100%

Concept



- FPBO Preheating
- No air preheating
- No pilot flame
- Stable combustion: 100% FPBO!
- NOx Emissions too high, mainly fuel NO





Sustainability chain evaluation

- Selection of feedstocks & regions
- Analysis according to RED I & RED II proposal COM(2016)767
- Sustainability risk analysis

FPBO feedstock:	Straw	Miscanthus	Forest residues	Bark		
GHG emission	90%	79%	85%	95%		
saving according	Accepted according to	Accepted according to	Accepted according to RED	Accepted according		
to RED and RED2	RED and RED2	RED and RED2	and RED2	to RED and RED2		
Carbon stocks	Possible impacts related to soil organic carbon balances due to straw harvest.		Possible impacts on soil carbon balances in forest due to residue harvest.			
Indirect land use change		Potential ILUC risk if miscanthus cultivation replaces food production.				
Biodiversity	Extensive extraction of straw may impact on nutrients and soil quality, and thus have a negative impact on biodiversity.		Collection of forest residues from forest impacts the availability of deadwood and can thus have a negative impact on biodiversity.			
Cascading use of biomass	If cascading principle was strictly applied concerning biomass, the biomass feedstocks should be first used as products (e.g. biomaterials) before their use for energy. However, it is not always possible to use (residual) biomass for products, and the direct energy use can be an optimal solution.					





Legal and pre-normative issues

- A draft overview of legal and pre-normative has been made at EU level and partially at the level of the focus countries.
- No binding European emission limits are in place for pyrolysis oil combustion in small units.
 - ☐ Formally pyrolysis oil combustion in heating systems of 20-200 kW does not fall under the Ecodesign Directive and its regulations
 - ☐ Pyrolysis oil might not fall under the definition of biomass as found in European emission regulations.
- In several countries (AT, DE, IT) pyrolysis oil has not the fuel-status, and thus cannot be used as a fuel.
- In other countries (like NL), a special fuel status is not need to allow combustion of pyrolysis oil.

During the project, a pathway to obtain the needed fuel status and further clarity on emission limits will be developed.







Legal and pre-normative issues

	Germany	Austria	Italy	France	United Kingdom
Classification as fuel relevant to bring FPBO on the market	yes (<100 kW)	yes	yes	no	no
Does FPBO already classify as fuel	no	no	no	n.a.	n.a.
Procedure available to classify FPBO available (without the need to change the law)	•	yes	no (!)	n.a.	n.a.
Environmental permit needed	< 100 kW: no 100 - 200 kW: yes	no (only if boiler is as part of commercial activity	no	no: if FPBO regarded biomass yes: if FPBO not regarded biomass	no, but notification is needed
Requirements to installation and operation	< 100 kW: type test from manufacturer available	Yes: found in Art 15 a B VG	Those relevant according to EU law	Yes: details in order of 24/06/13 on class 2910-B	In Building regulations 2000





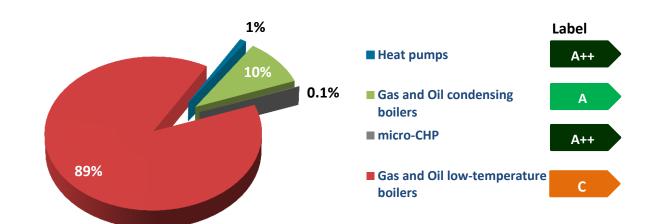


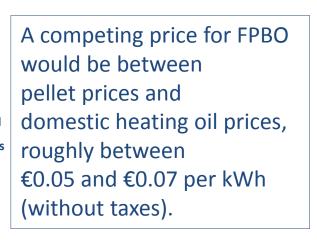
Market and Business Assessment

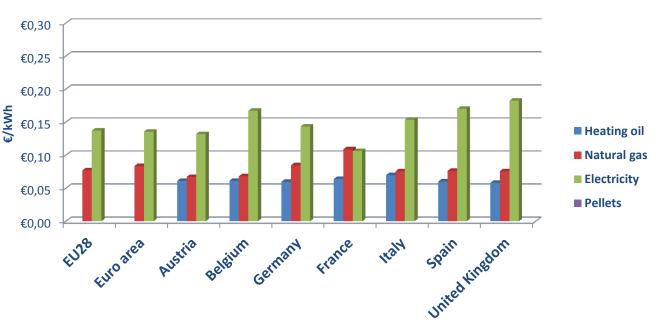
The market share of units installed in Europe with their typical energy labelling classification.



89% are outdated!











Expected Impact

Prior work situation	WP	Result	Next step	Impact
Present FPBO not suitable for residential boilers	WP2	Residential boiler grade FPBO from various high- ash biomass residues	Increase FPBO production from residues to demonstration scale	Efficient use of renewable low-grade biomass residues creates more jobs
Residential use of FPBO excluded from on-going standardization	WP3	Minimum one fuel oil grade suitable for residential use	Standardization of FPBO for future application	Widening the EU renewable liquid biofuels base
Limited fundamental knowledge on FPBO combustion	WP4	Enhanced knowledge on atomization and combustion conditions for FPBO	Optimizing of FPBO residential boiler concept	Strengthening EU industrial technology base, creating economical growth
Low emission burners for liquid fuels, unsuitable for FPBO	WP5	Residential-scale FPBO fuelled boiler concept, proof of concept validated in > 100 hour test	Technology demonstration & market introduction of FPBO fuelled boiler system	Improvement of EU energy security Increasing the attractiveness
Social, environmental impact of FPBO fuelled residential boilers unknown	WP6	Socio-economic and environmental impacts for FPBO fuelled residential boilers known	Increase FPBO production from residues to demonstration scale Standardization of FPBO for future application Optimizing of FPBO residential boiler concept Technology demonstration & market introduction of FPBO fuelled boiler system Advice to Regulatory framework to positively influence socio-env. impact Deployment of new renewable FPBO concept to markets Focusing the dissemination of residential boiler concept to early adopters	of renewable heating technologies Reducing renewable energy technologies installation time
No market for residential heaters using biomass residues	WP7	Market Assessment for key countries, business plan to implement value chain	Deployment of new renewable FPBO concept to markets	and costs and improved reliability Bringing cohesions and coherence and strategy in
Public perception on utilization of biomass and bio-liquids limited	WP8	Successful deployment for public perception. Stakeholders aware of possibilities	Focusing the dissemination of residential boiler concept to early adopters	the development of renewable energy technologies

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Thank you for Attention!

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