

TGA

Thermogravimetric analysis for torrefaction

A.H.H. Janssen

October 2012
ECN-L--12-085



TGA

Thermogravimetric analysis for torrefaction

WP8 - 1st technical meeting

Arno Janssen

Vienna, Austria

October 25th, 2012

TGA

Experimental validation of TGA method

In order to verify the effect of heating rates on mass yields in TGA several experiments have been performed with 10-20 mg ground chips (pine).

In all these experiments a residence time of 60 minutes was chosen. A 60 minutes TGA allows interpretation for shorter residence times as well.

The temperature profile applied in these TGA experiments consists of:

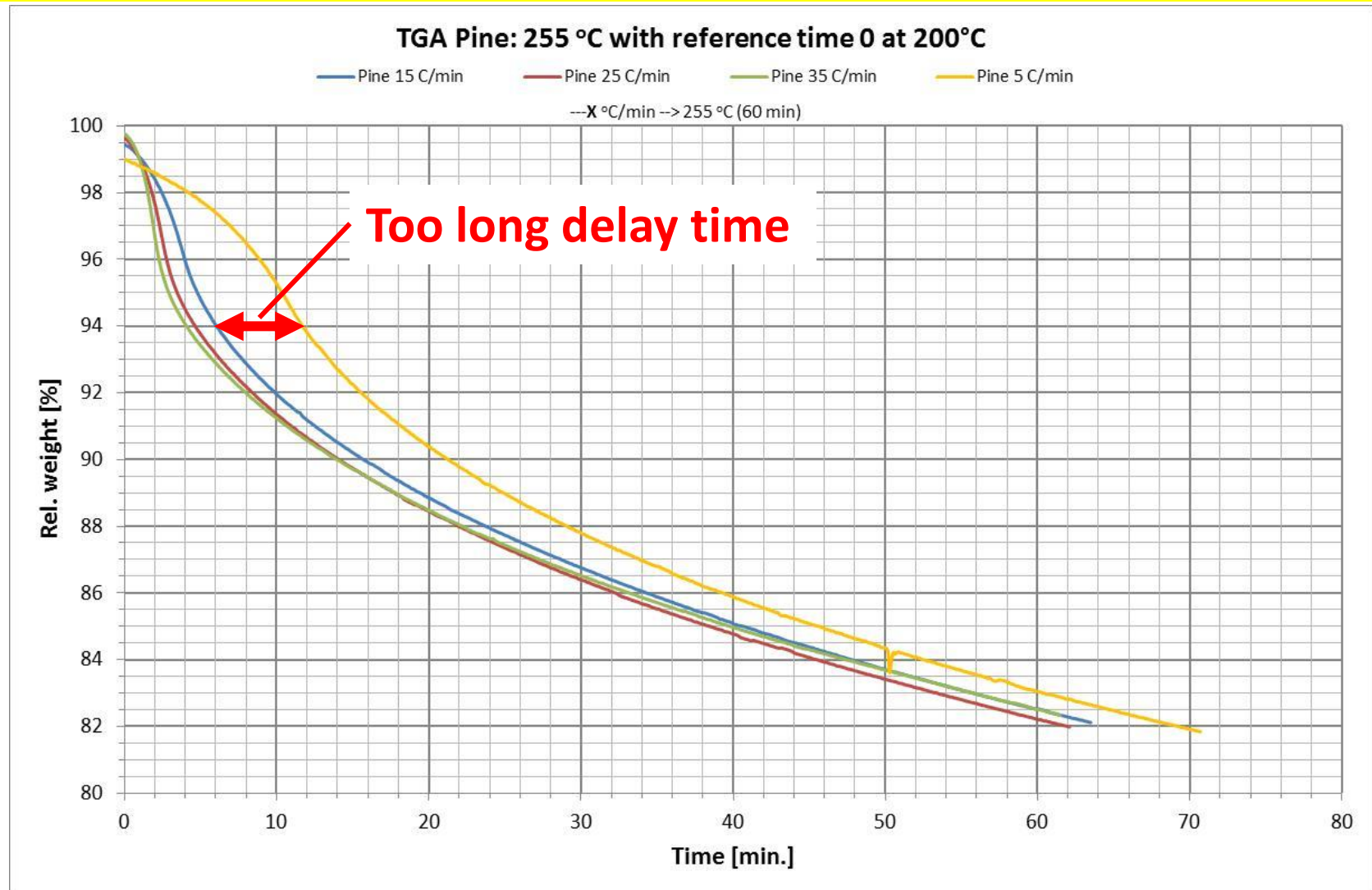
- Start of experiment: 30°C for 1 minute
- Heating to drying temperature: 15°C/min
- Drying: 105°C for 15 minutes
- Heating to torrefaction temperature: χ °C/min
- Torrefaction: T°C for 60 minutes

- Cooling with nitrogen: <30°C

Summarised in an equation this results in the following temperature profile:
30°C (1 min) → 15°C/min → 105°C (15 min) → χ °C/min → T°C (60 min) → 30°C (stop)

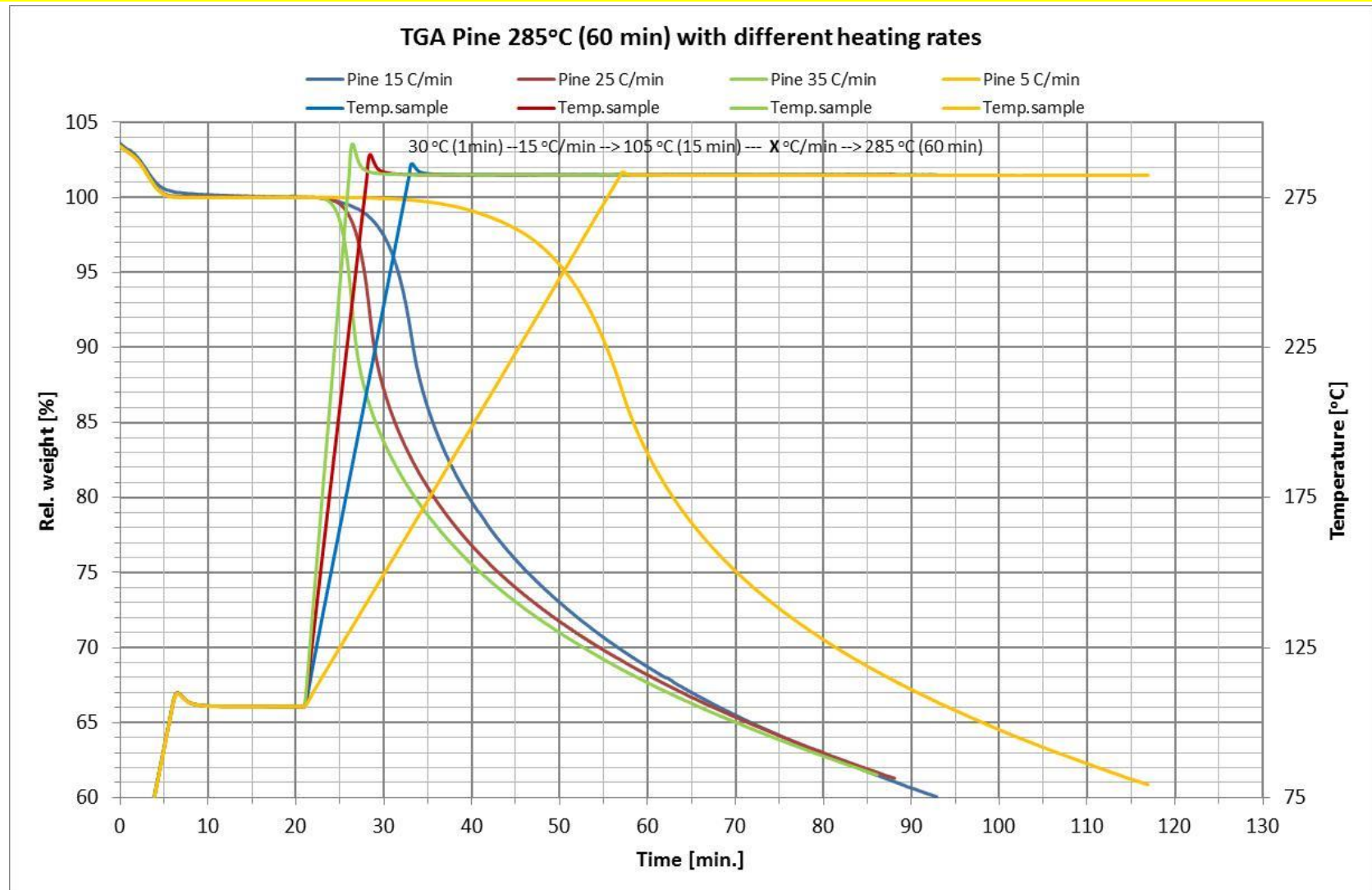
TGA

Experimental validation of TGA method (255°C)



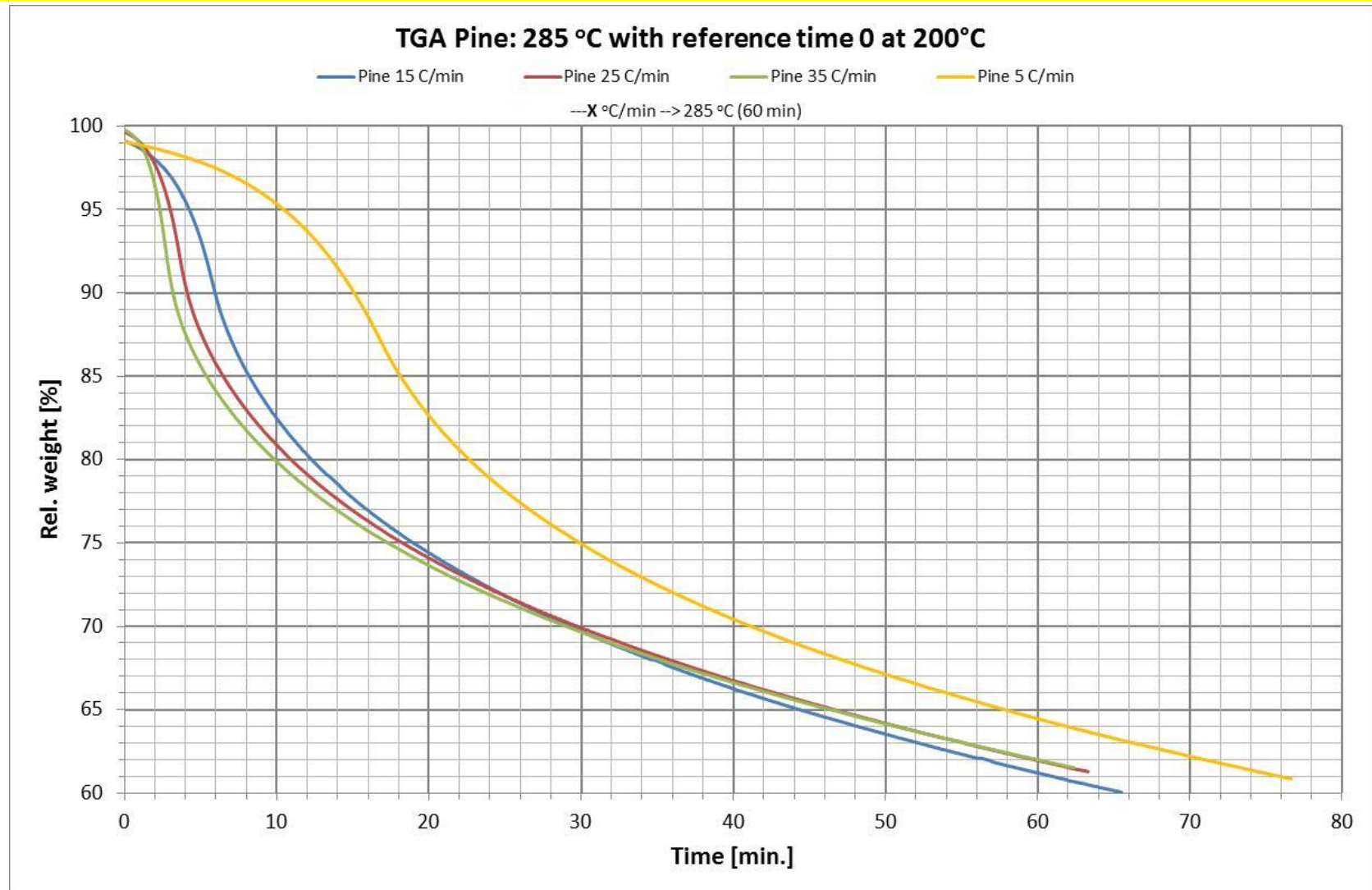
TGA

Experimental validation of TGA method (285°C)



TGA

Experimental validation of TGA method (285°C)



TGA

Standardised TGA method

Initial amount of biomass 10-20 mg ground chips (pine).

Residence time of 60 minutes at the torrefaction temperature.

The temperature profile applied in these TGA experiments consists of:

- Start of experiment: 30°C for 1 minute
- Heating to drying temperature: 15°C/min
- Drying: 105°C for 15 minutes
- Heating to torrefaction temperature: 25°C/min
- Torrefaction: T°C for 60 minutes

- Cooling with nitrogen: <30°C

Summarised in an equation this results in the following temperature profile:

30°C (1 min) → 15°C/min → 105°C (15 min) → 25°C/min → T°C (60 min) → 30°C (stop)

TGA

Comparison with batch and pilot scale tests

Amounts of biomass used for the tests:

- TGA: 10-20 mg ground chips
- Batch: 3-4.5 kg chips
- Patrig (pilot scale): 50 kg/hr chips

Temperature gradient during tests:

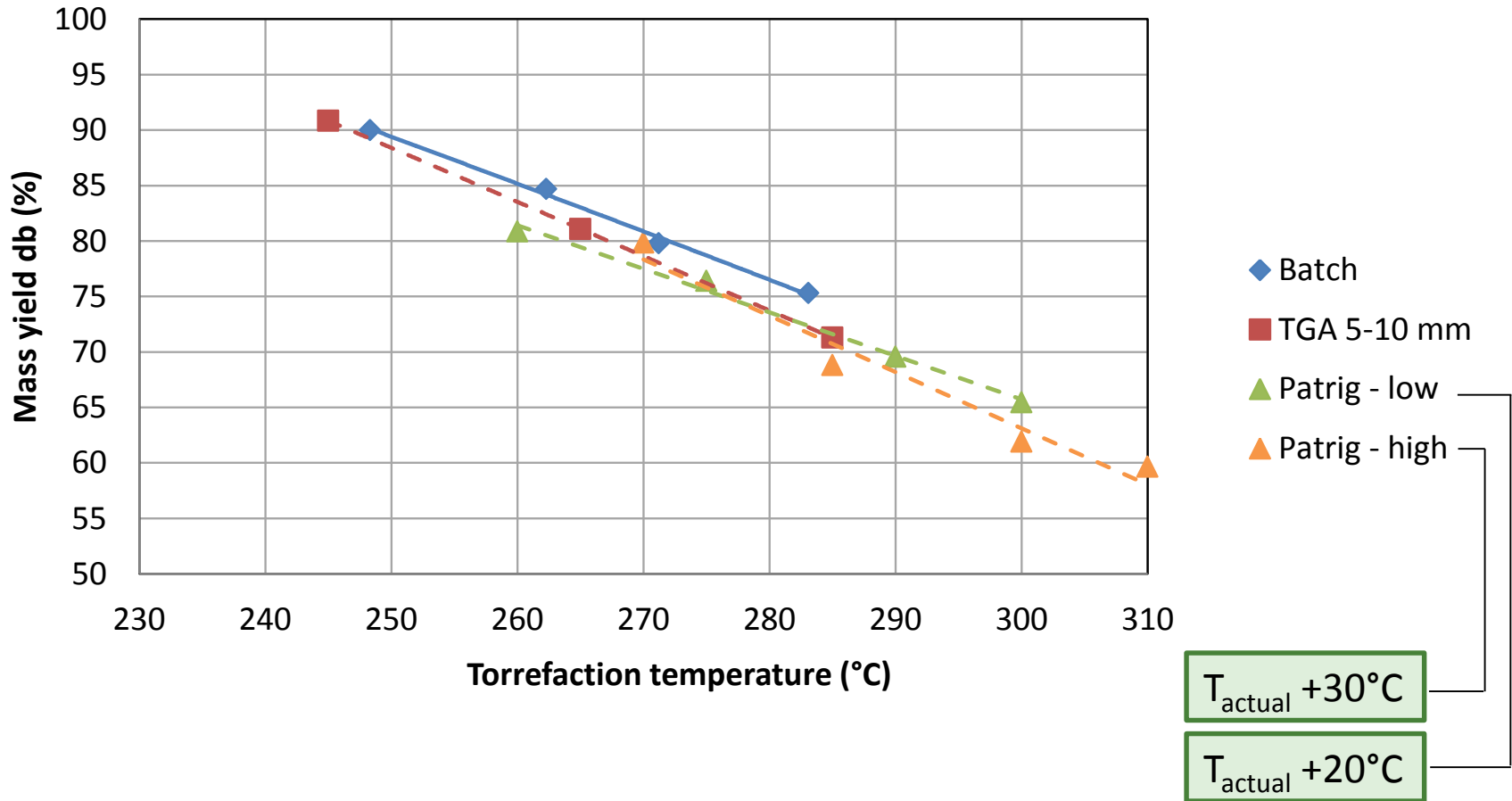
- TGA: ++
- Batch: +
- Patrig (pilot scale): 0

Time determination during tests:

- TGA: ++
- Batch: +
- Patrig (pilot scale): -

TGA

Comparison with batch and pilot scale tests



Significant impact on mass yield due to particle size and thermal conductivity.

TGA

Conclusions

TGA measurements:

- are relatively fast
- use only a very small amount of material
- deliver accurate results.

In comparison with other torrefaction reactors:

- the right sample size has to be used
- highly valuable in predicting the behaviour of the feedstock.

Thank you for your attention!

This presentation was prepared within the framework of the EU FP7 project:



Production of **Solid Sustainable Energy Carriers** from Biomass by Means of **TORrefaction**

For more information, please contact:

Arno Janssen
Researcher bioenergy
Biomass & Energy Efficiency



T +31 88 515 45 63
F +31 88 515 84 87
a.janssen@ecn.nl

P.O. Box 1, 1755 ZG PETTEN
The Netherlands
www.ecn.nl



ECN

Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 LG Petten
The Netherlands

T +31 88 515 4949
F +31 88 515 8338
info@ecn.nl
www.ecn.nl