



Located in Yverdon, Switzerland

- Partner of 27 University Conglomerate Western Switzerland
- Employees : 660
- Students: 1500 (17% foreign)

aR&D activities

Total budget: 55 – 70 Mio Euro

- R&D budget: 25%
- Organisation & Infrastructure for Tech Transfer

Core competences and laboratory installations for applied research projects and industrial contracts:

> **combustion, biogas, torrefaction and characterization of biomass**

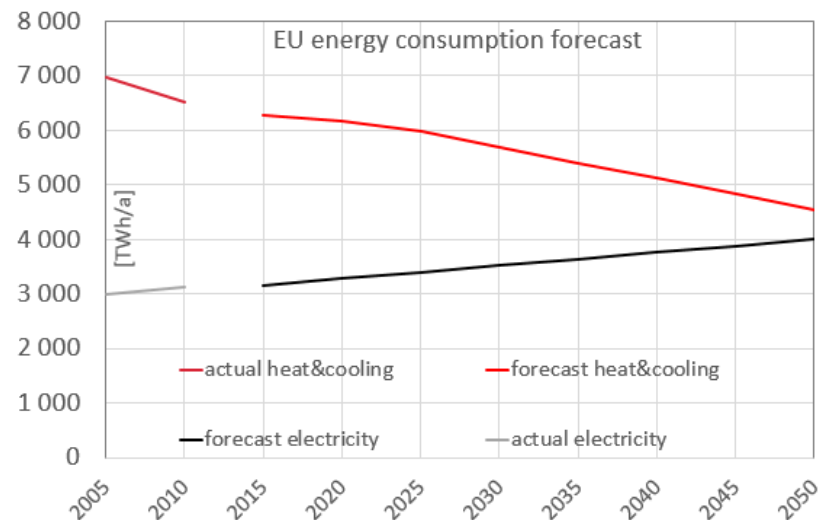
Activities in Torrefaction

- **Laboratory-scale torrefactor**
 - 5 kg/h screw electric heating, operational since 2012
- **Experimental combustion facility**
 - 50 kW experimental, operational since 2009
- **Tests with small scale oven**
 - 30 kW installed burner, performed in 2012



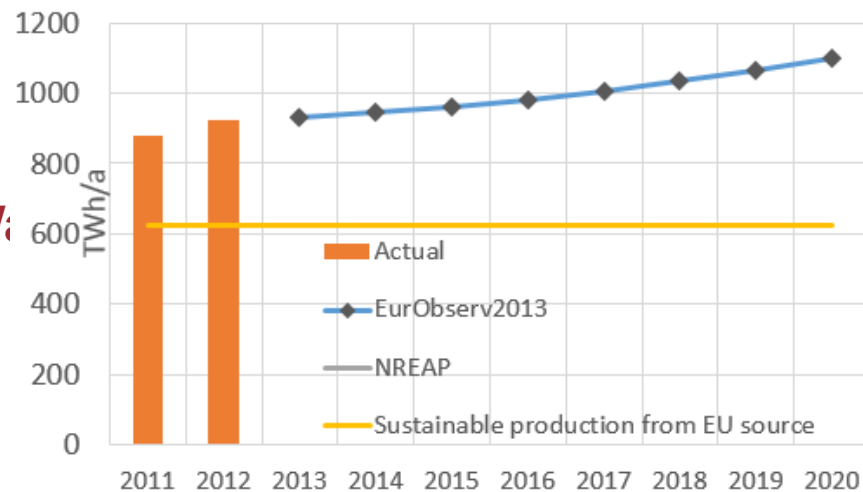
Energy Consumption Target

- Heating demand decline - 1 %/a
- Power demand increase + 1 %/a
- Reduction of variation
- > Improve efficiency, storage cap & grid



Solid Biofuel Prod. Plan

- Growth of solid biomass + 1 to 3 %/a
- Exploit solid biomass potential 733 TWh/a
- Increasing imports
- > New technique & application (CHP)

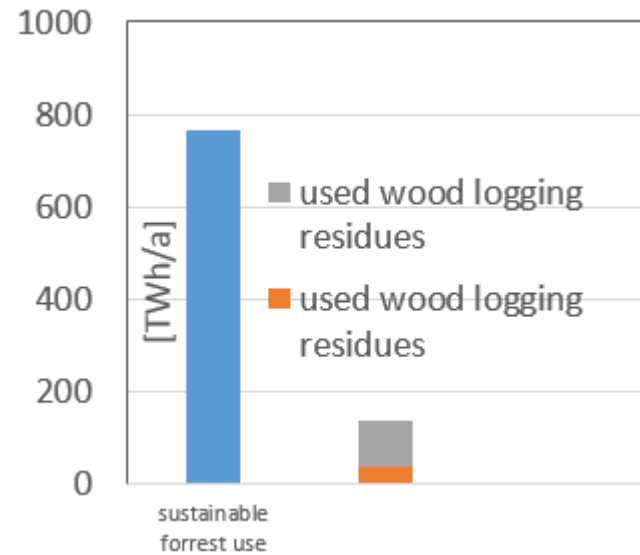


Estimated utilization and potential

- Non used potential 50% to 80%
- Estimated potential 100 TWh/a (33 Mio to/a)
- Low price
- > Niche: High potential but low volume

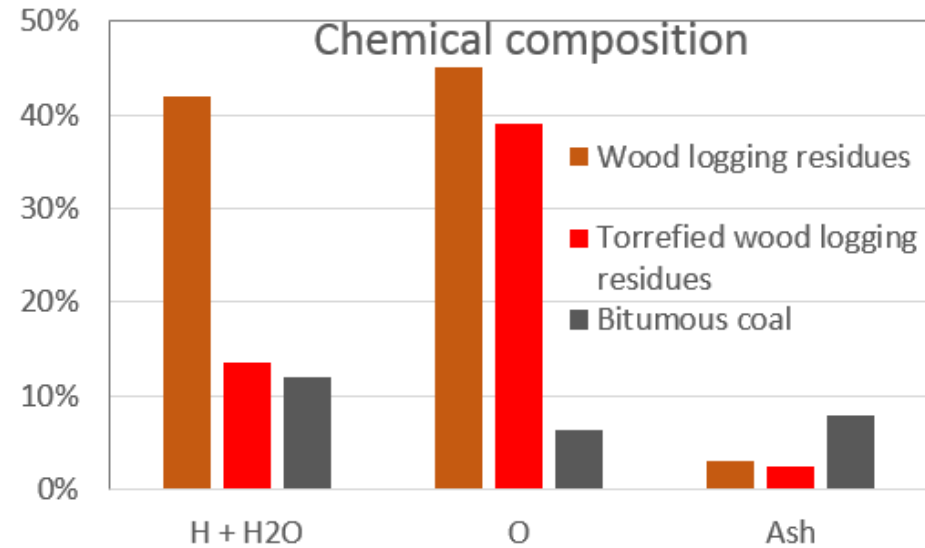
Existing Installation

- Forrest houses
- Incinerators
- Compost plant
- > Local, decentralized installations



Chemical composition

- Reduction of hydrogen & humidity
- Small reduction of oxygen
- Small increase of carbon
- Constant ash content
- > Biggest change in humidity



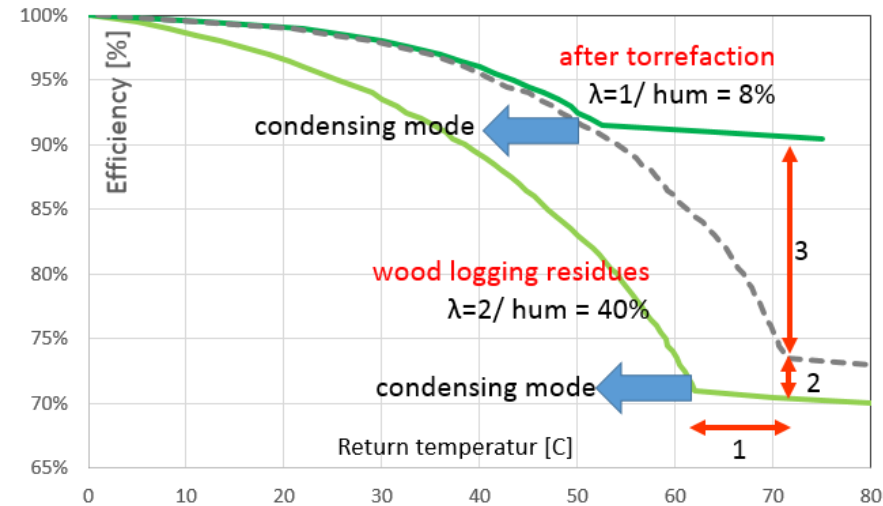
Physical properties, non densified

- Higher heating value + 70 to 80%
- Fewer volatiles – 10 to 20 %
- Lower bulk density – 40 to 50 %
- > Biggest change in heating value

	Wood logging residues	Torrefied wood logging residues	Bitumous coal
LHV [MJ/kg]	11	19	25
Volatiles [%]	80%	75%	55%
bulk density [kg/m ³]	350	225	700
energy density [MJ/m ³]	3 850	4 275	17 500

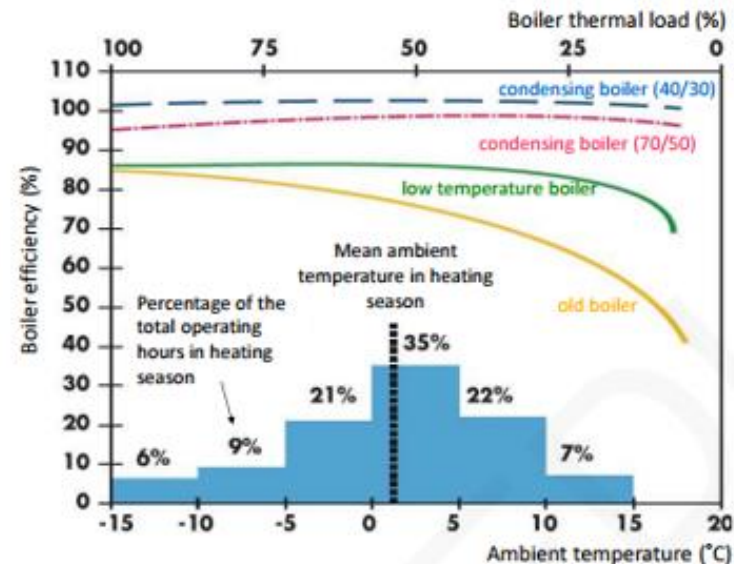
Efficiency normal cond.

- (3) Humidity reduction: eff. + 15% - 30%
 - (2) Excess air reduction: eff. + 2% - 5%
 - (1) Higher temperature > incr. generation
- > Higher efficiency with improved fuel



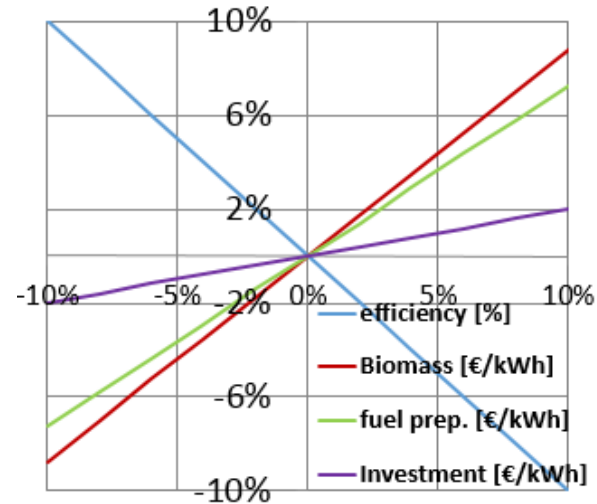
Efficiency with diff. temp.

- Regulation with condensing unit
 - Reduced ambient depends
- > Improved seasonal efficiency



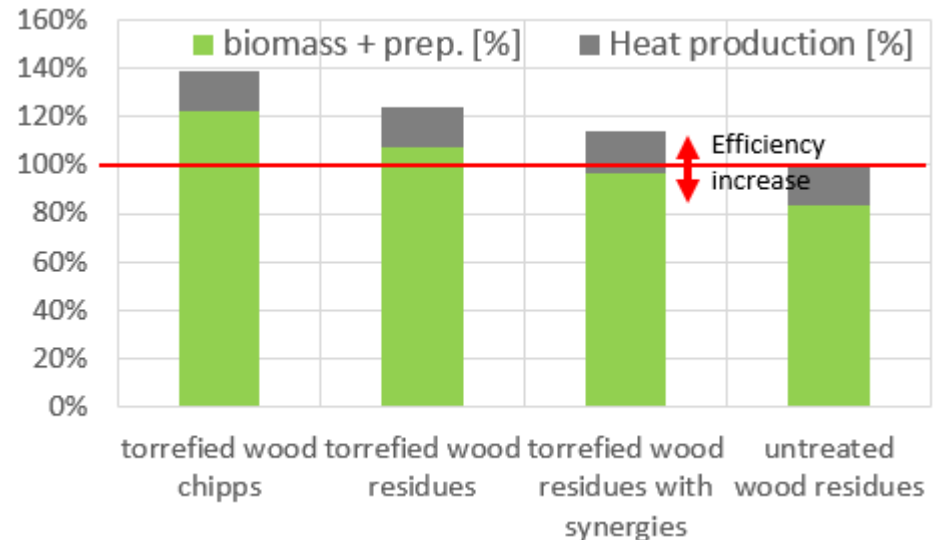
Cost sensitivities









- 1) Important effect of efficiency
- 2) Biomass
- 3) Torrefaction process
- > Combustion & fuel combination



Heat production cost

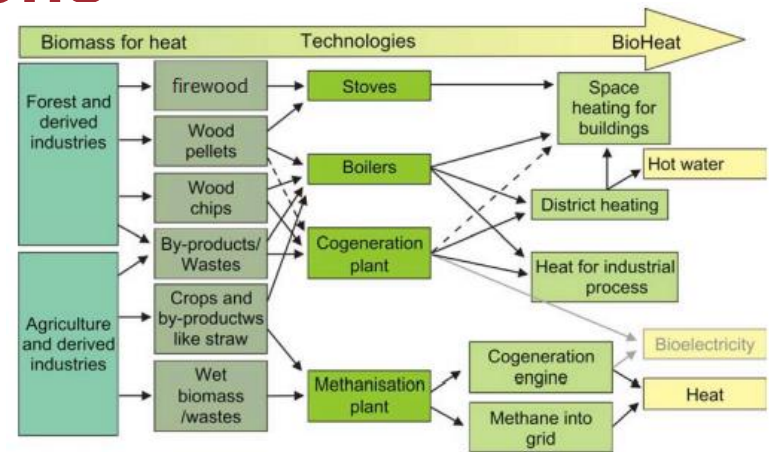
- Torrefied residues are competitive
- Consideration of integration
- > Decentralized solutions feasible



Comparison	Torrefied Wood logging residues	Wood logging residues
Thermal efficiency		
Condensing demand		
Potential corrosion		
Emission		

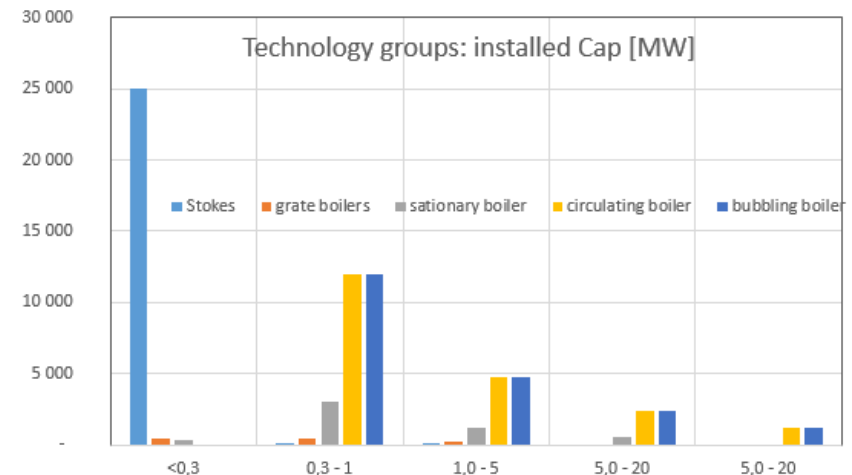
Energy generation combinations

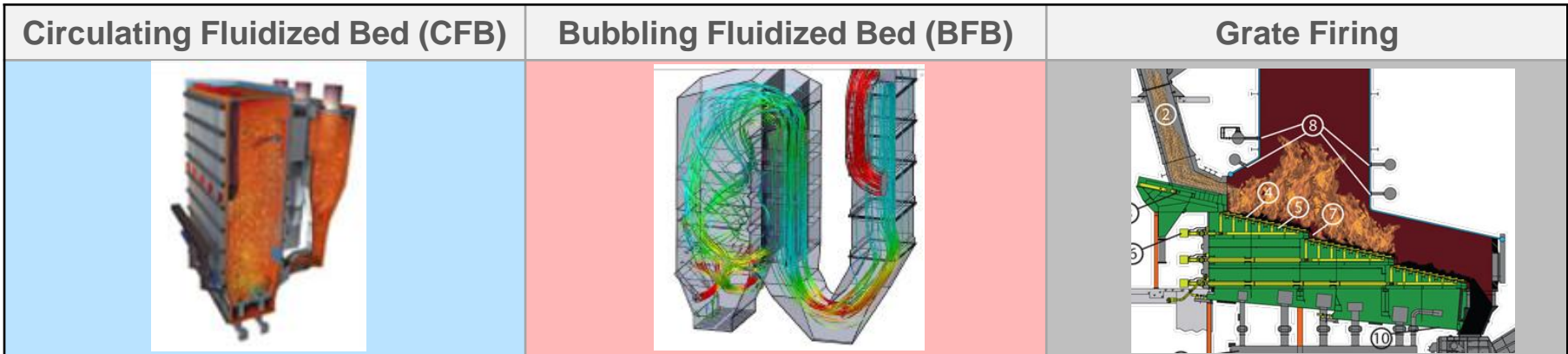
- 2 Combustion types
- 3 Energy generation types
- 2 Energy distribution systems
- > EU measures: increase CHP, DH, multi-biomass



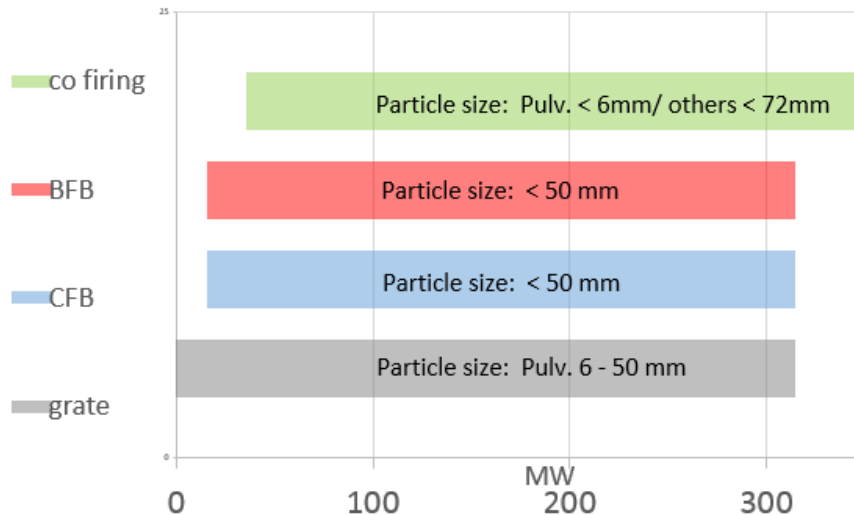
Installed Capacity

- Main Fuel: wood chips
- Main Application: small scale, grate
- > New technique & application (CHP)

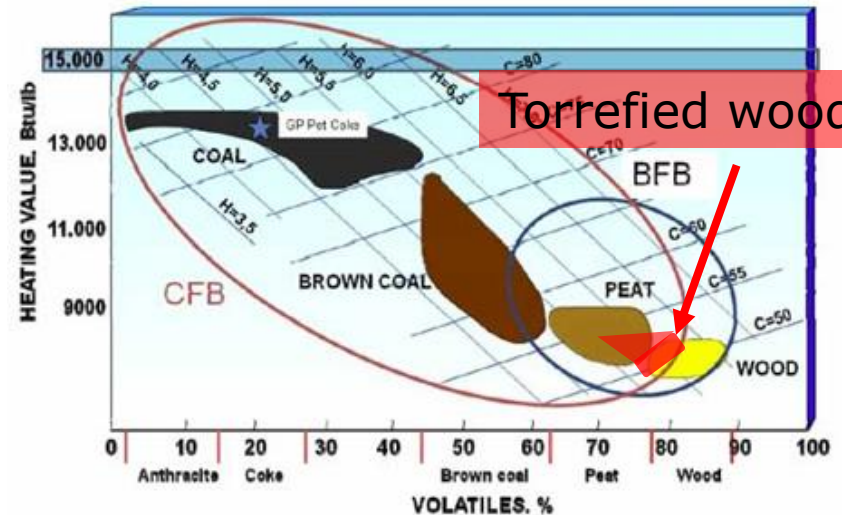




Characteristics

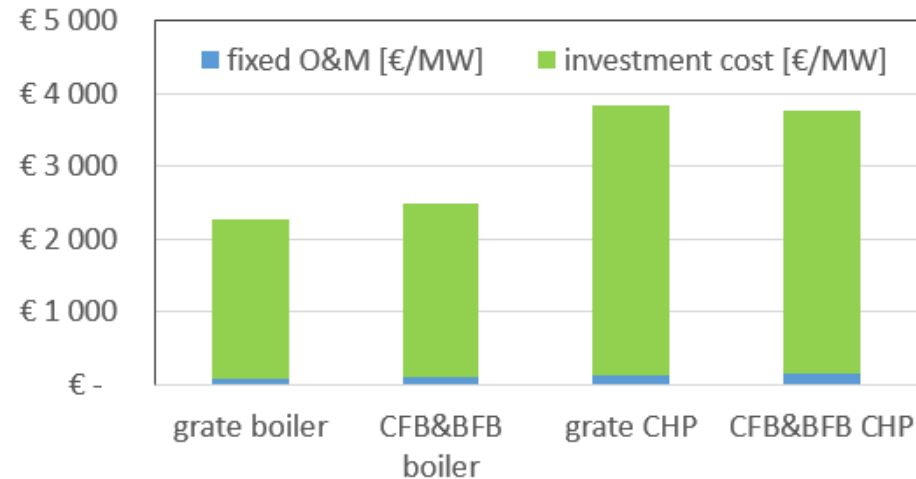


General fuel range of use



Fixed O&M + Invest

- Grate firing most economic
- FB: higher O&M cost
- Ash removal same (...sand)
- > Grate firing for boiler operation



Electricity production cost

- Fluidized bed more efficient
- Broad range
- > Depends on specific case

	Electricity production cost [€/kWh]
grate boiler	0,04€ - 0,16€
CFB&BFB boiler	0,05€ - 0,16€
grate CHP	0,05€ - 0,22€

Comparison	BFB	CFB	Grate firing
Fuel Range	Limited	Unlimited	Unlimited
Small scale	No	No	Yes
efficiency	Higher	Higher	Lower
Total operation cost	Higher	Higher	Lower

Advantages of torrefied wood logging residues

- High efficiency
 - High potential for co-gen due to higher temperature
 - Minimum condensation requirement
- > Next step: confirm with tests

Potential application for torrefied wood logging residues

- Small to medium scale < 20 MW: grate
 - Low Combustion unit investment costs
 - Low Combustion operation costs
- > Depends on application, potential to improve all existing installations