Sustainable Bioenergy Solutions for Tomorrow

MEASUREMENTS IN A FOREST-BASED MATERIAL SUPPLY CHAIN

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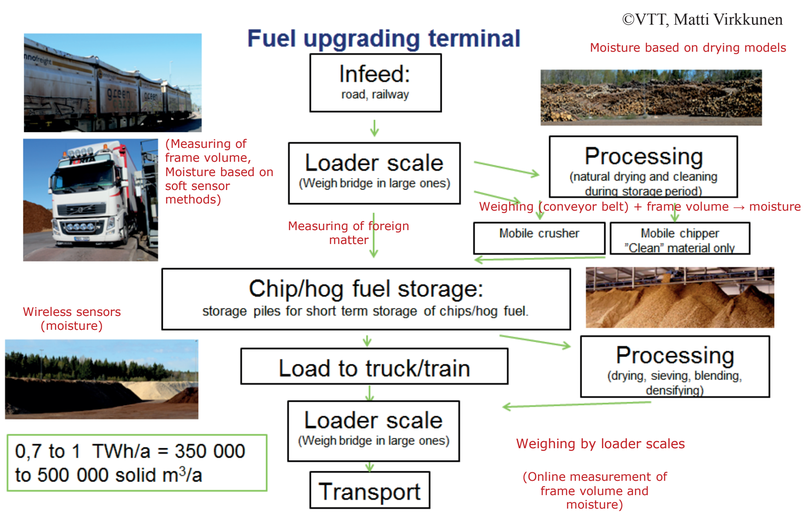
Measurement needs in raw material supply chains and measurements in biomass terminals

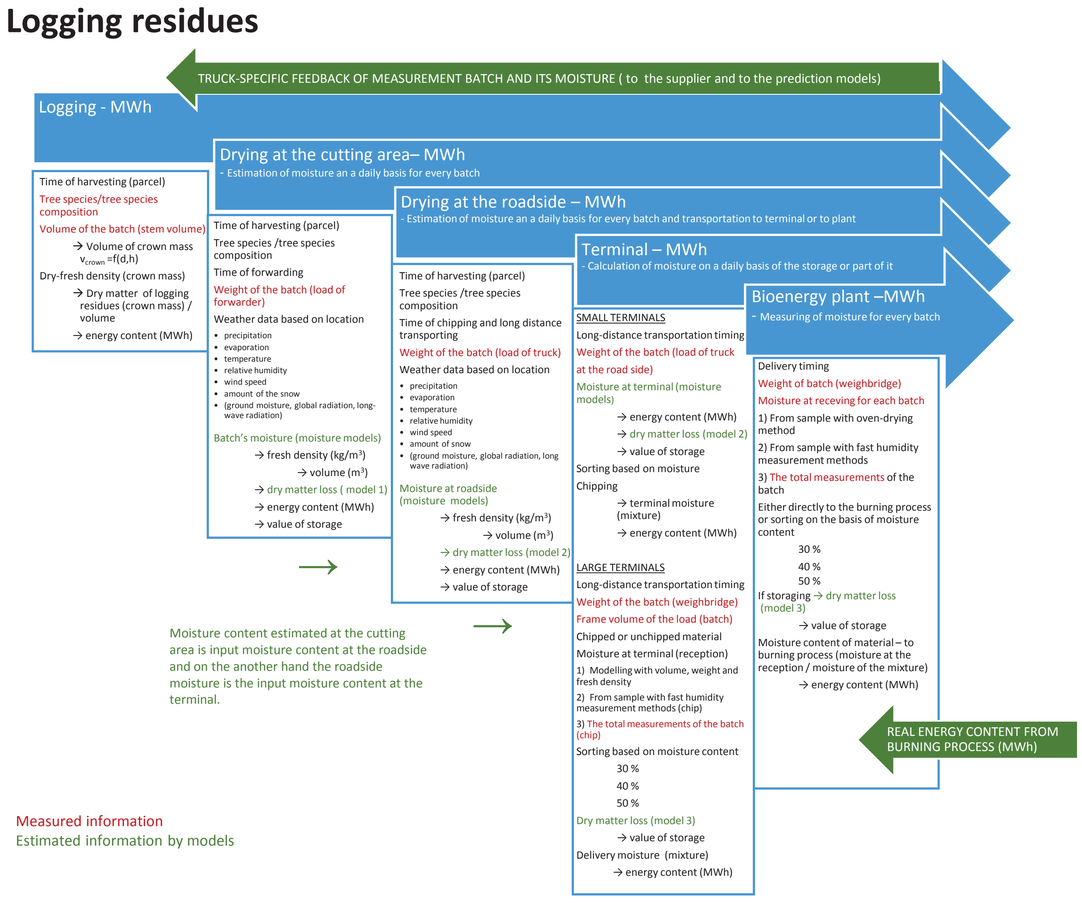
The MWh-roadmap and Flow-charts describe at a general level what kind of measuring information and in which stage of the supply chain it is needed to calculate heat value and energy content throughout the supply chain and how this information can be combined and stored. Flow-charts were created for logging residues, small size stem wood and stumps.



Picture 1. Measurements in a Fuel Upgrading Terminal. Picture © VTT, Matti Virkkunen

- In the future, moisture content will be estimated on a daily basis for each storage from the parcel storage to roadside and always for the biomass terminals based on the drying models and weather data
- Measurements are done as part of the logistic supply chain

- At the biomass terminals and plant reception, moisture content and foreign matter are measured based on samples or total measurement of the batch
- Real-time feedback information of moisture content and foreign matter guarantees high-quality material to the process



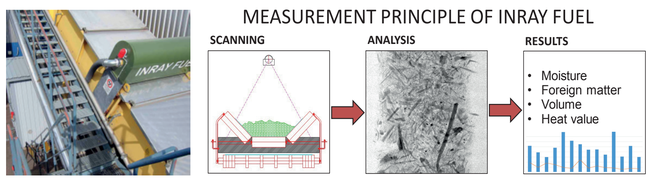
Picture 2. Flow -chart of logging residues. Flow-charts describe at the common level the what kind of measuring information and which stage during the supply chain it is needed to calculate the heat value and energy content throughout the supply chain.

Key Measurement Technologies and Methods (CASE STUDIES)

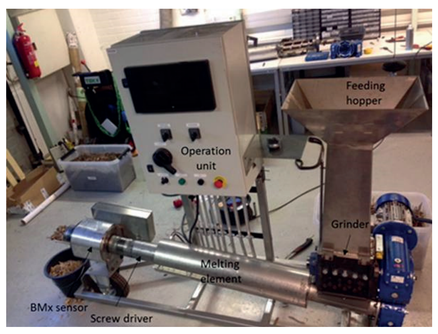
Inray FUEL X-ray measurement system for continuous analysis of the quality of biofuels.

- The system measures solid biofuel moisture, density, volume and the amount of contaminants from each fuel load and analyzes the results immediately
- Total survey (not based on samples); measures everything carried on the conveyor

More information:
http://www.inray.fi/
https://bestbioenergy.wordpress.com/2015/06/24/x-ray-technology-revolutionizes-biofuel-quality-management/



Picture 3. Measurement principle of INRAY FUEL



Picture 4. Senfit BMx Online - Moisture Analyzer

Senfit BMx online and BMA desktop moisture analyzers are based on microwave technology and can measure all fuel types.

- Measurement (BMA) range 0-70% (either 0-15% or 15-70%)
- Good correlation with Loss-on-Drying (LoD) reference obtained when the calibration and measurement samples are both between 15-70%mc and when the measurement samples and the calibration samples were both from the same supply location
- Difference between the microwave instrument and the reference method was 0.0 ± 1.8 %-unit on average at a 95% confidence level (Österberg et al 2015).

More information:
http://www.senfit.com

Valmet MR Moisture Analyzer utilizes Nuclear Magnetic Resonance (NMR) for moisture analysis. It measures absolute water content by detecting the resonance signal of hydrogen atoms from free water molecules. The device measures virtually any sample containing water in a couple of minutes regardless of particle size and material type – except in the case of the material containing ferromagnetic metals.

- Measurement range 0-90%
- Good correlation between the NMR and the LoD measurements were in general obtained when the water mass of the sample is more than 20g
- Difference between the reference method was 1.0 ± 3.8 %-unit on average at a 95% confidence level. Standard deviation of parallel samples was 0.9% on average for the NMR instrument (Österberg et al 2016)

More information:
http://www.valmet.com/

Picture 5. Valmet MR Moisture Analyzer

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Truck-Specific Moisture Measurements and Energy Content Determination

- If truck-specific moisture determination with best known practices are utilized, the energy content is about 5% less than practices commonly in use today
- Correlation between bulk density and moisture content has to be defined for each fuel type
- When the trucks weight and volume are known, moisture can be calculated from the bulk density (volume and weight of the load)
- Volume measurement accuracy is important for the method

More information:
http://www.prometec.fi/fi/naytteenottorobotti/

QUALITY CONTROL CONCEPT

QUALITY CONTROL STATION FOR INCOMING AND OUTGOING BIOMASS

- *WEIGHBRIDGE AND SAMPLING ROBOT*
- *QUALITY ANALYZING*

FUNCTIONS: WOOD CHIPS and SAWDUST
- Weighbridge: Turcks' gross weight and empty weight
- Fully automated sampling robot
- Online volume estimation by machine vision
- Truck spesific moisture measurement by MR or BMA, measurements calibration according to standard SFS-EN14774
- Net calorific value determinations in laboratory

OUTPUT:
-> predicted moisture by bulk density models for terminal process control
-> truck spesific energy content to payment basis for biomass seller and power plants

FUNCTIONS: SMALL SIZES ROUND WOOD
- Weighbridge: Turcks' gross weight and empty weight
- Online volume estimation -> solid cubic metre

OUTPUT:
-> truck spesific energy content to payment basis

FUEL SUPPLY CHAIN ADMINISTRATION SYSTEM; Protacon Once
Act as the fuel management system, where all truck-specific measurement data transferred to.
- Net weight (kg)
- Volume (m^3)
- Predicted moisture (%)
- Measured moisture(%)
- Net calorific value (MJ/kg)

Act as a stock management system: calculates energy balance in terminal
- Incoming energy
- Outgoing energy
- Total energy in terminal

Picture 6. Quality control concept and Q-Robot biofuel sampler developed by Prometec.

Conclusions

- Present, fast moisture-measurement devices are accurate enough for truck-specific measurements. Calibration to LoD can cause absolutic inaccuracy.
- Sampling is the most critical step in determination of fuel moisture (can cause about 5-10 % inaccuracy, 80% of the unreliability). Sampling machinery is quite difficult to implement and is very expensive part of the system.
- Energy content determination accuracy can be improved by online volume detection.
- Energy content Truck-specific measurement data allows more reliable energy content information than the current practice.
- New technologies are estimated to create significant cost reductions in power plants and the possibility to give immediate feed-back to the biofuel supply chain opens a whole new possibility to control fuel quality and increase the energy content.
- The feedback information of moisture content and foreign matter is needed to optimize and improve the quality of the raw material. In the future the feed-back information can be also used to calibrate the self-learning drying-models used at the logistic supply chain.

Publications

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