VTT TECHNICAL RESEARCH CENTRE OF FINLAND LTD

Bioenergy RES Hybrids – Finnish Country Report

Sustainable Energy Week

15th June, 2016, Brussels

Elina Hakkarainen
VTT Technical Research Centre of Finland Ltd.

Content

- Background
  - Drivers for Bioenergy RES hybrids in Finland
  - Renewable energy in Finland
- Bioenergy RES hybrids in Finland
  - Current status – Case examples
  - Potential market areas
  - Main drivers & challenges
- Summary

Background

Background

- The definition for hybrid system challenging, since energy systems are becoming more complex
- *“Process having at least two different renewable energy inputs”*

- Hybrid system classification in this work:
  1. Domestic applications
  2. District heating and cooling networks
  3. Industrial applications
  4. Farm-scale applications

- More detailed classification could be done: e.g. light, medium and strong hybrids*

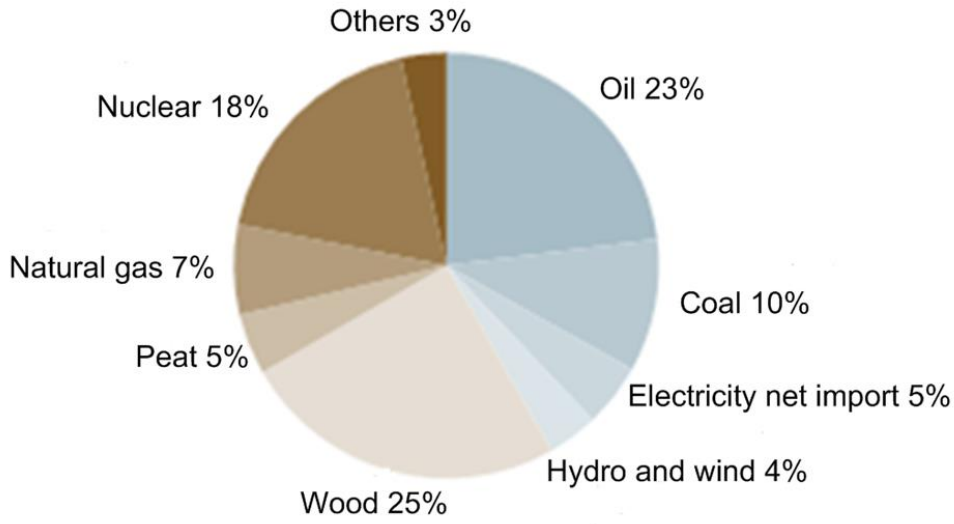
* Source: Peterseim, J.H. et al., 2014, Concentrating solar power hybrid plants – Enabling cost effective synergies, Renewable Energy 67 (2014) 178-185

Drivers for Bioenergy RES hybrids in Finland

- Target for RES share of final energy consumption 38% by 2020
  - Exceeded in 2014 →50% by 2030
- Target for RES in transport 20% by 2020
  - Exceeded in 2014 →40% by 2030

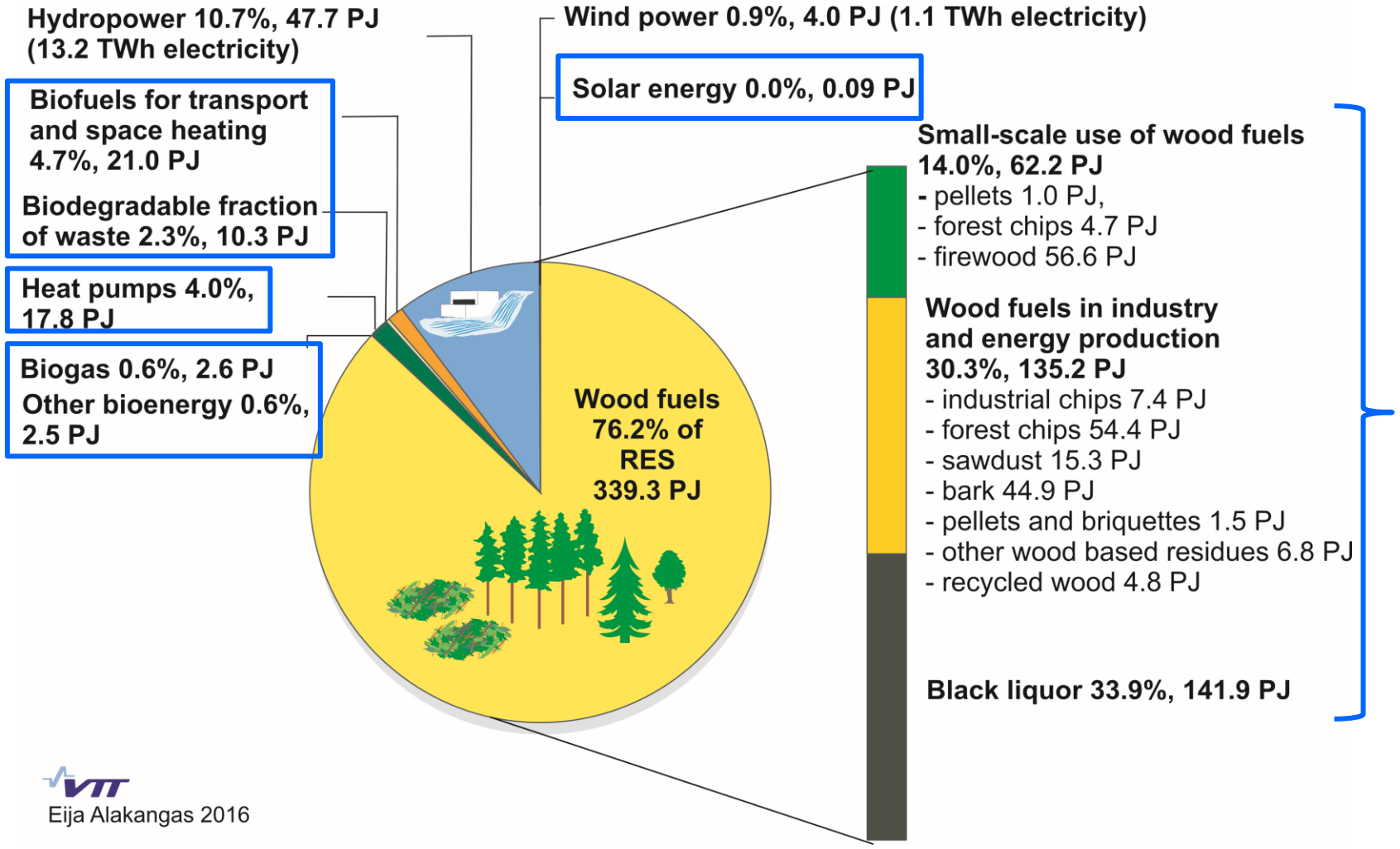
- Bioenergy contribution significant (2014):
  - 25% of the total energy consumption
  - Over 80% of all renewables
  - Biomass residues from forest industry
- Bioenergy a fast way to increase the share of renewables
  - Availability for all end-uses and price in question
  - Hybrids can release pressure from bioenergy consumption
- Self-sufficiency and domestic resources to be increased

Total energy consumption 2014



Source: Motiva

Renewable energy in Finland



Source: Statistics Finland

Domestic applications

Domestic heating systems

- Most of the household-scale hybrids found in the heating sector
- Hybrid system not a new phenomenon
  - Oil, bioenergy, electric heating, heat pumps
  - Bioenergy typically found in detached houses (86%)
- A few companies providing RES hybrids as a “product”
- Investments in RES hybrids fully market driven
  - Self-sufficiency, minimized operational costs, reliability
- The main potential outside the DH network

- 200,000 oil boilers (5 TWh/year oil)
- 100,000 other water circulation based systems
- 500,000 directly electric heated systems
- 500,000 summer cottages
- 100,000 premises outside the DH network
- 30,000 apartment buildings for ventilation heat recovery

District heating and cooling networks

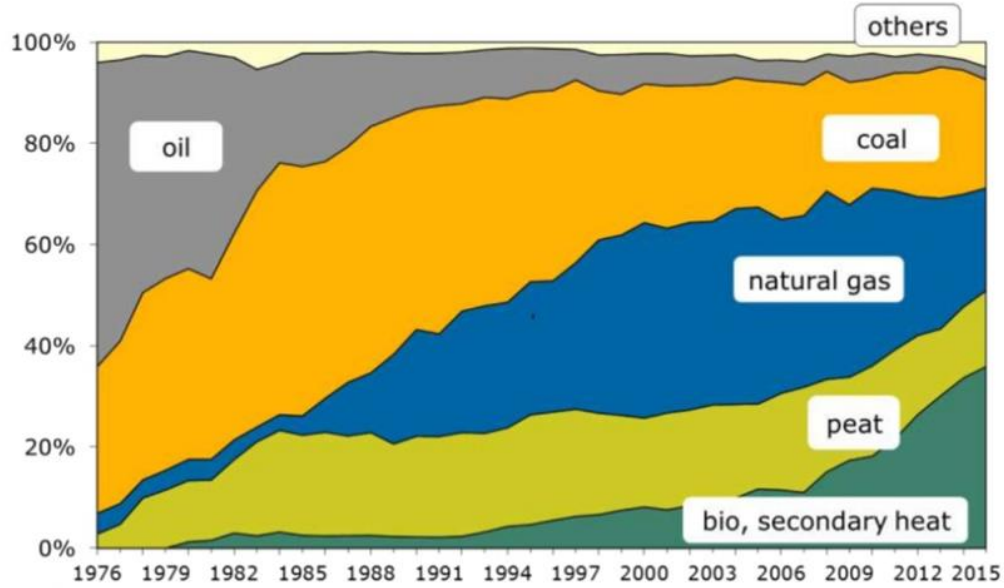
District heating and cooling in Finland

- District heating and CHP common in Finland

- District heating/cooling networks offer good base for bioenergy and other renewable resources
  - Fast adaption of renewable energy
  - Bioenergy fast way to increase RES share
  - Coal replacement in existing CHP plants
  - Pulverized wood pellet boilers for peak demands

- Current district heat 33 TWh (119 PJ), projected 40-42 TWh (144-151 PJ) by 2025
- Current district cooling 190 GWh (684 TJ), projected 425 GWh (1,530 TJ) by 2030

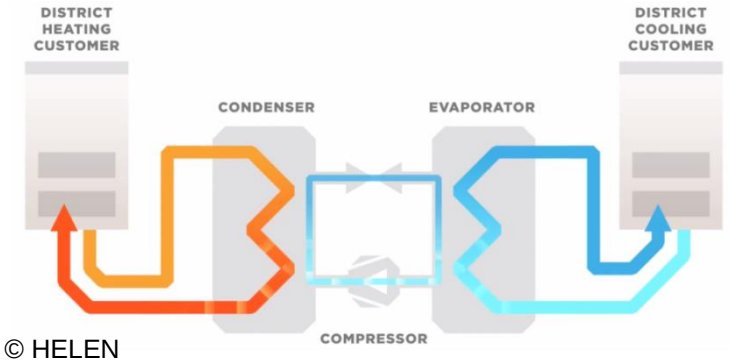
Fuel consumption in production of district heat and CHP



Source: Finnish Energy

Case HELEN: District heating & cooling network

- A large-scale hybrid platform: trigeneration of heat, power and cooling with high efficiency
- HELEN's goal to be CO_2 neutral utility by 2050

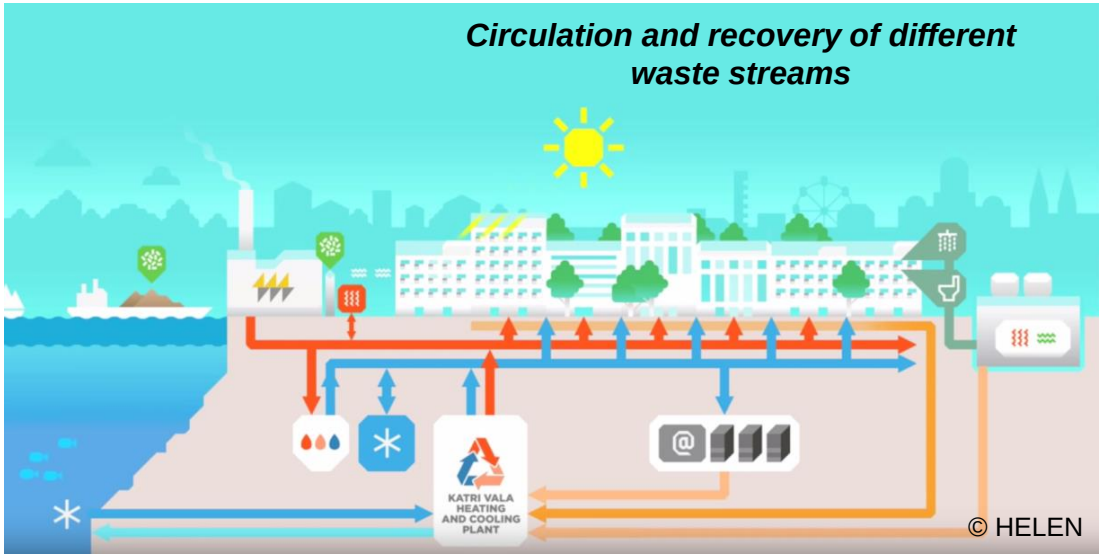


© HELEN

- 90% of DH produced by CHP:
  - Co-combustion of wood pellets and coal
  - Distributed heat generation based on biomass
  - → Increasing role of bioenergy, fast way to achieve RES targets
- 7% of the DH produced by heat pump station:
  - Waste stream utilization (purified sewage water)
  - Passive solar energy (cooling)
  - → Reduced investment in generation capacity

Largest co-generation system of district heating and cooling in the world – a hybrid process

Circulation and recovery of different waste streams



© HELEN

Case Savon Voima: Pilot solar/biomass hybrid

- First RES hybrid pilot replacing fossil fuel based DH unit
  - Wood pellet burner; 500 kW_{th}
  - Solar thermal collectors (by SavoSolar); 8 kW, 12 m^2
  - Electric heater; 70 kW
  - No heat storage
- Solar collectors to preheat the return water
  - → High solar thermal efficiency
  - Summer period: solar thermal + electric heater
  - Storing biomass to later use
- Annual wood pellet replacement still small
  - Pilot to test the operation of the system
  - Annual solar production 3-4 MWh, focused on the summer period
- More knowledge will be available after first summer

© Kari Vesterinen, Savon Voima Oyj

Industrial applications

Industrial examples

Case Adven: “GeoBio” Hybrid

- Hybrid system for **logistic center** to cover heating and cooling demand
- Base load from ground-source heat
- Wood pellet burners as balancing element
- Waste heat recovery from the cooling system
- Heavy fuel oil as backup fuel

Case Snellman: Meat production

- Hybrid system for **food industry** to cover heat demand, replacing oil
- Centralized production of biogas from the sludge and sewage of the facility to produce heat and steam
- Reduced consumption through ventilation heat recovery
- In the future, biogas also for electricity

© Snellman

- Cost-competitiveness the main driver
- Better management of sludge

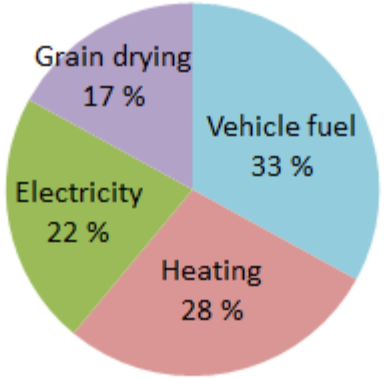
- Energy consumption in food product manufacturing industry 4.5 TWh
- Energy consumption in beverage manufacturing industry 0.57 TWh

Farm-scale applications

Bioenergy potential in agriculture

- Wide variety of technological options
  - Some RES hybrid examples already exist
- Energy demand in agriculture is high
  - Bioenergy already covers 4.5 TWh
  - Forest biomass and waste biomass available
  - A lot of rooftop and other area available
  - High, but rather stable energy consumption
- Main drivers:
  - Self-sufficiency
  - Cost reduction in energy
  - Additional incomes (biogas, biofuels)
  - Waste treatment & Nutrient circulation
  - Investment subsidy (35%)
- Local networks important!

Energy consumption in agriculture



© GreenEnergy Finland

- Direct energy use in agriculture 10 TWh
- Energy use in greenhouses 1.8 TWh
- 55,000 farms
- Average energy consumption 180 MWh

Summary

Summary – Role of hybrids in different applications

- Domestic applications
  - ✓ Minimized operational costs and self-sufficiency
  - → Biomass for base load + solar thermal, electric heating, heat pump
  - → Ground-source heat + biomass to decrease peak demand costs
- District heating/cooling networks
  - ✓ High potential for renewables - Bioenergy the fast way to achieve the targets
  - → Biomass for balancing and peak demands, waste streams and solar energy
- Industry
  - ✓ Reduced energy costs, better management of sludge (food product industry)
  - → Bioenergy to replace oil consumption, complemented with waste heat recovery
- Farm-scale
  - ✓ Self-sufficiency and additional incomes – Match between resources and consumption
  - → High potential for local biogas production, also outside the gas grid
  - → Biogas economy: energy, waste management, nutrient recycling
- Most hybrids in the heating sector: A lot of resources available
- Transport sector more dependent on bioenergy

Thank you for your attention!
Questions?

Contact: elina.hakkarainen@vtt.fi


TECHNOLOGY FOR BUSINESS