

Residential Heating with Wood



FORESTRY MINICOLLEGE 2011

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- **Goal:**
 - High combustion efficiency
 - High system efficiency
 - **Low PM emissions** → Complete Combustion!



- Prerequisites for highest efficiencies:
 - Dry fuel
 - Fuel with low ash content
 - Gasification temperature of 1,500-1,650 F
 - Distinct air grading
 - Sufficient exposure time in the combustion chamber
 - Extensive intermixture of the syngas at about 1,800F

It's about TOM ...



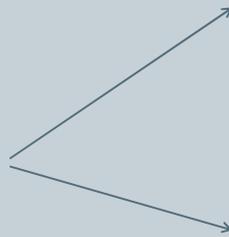
1. **T**echnology & Design
2. **O**peration
3. **M**aintenance

1) & 3) mostly addressed by REGULATION/INCENTIVES
2) addressed by NON-REGULATORY COMPONENTS/EDUCATION

Technology & Design

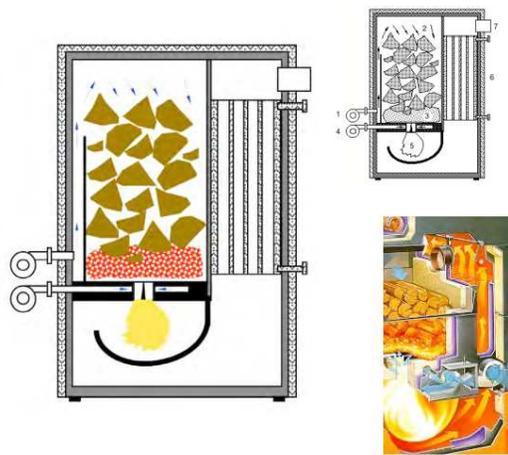
- Efficiency by Design. More than just the fire box ...
 - The building
 - × source and sink as a system (output vs. demand)
 - Combustion chamber
 - × Catalytic/non-catalytic, single/dual stage, fuel/air staging (air flow, pre-heating, secondary burn)
 - Air supply/ Exhaust
 - × dedicated air supply?
 - × flue sizing/routing (325-400F min)
 - Thermal characteristics
 - × from simple iron stove to masonry heater (insulation, thermal mass)
 - Heat storage/ distribution
 - × radiant, convective, conductive
 - × air, water, other
 - × central vs. space heating

Same Utility, different Design ...

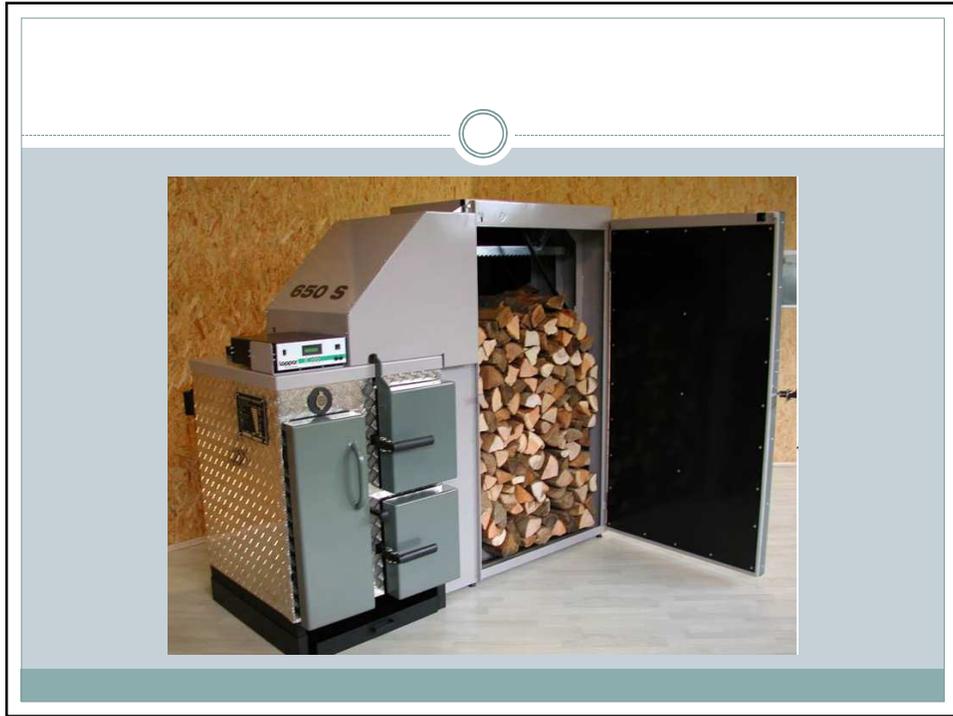


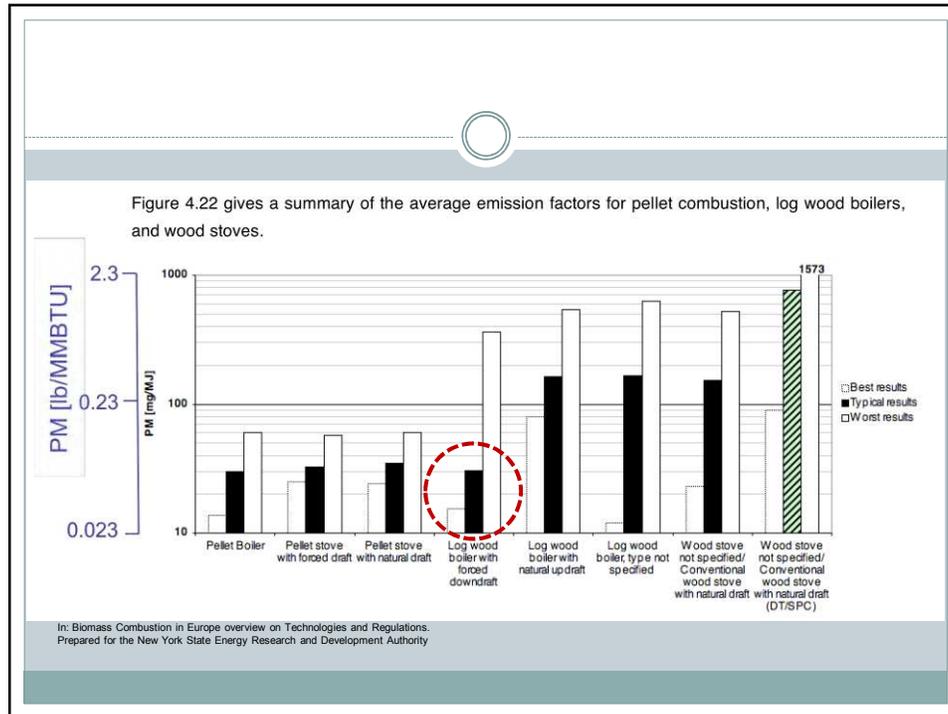
And, yes, a different price tag too ...

Automatic wood boiler



In: Biomass Combustion in Europe overview on Technologies and Regulations.
Prepared for the New York State Energy Research and Development Authority





Operation

- The real challenge (opportunity?)

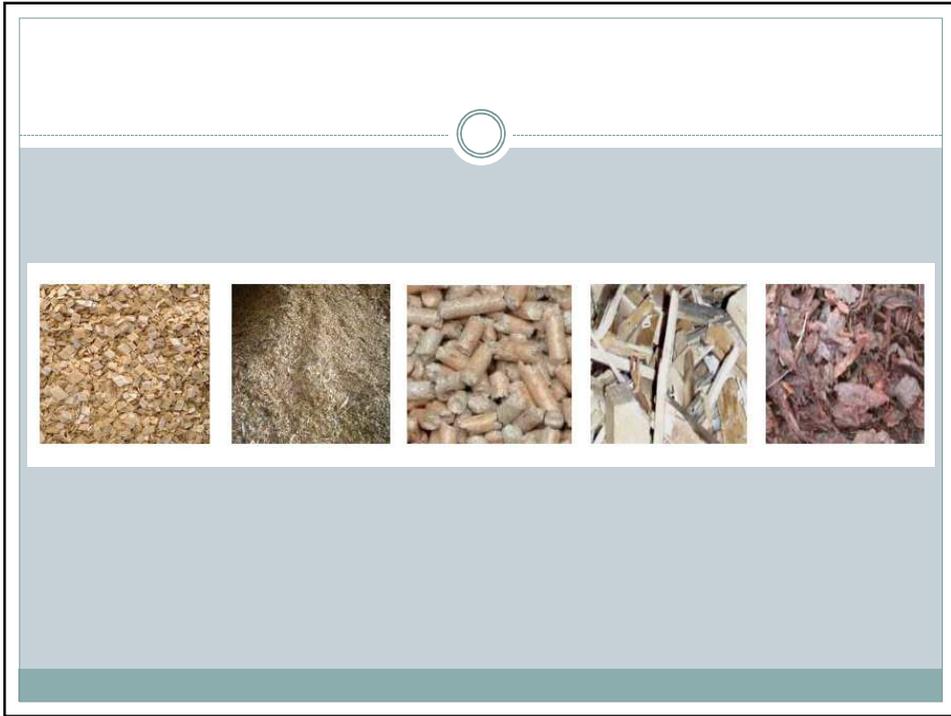
= The user/operator!

- Choice of fuel source
 - × pellets, chips, cordwood
- How to extract the most utility from a piece of wood (i.e. maximize ROI?)
- How to reduce emissions (i.e. minimize externalities?)
 - × When do emissions occur?
 - × What kind of emissions?

Know what to burn – and what NOT to burn (Consistency in fuel quality).

Understand how a fire/your burner works.

Know how to best start and maintain a fire.

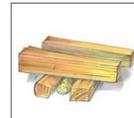


Energy Source	Ash Content % by Weight	Ash Sintering Point in (°F)
Wood Chips	0.2 – 0.9	2170
Wood Chips with adherent bark	0.8 – 2.0	-
Bark	3.0 – 10.0	2215
Shavings	0.3 – 0.5	2192
Quality Pellets	0.5	2192
Debris Wood	5.0 – 12.0	-
Wheat Straw	5.7	1828
Miscanthus	3.9	1582
Barley Straw	4.8	1328
Wheat	2.7	1224

- Fire Start-Up Module
(for low PM emissions)



Einzelle Anfeuermodul



Aufgebautes Anfeuermodul



Maintenance

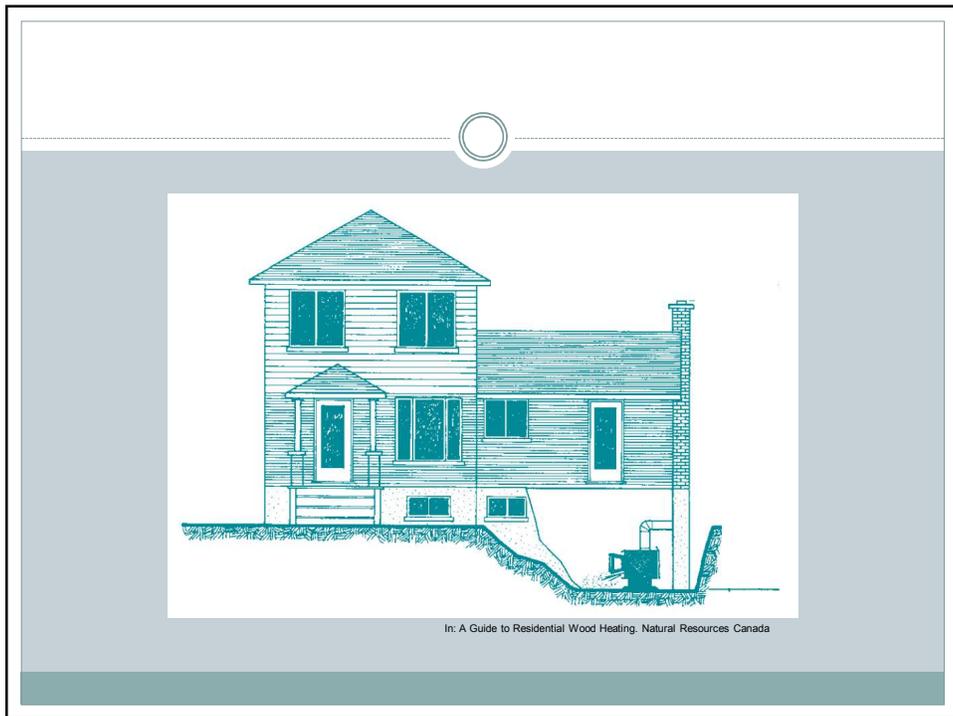
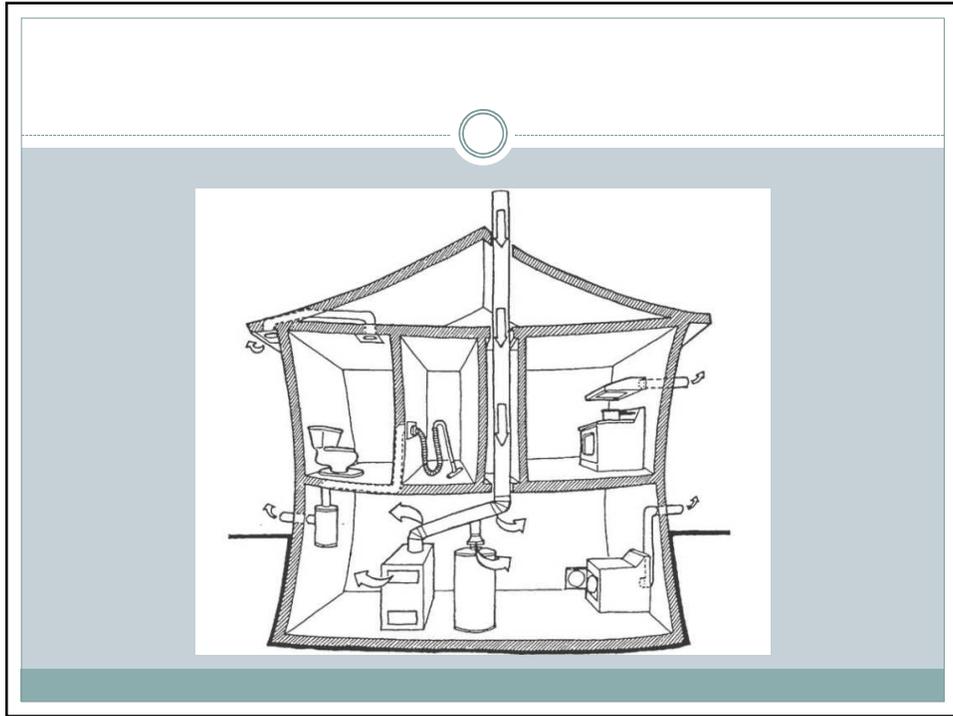
- Keep the system working at peak performance.
 - Mandatory regular/professional maintenance includes ...
 - × Chimney sweeps
 - × Emissions testing
 - × Upgrades/Repairs

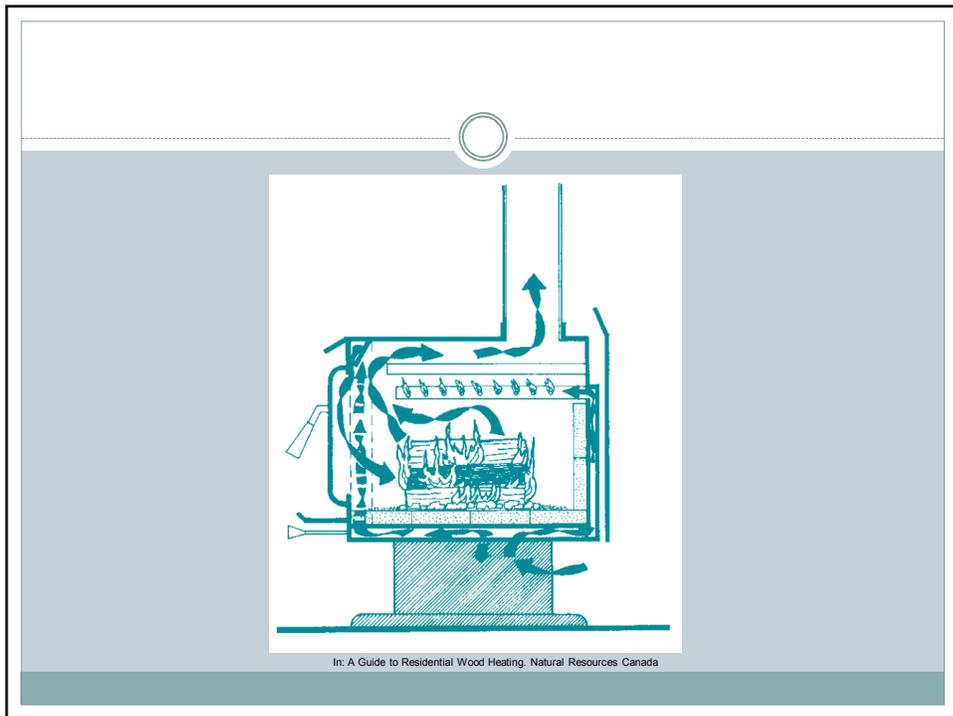
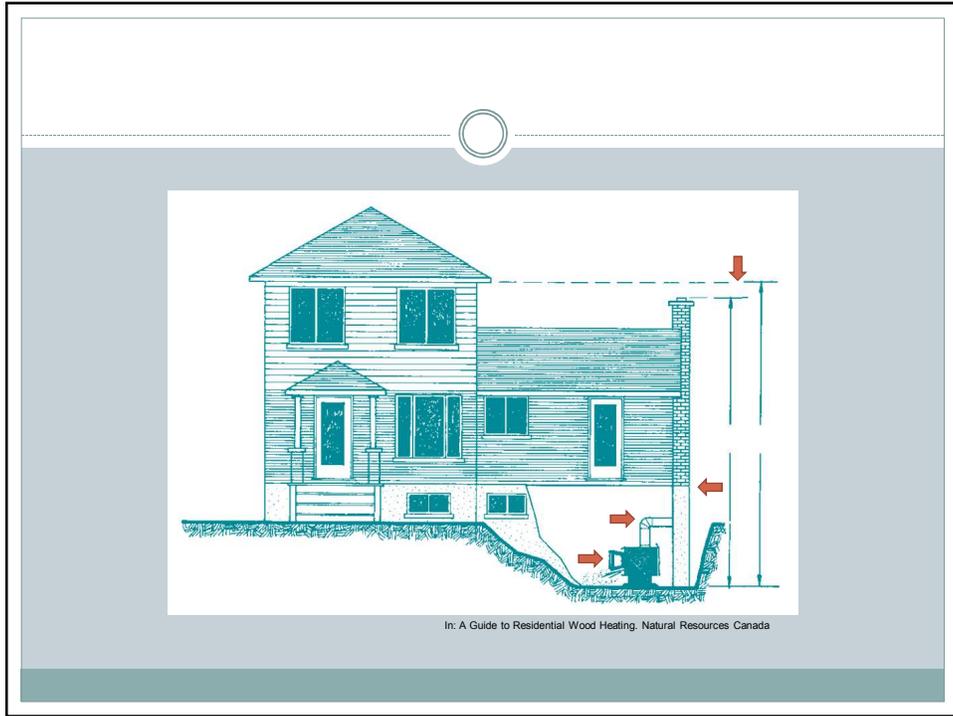


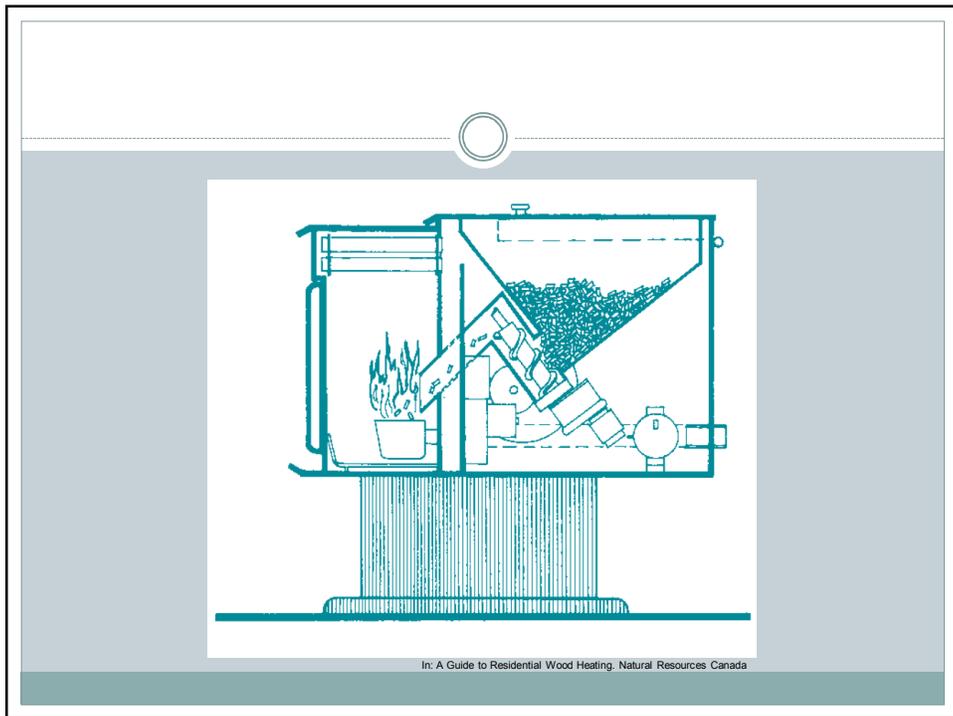
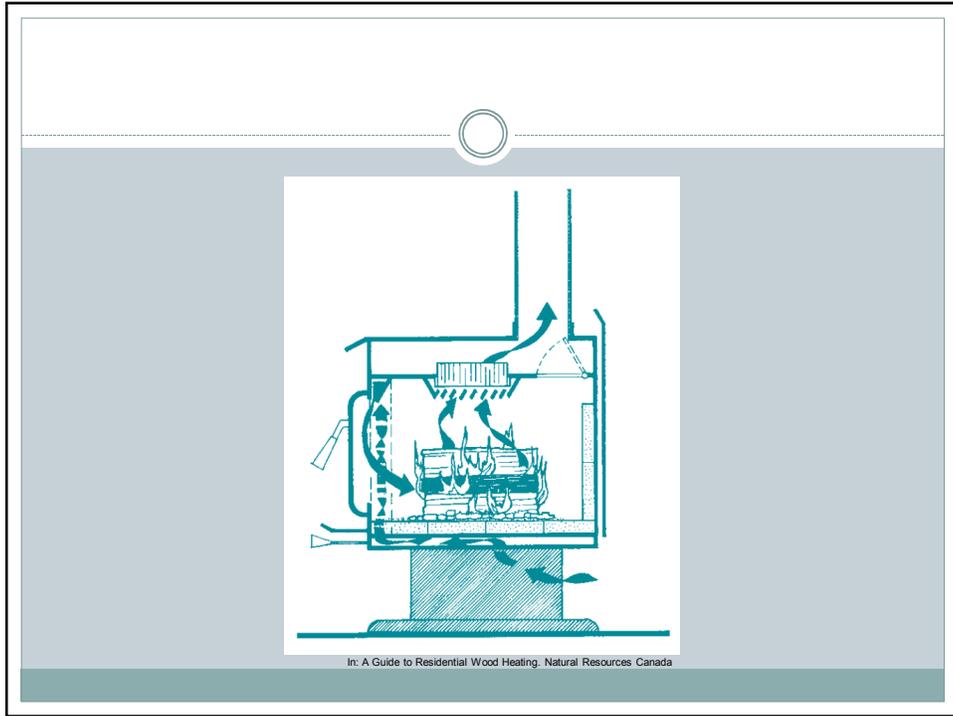
- **Standards/Deadlines/Testing/Enforcement**
 - Manufacturers, Importers, Dealers sign-off on industry wide standards for mass-produced units.
 - New models have to be tested and approved by accredited inspecting authorities to meet standards.
 - Deadline for implementation is enforced.
 - For custom designs: “Kachelofenberechnungsprogramm” (Masonry Heater Calculation Software)

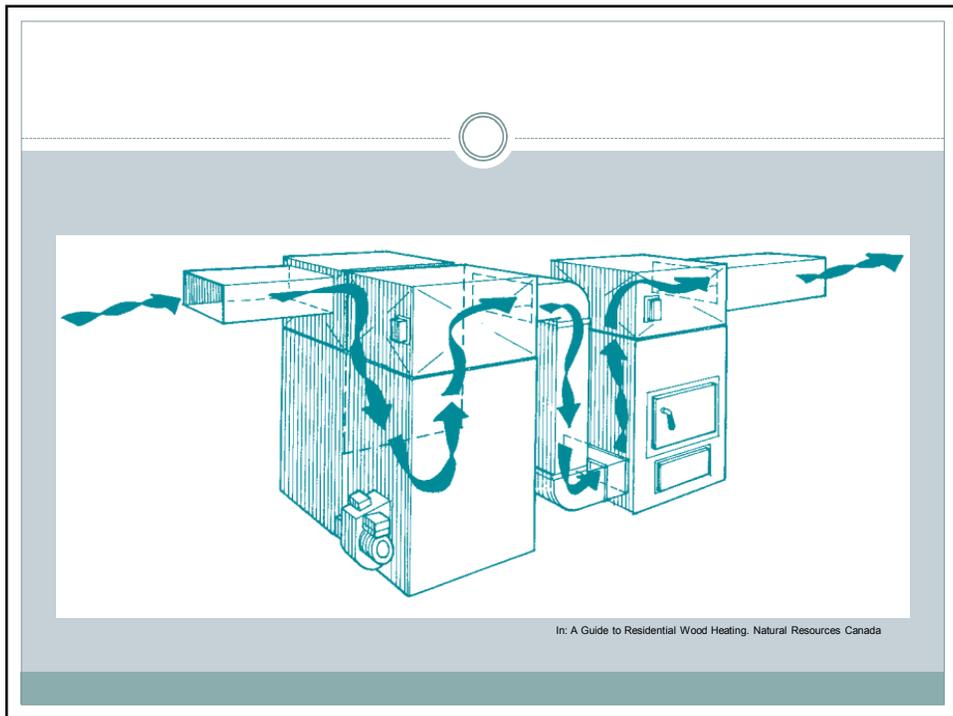
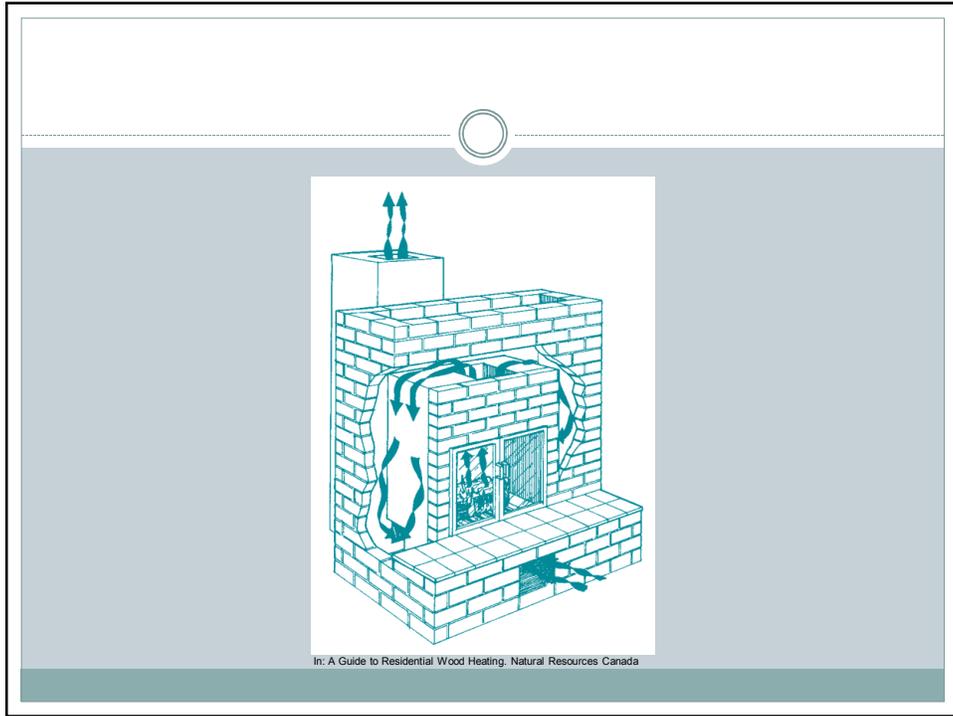
Pop Quiz!

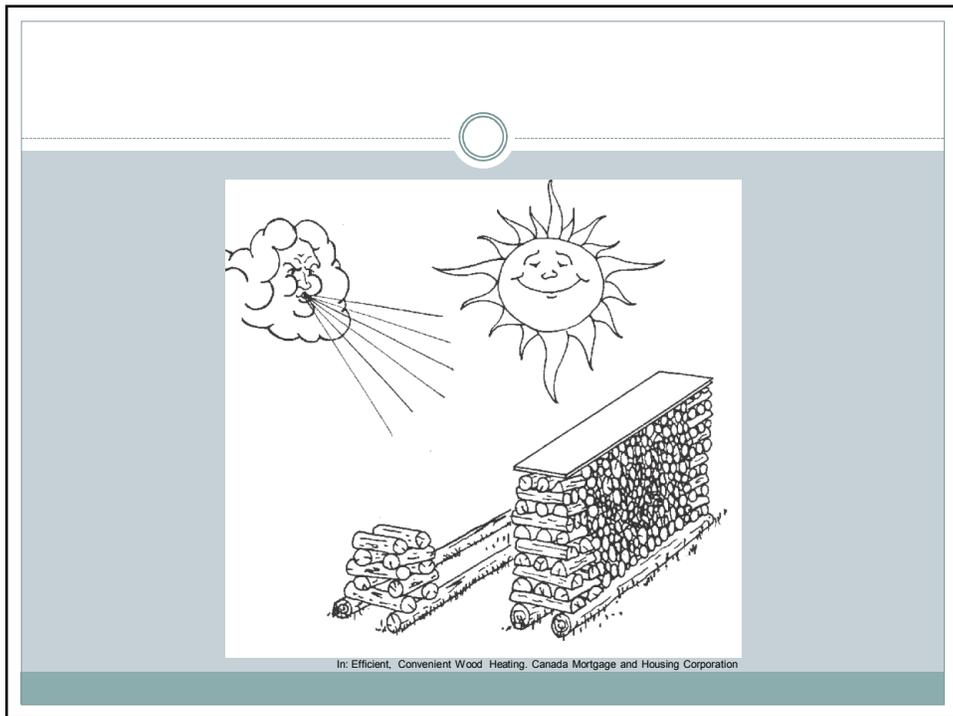
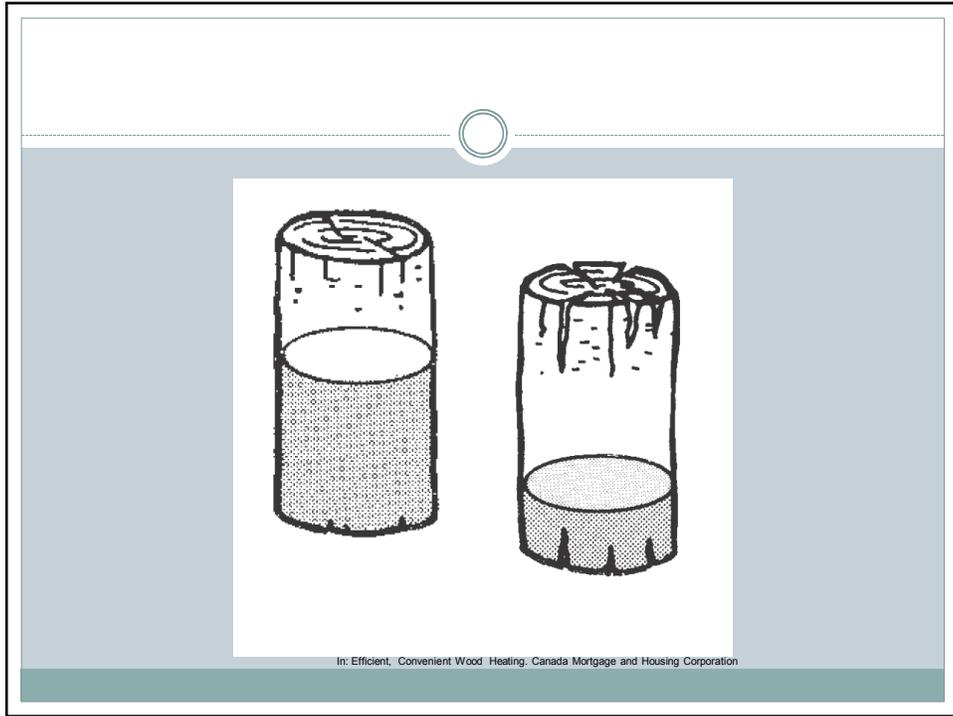


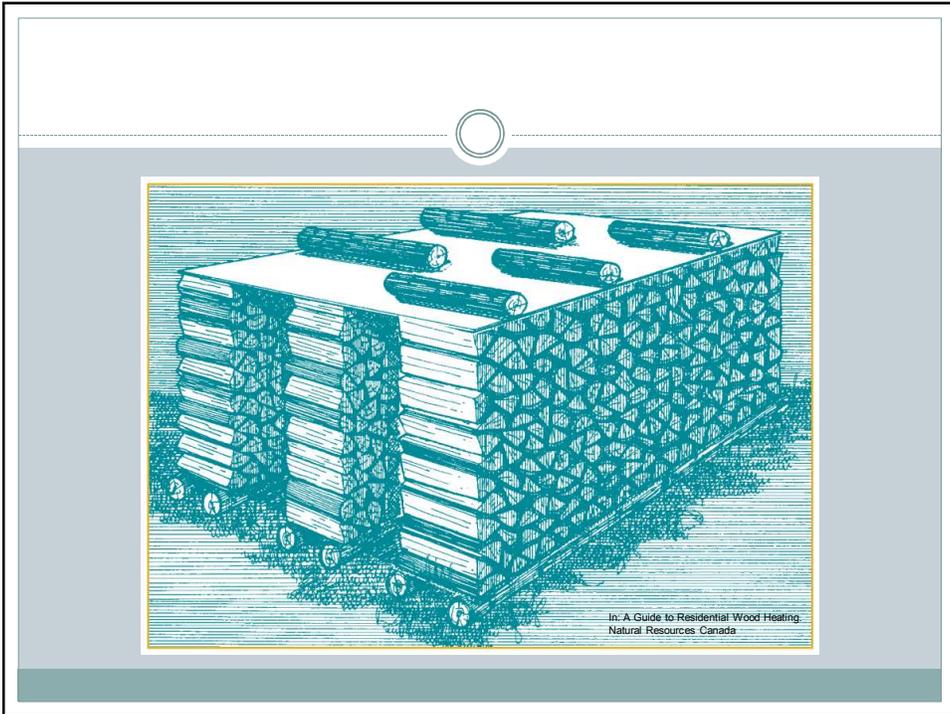




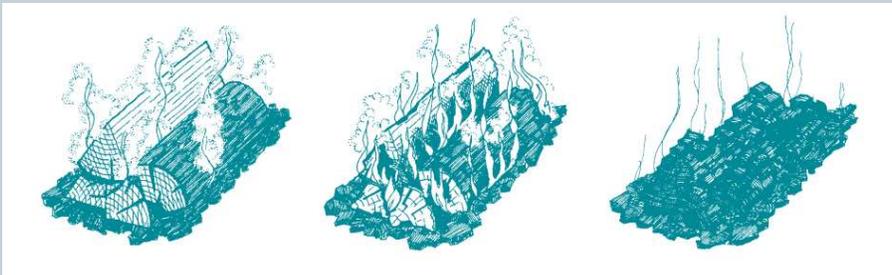








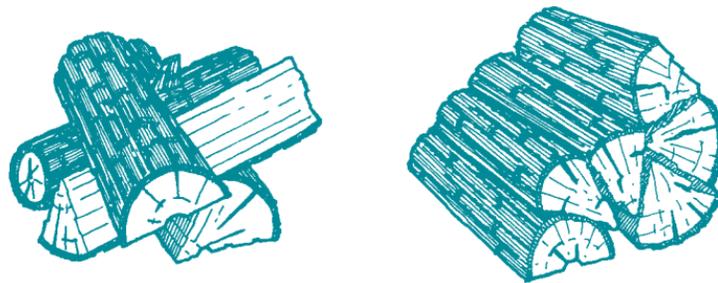
- Three phases



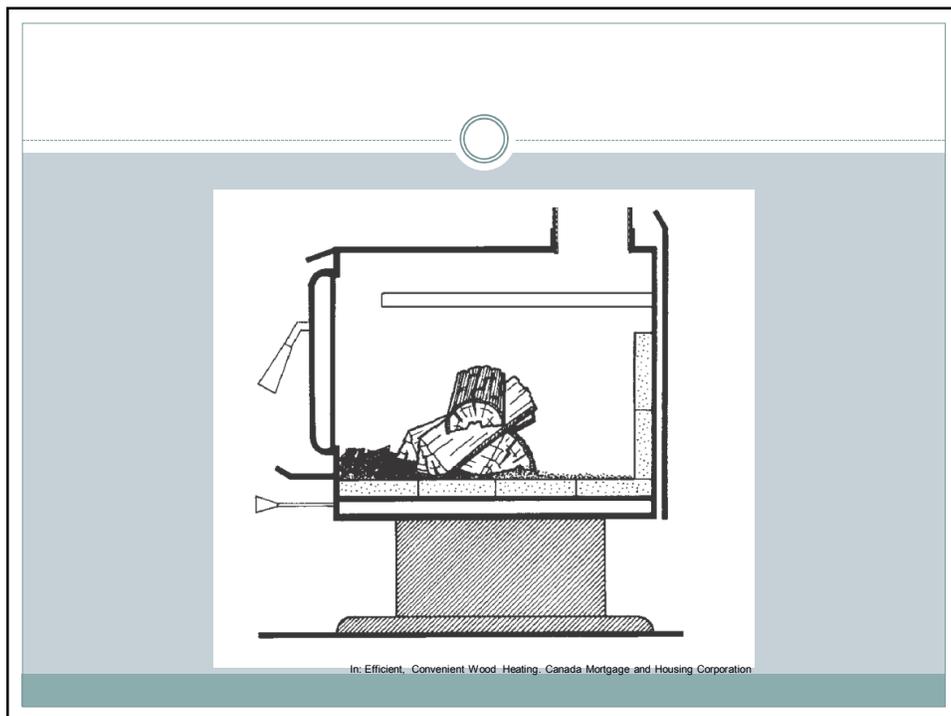
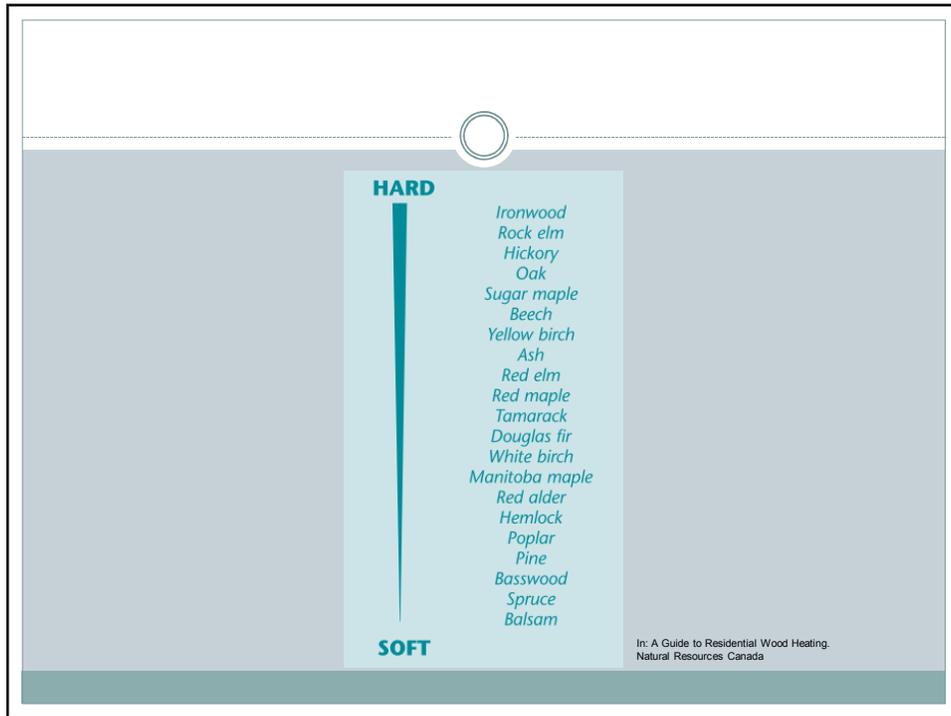
Advanced Combustion Systems

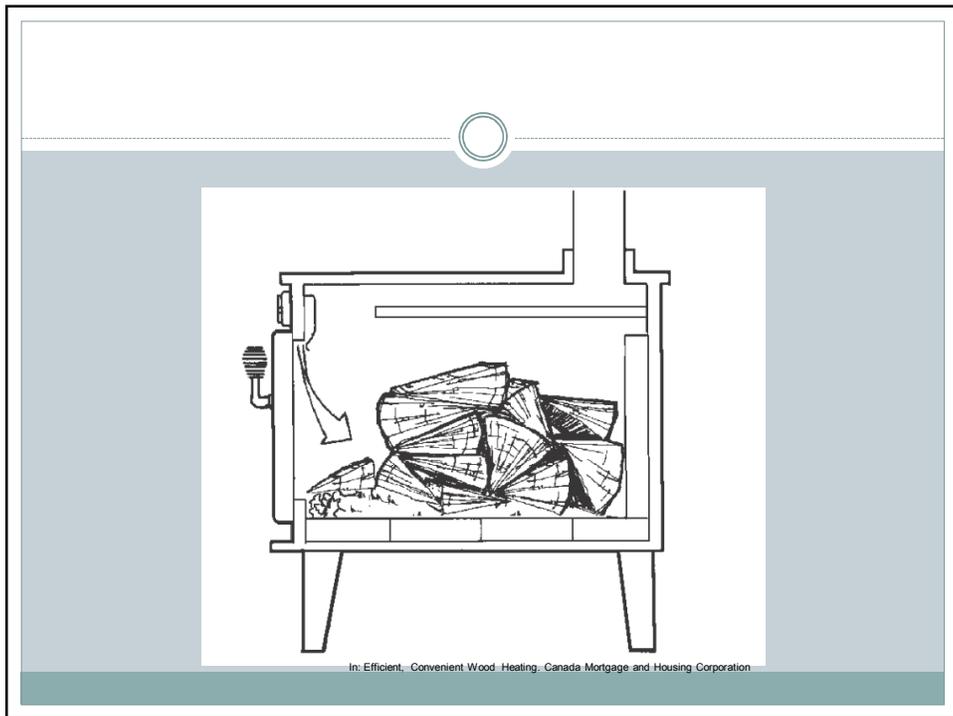
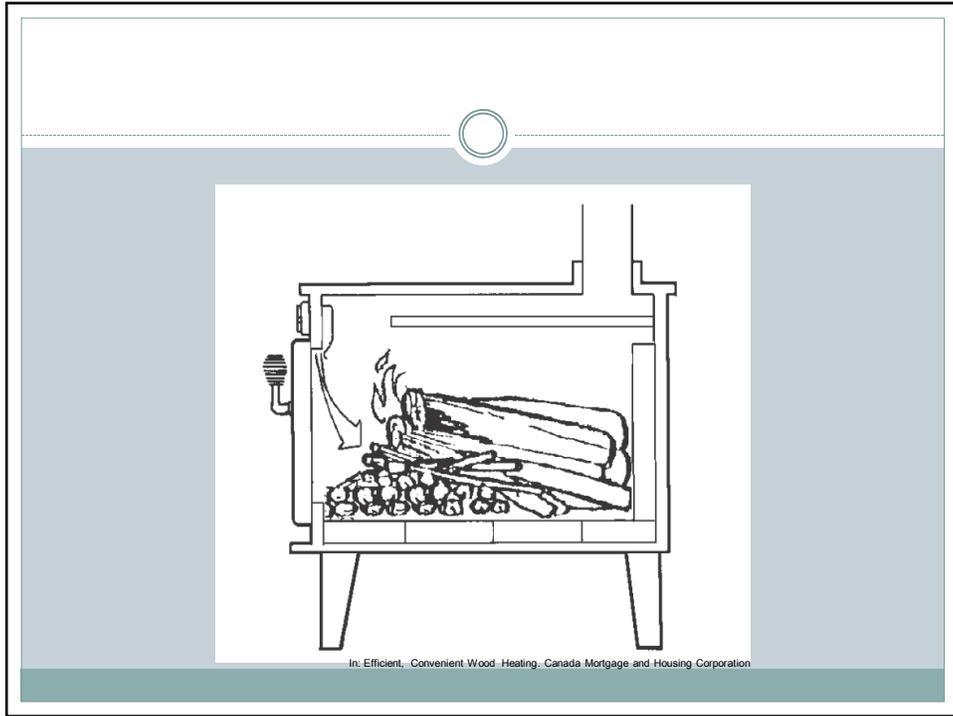
Highly efficient combustion systems create the conditions needed to burn the smoke before it leaves the appliance. The technology has the following characteristics:

- firebox insulation to keep temperatures high;
- primary combustion air that is preheated so that it doesn't cool the fire;
- preheated secondary air that is fed to the fire through sets of small holes in the gas-burning zone, above and behind the fuel bed; and
- internal baffles that give the gasses a long and hot enough route so that they can burn completely.



In: A Guide to Residential Wood Heating.
Natural Resources Canada







What to burn?

ALWAYS BURN

- Clean, dry wood
- Properly seasoned, split wood
- A mix of hard and soft wood, where possible, depending on what is available in your region

NEVER BURN

- Wet or green wood
- Household garbage such as plastic or cardboard
- Painted or stained wood
- Pressure-treated wood
- Particleboard or plywood
- Ocean driftwood
- Glossy magazines
- Any materials prohibited by local by-laws

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