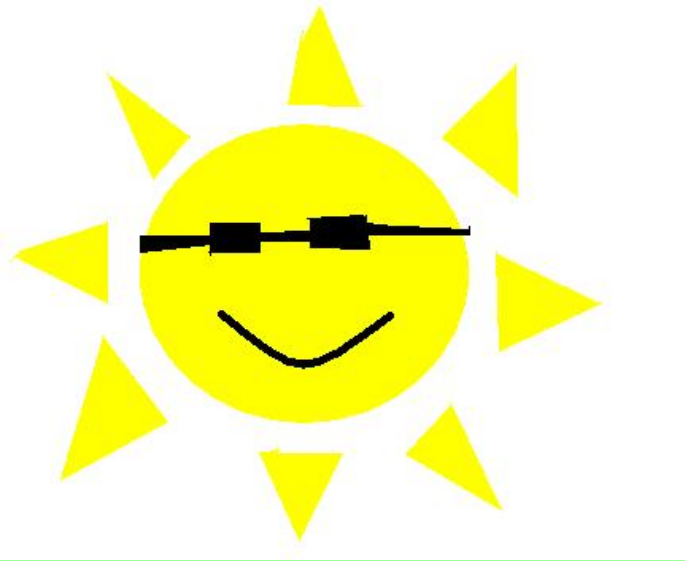


Mechanical & Electrical Components & Systems

Ed Lowans

Lowans & Stephen



Source Energy

Passive before Active

- **Solar** First (hot water, space, electric)
- Evaporative Cooling
- Heat Pump (ground, water or air source)
- Wood (or other biomass)
- Electric (if you are factor 9 or better)
- Natural Gas
- Oil or Propane (if you have to)

Control Energy Don't Loose It

- Ground **Coupled** Envelope
- Heat Gain / Rejection Glazing
- Seal and Insulate
- **Reflective** (need a 3/4" air space!)
- Heat **Traps** (DHW tank, Exhausts)
- **Zone** Control
- On Demand not Stand By (storage)
- **Radiant** heat first

Heat Pump Efficiency Rating

SEER - Seasonal Energy Efficiency Rating
(cooling)

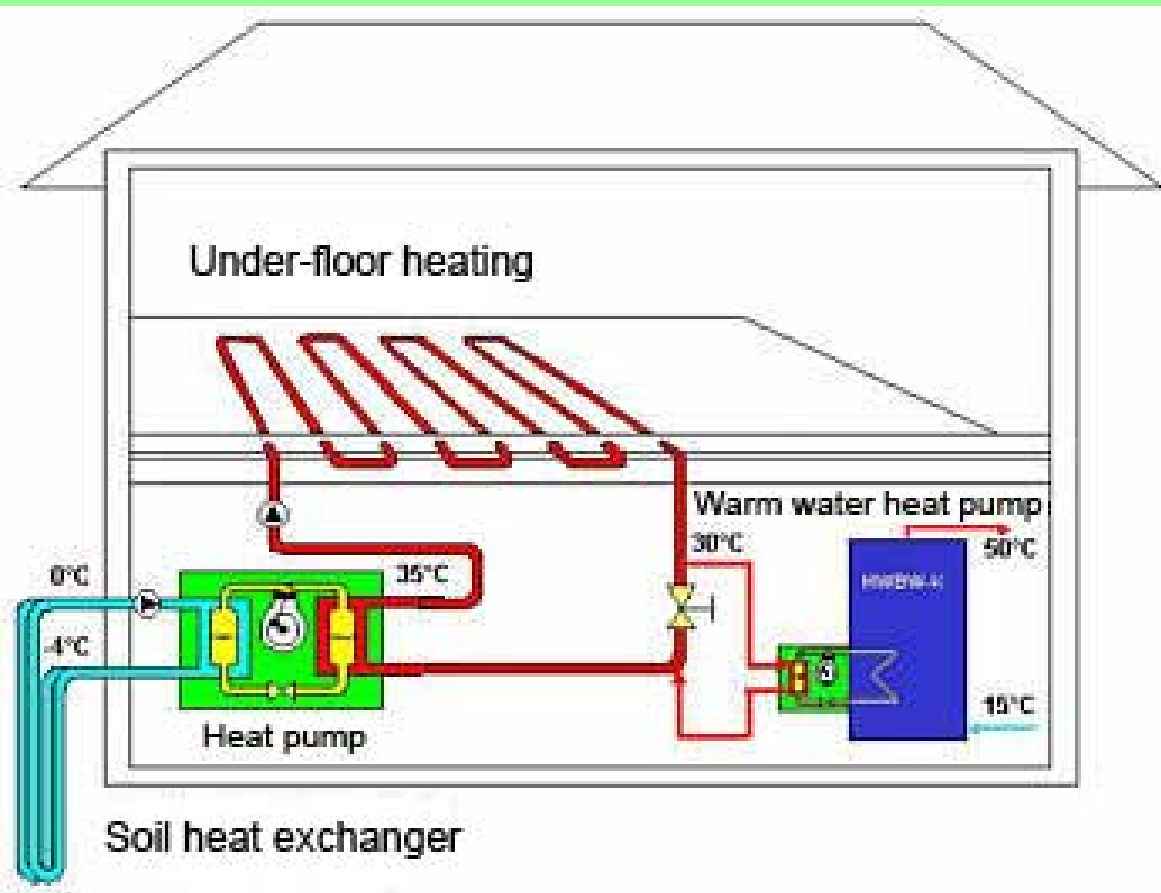
HSPF - Heating Season Performance Factor
(heating - BTU's delivered per watt hour
consumed)

Less Used

COP - Coefficient of Performance (heat
delivered or removed per watt consumed)

EER - Energy Efficiency Rating (steady state
efficiency)

Multiply Energy (up to $1 > 5$ COP)



Heat Pumps

- Refrigerator
- Freezer
- Ground Source
- Water Source
- Air Source (Northern)
- Desuperheater

Recover Energy

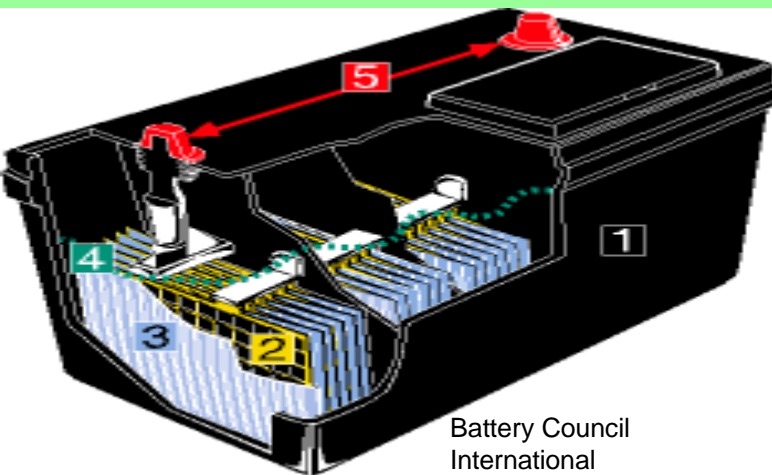


- Gravity Film Exchange (GFX)
- Heat Recovery Glazing or wall
- Destratifier (fan)
- Heat Recovery Ventilator (HRV, or ERV)



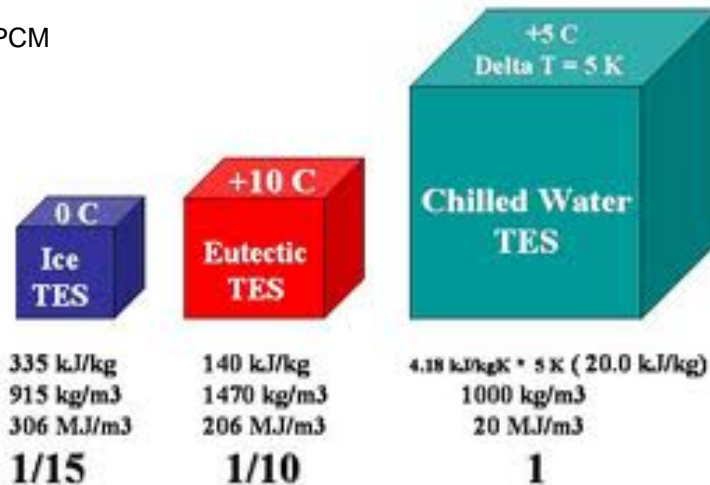
Store Energy

- Thermal mass
 - use **smart** mass
 - not **dumb** mass
- Stratification (high ceiling)
- Batteries
 - electric: battery, UPS
 - thermal: iron, water, earth,
 - phase change materials
 - kinetic (flywheel)



Battery Council
International

PCM



Distribute Energy

Natural

- High (clearstory) windows, no or low walls
- Ventilation (atmospheric pressure)
- Siphon (solar hot water)
- **Gravity** (water, air = buoyancy)
- **Radiation** (sunlight, stove, masonry stove, IR)
- **Conduction** (conductor e.g. metal rebar)

Mechanical

- Forced Air (fan, blower)
- **Hydronic** (water - pump)
- **Induction** (magnetic e.g. stove element)

Optimize Mechanical Systems

- Furnace / Boiler
- Air Conditioner
- Air Filtration (particulates, gasses)
- Air Purification (Ozone, Ultra Violet sterilizer)
- Humidification
- Dehumidification
- Domestic Hot Water Heater
- Solar Hot Water
- Solar Air Heater (Transpired Solar Collector)
- Generator
- Compressor
- Appliances

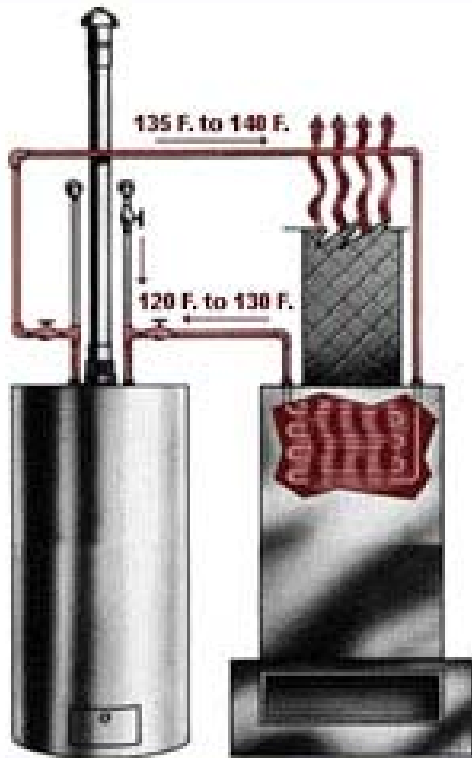
Combined Mechanical Units

Hot Water Tank to
Air Handler (Furnace)
via a Heat Exchanger

Combination (2 functions in 1)

Examples

1. heat pump + gas furnace)
2. photovoltaic & thermal
3. heating + domestic hot water
4. cogen (CHP)
5. solar DHW to fueled DHW



Integrated Mechanical Units

Integrated systems
combine 3 + functions
Example

- Solar HW + DHW + hydronic heat

Polar Power unit integrates Micro-cogen, heat pump, air conditioning, and Hot water





Capstone

Hybrid Mechanical Units

“Synergy”

Produce two types
of energy & raise
overall efficiency

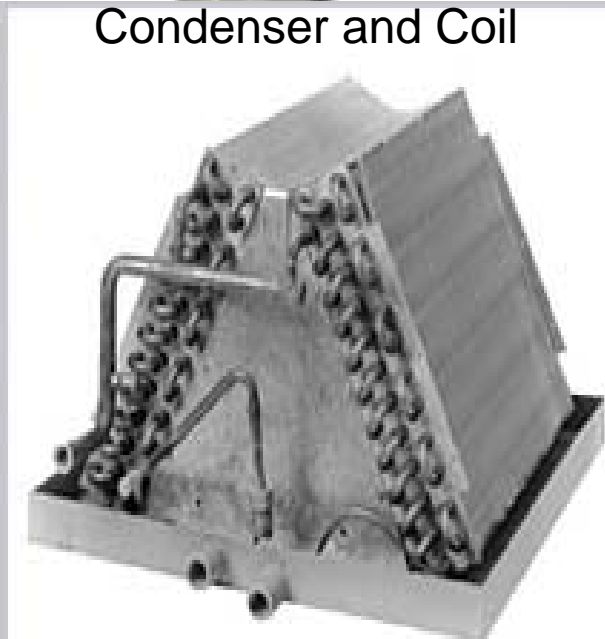
Example
Combined Heat and
Power (CHP) e.g.
Micro-Co-Gen

Air Conditioning

- Seasonal Energy Efficiency Rating (**SEER**) current (8-12) code 13 available up to 24.5
- Inverter driven rotary compressor
- AC or Heat Pump
- Lowest impact **refrigerant**
- Locate condenser in shade & wind with good air circulation



Condenser and Coil





Elegance
Mini- Split
AC or
heat
circulate
refrigerant
not air



Hankley & Brown



High Performance = “Condensing”

- ENERGY STAR qualified boilers have an annual fuel utilization efficiency (AFUE) rating of 85% or greater
- 2012 Ontario Building Code furnace 90% (AFUE) (gas, propane OK, caution on oil)
- Condensing gas 92 – 98% efficiency
- Vent through the wall
- Avoid orphaned appliances
- Use combo or integrated equipment

Gravity (antique)
Natural Draft
(outdated)
Induced Draft
(outdated) (2012)

**NATURAL-DRAFT
WATER HEATER**

**DRAFT
DIVERTER**



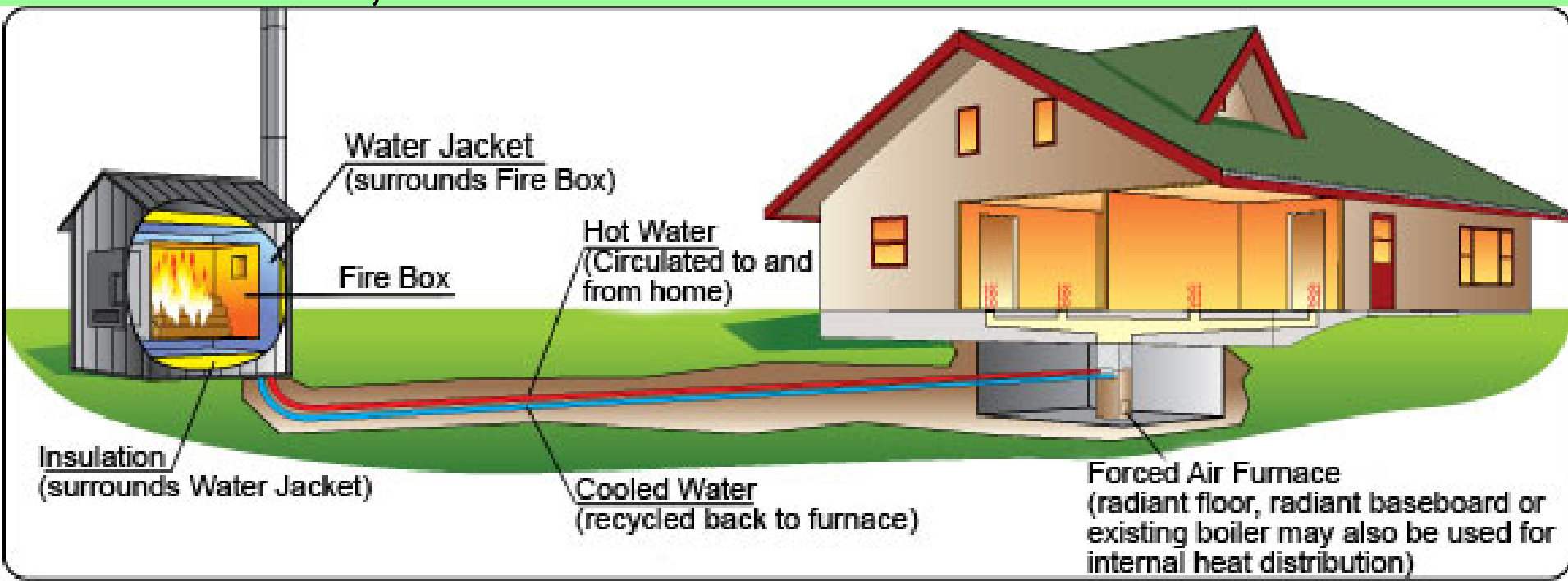
Condensing

- intake pipe
- exhaust pipe
- drain pipe
(sealed combustion)



Exercise caution with **Outdoor Boilers**

EPA's Outdoor Wood-Fired Hydronic Heater program. Phase 2 units have a white tag and are at least 90 percent cleaner than unqualified units. EPA's Phase 1 models are no longer considered "qualified" under the Program after March 31, 2010.



Never burn trash



EPA – 2 to 40 barrels = 200 ton/day incinerator

Don't Bug Me!
Photography © 2010

Reduce water use

Choose

WaterSense labeled

- Toilets
- Taps
- Urinals
- Showerheads
- Irrigation (avoid the need)



Domestic Hot Water Heater (Tankless = Instantaneous)

- Heat DHW, and/or
- Hydronic
- No standby tank losses
- Less space cost
- Own don't rent



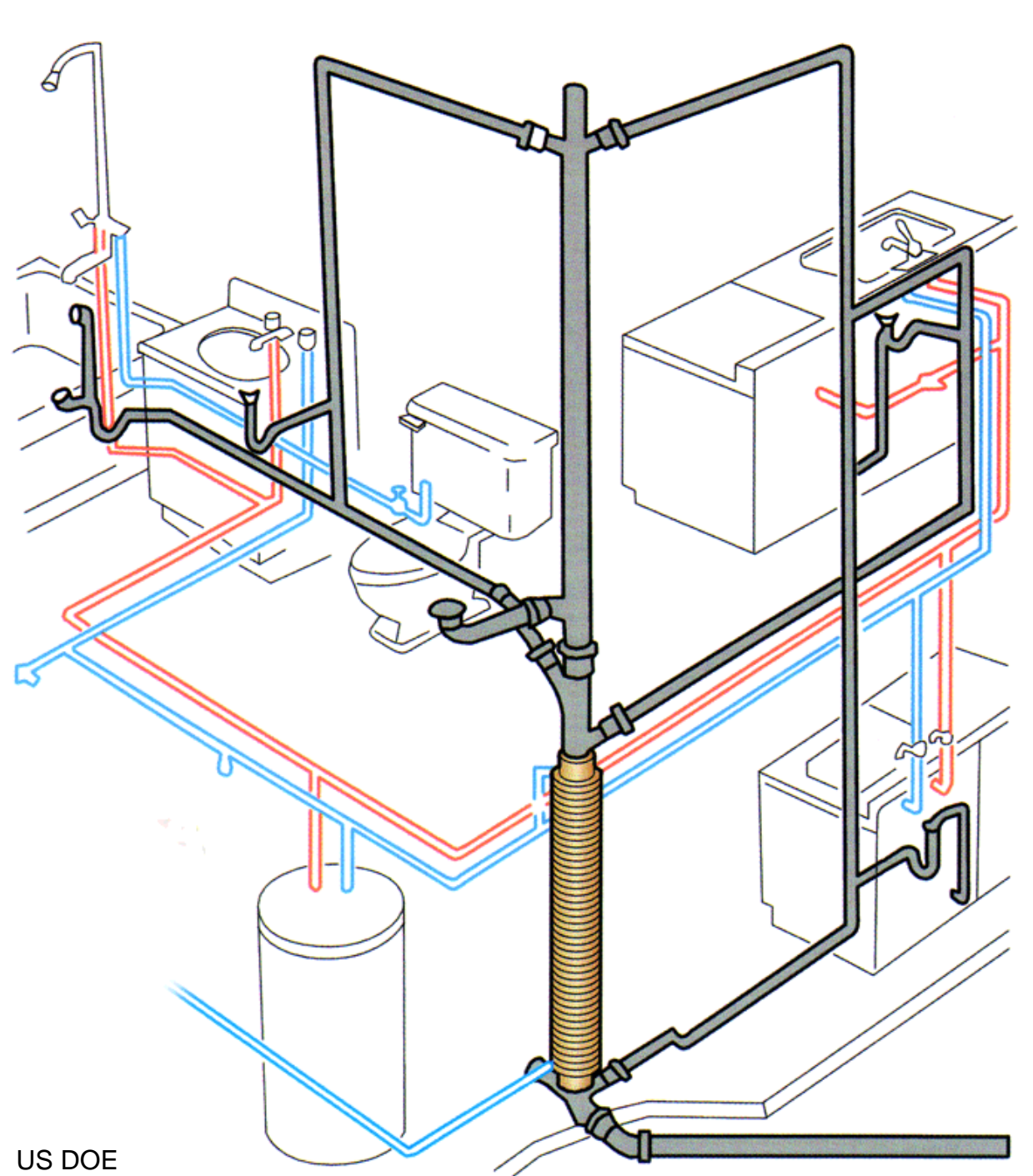
Hot Water Heaters (Tank)



States Industries

Own – don't rent
Condensing
Tank
Solar Assist
Stainless Steel Tank
Thicker Insulation (or add)
Replace Sacrificial Anodes
Drain a pan full occasionally
Use earthquake straps
Use drain pan (flood)
Avoid orphaned status

States Industries



Recover Heat

Drainwater
Heat
Recovery
(GFX)

Plumbing Supply Side

- PEX (cross linked polyethylene tubing) has lower impact and cost than copper
- $\frac{3}{4}$ " main lines
- One run for drinking water tap (new/long run copper is **toxic**)
- Avoid constant circulation systems
- **No standing water** anywhere in system (Legionella)

No/Low Flow Toilets



Water Use

- Code < 1.6 (gpf)
- Water Sense < 1.28
- Some < 1.0
- Pressure assist (can be noisy)

Flushing Efficiency

- Latest **MAP** rating
www.cuwcc.org



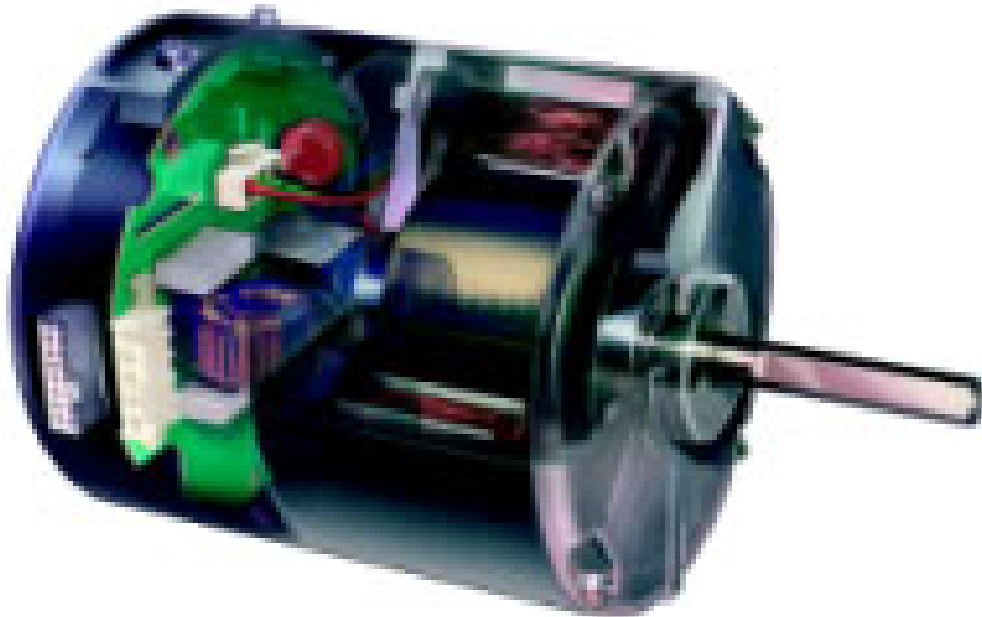


Urinals

1. Tree first
2. **Waterless** second
3. **WaterSense 0.5** (1.9 lpf)
4. **Code 1.0** (gpf) (3.8 lpf)



SKF



Advanced Mechanicals

Eliminate friction
with Magnetic
Levitation
Bearings

Use **Highest**
Efficiency Motor
Electronically
Commutated Motor
“**ECM**” or **Cast**

Use Smart Controls

Programmable thermostats can save up to \$150. / year in an older home, less in a high performance home, **negative** in a low income apartment

New Touch Screen and computer integrated controls and **Dashboards**

Smart meter if controls loads!

Dumb meter if not!

New revenue stream for utilities!

They will all? have to be replaced!



Visible Energy I Phone App



Honeywell

Washing Machine

- **Horizontal axis** front loading (some exceptions)
- **Minimum Energy Star**
- **Preferably** highest Energuide rating

Dishwasher

- **Minimum Energy Star**
- **Preferably** highest Energuide rating
- Temperature booster
- **Compartmentalized**



Kitchen Fan

- Minimum Energy Star
- Preferably highest Energuide rating
- Less than 4-5 **sones** (noise) rating
- Slope exhaust pipe down to exterior and insulate as appropriate
- The lower and more encasing the hood the better
- **Warning** – An oversized fan can back-draft your furnace and hot water heater



Bathroom Fan

- Minimum Energy Star
- Preferably highest Energuide rating
- 0.5 sone or less (noise rating)
- Insulate & slope duct down to outside
- Through wall before roof **never** to soffit





Refrigerator

- Minimum Energy Star
- Highest Energuide
- Compartmentalized
- Good airflow
- Clean the **heat sink**
- **No** icemakers, ice-water dispensers
- **Not** in sun or near heat source

Integrated Cooking Appliances

Miele – Right Sized

- **induction** top
- **convection**
- **microwave**



- Minimum Energy Star
- Highest Energuide
- **Self cleaning**
(+ insulation)
- Convection
- Induction Elements
(safer)
- High Performance
pots

Use Smart Applications



- Desktop energy management **software** and (cell phone) aps
- **Smart** power bar (current-sensing)
 - 10% house load
 - 75% of appliance energy used
- Smart appliances preferably **with** smart controls (home or utility)
- Use a **kill switch**

Use High Performance Lighting

- Optimize the **system** – not the component
- LED if cost-effective (**mercury** free)
- T 8 High Output (vs regular T8, **maybe**T5)
- Low mercury (Phillips Alto I or II)
- Electronic **dimnable** lighting
- **Electronic** not magnetic ballasts
- **Avoid** recessed (to cut air leakage / energy loss – no pot lights) substitute track lights