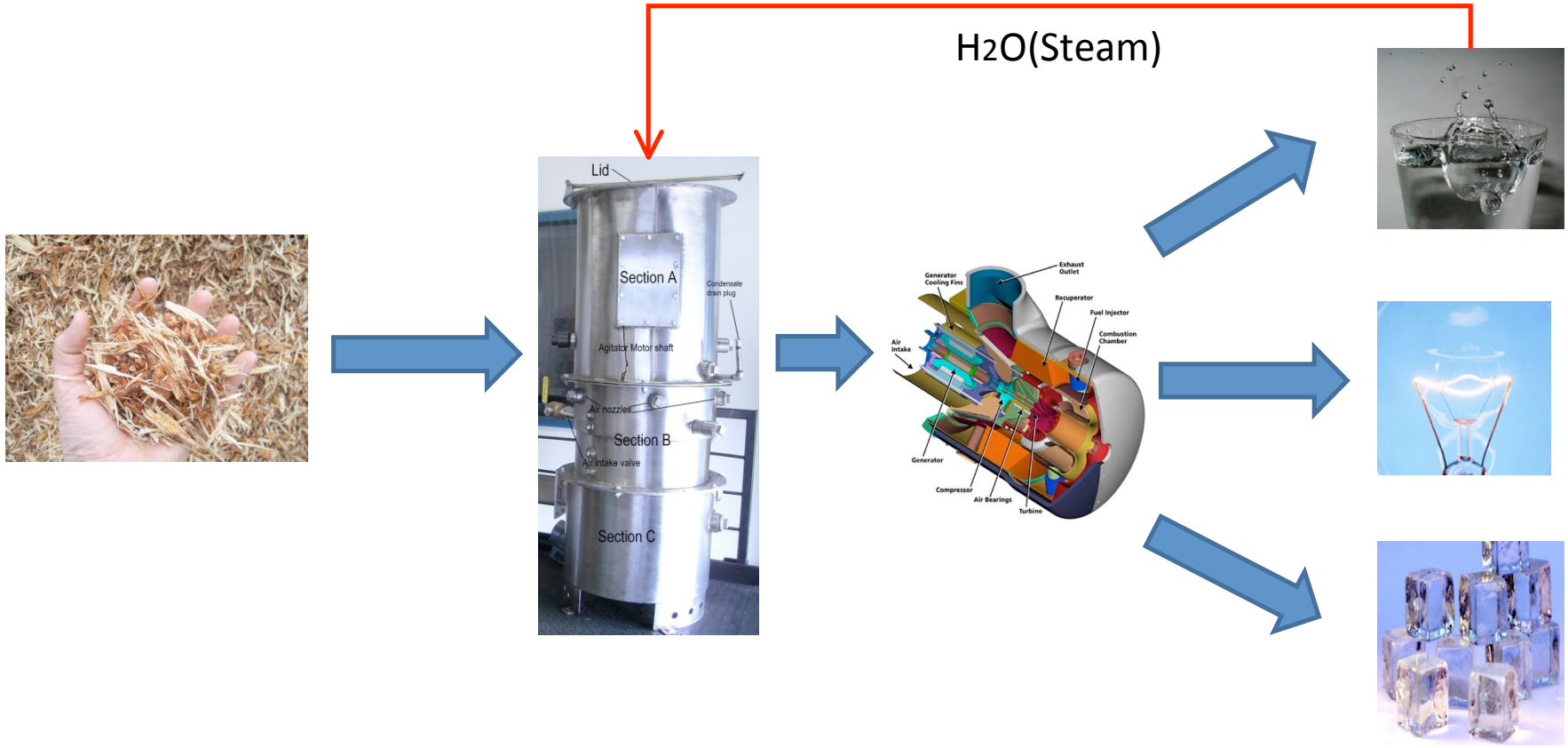
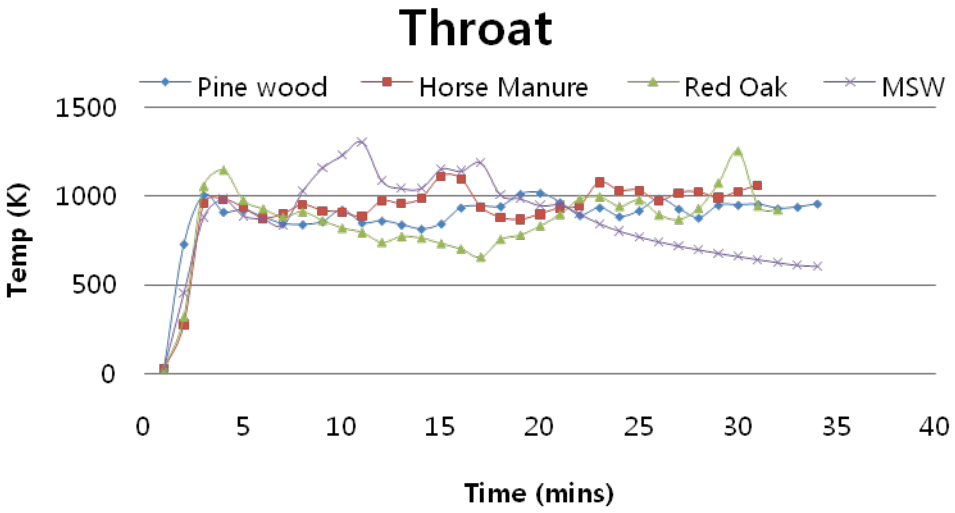
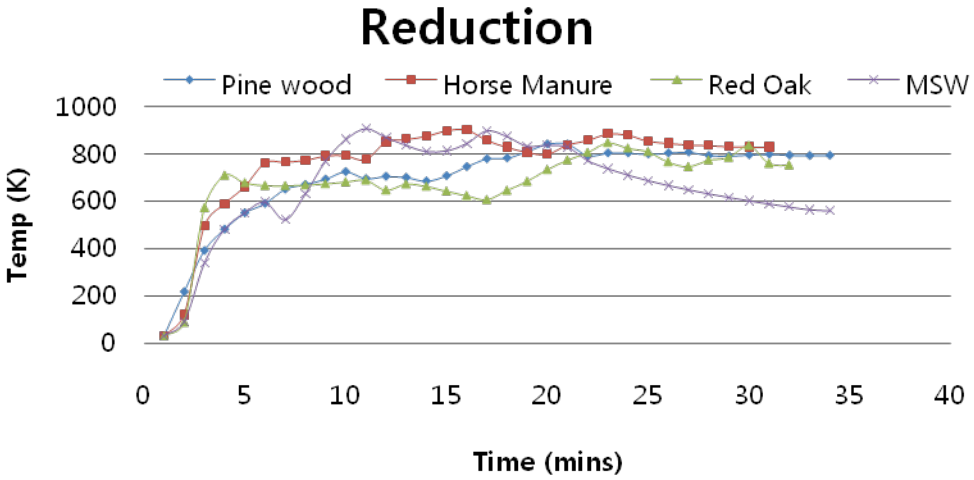
6. Integrated PoWER-HiTS System : Advantages

- Integrated system produces water, heat & power using biomass
- Fraction of water produced is used in the gasifier to maximize H_2 production
- Steam gasification almost eliminates the emission problems
- Increasing efficiency of the system by recycling part of water produced

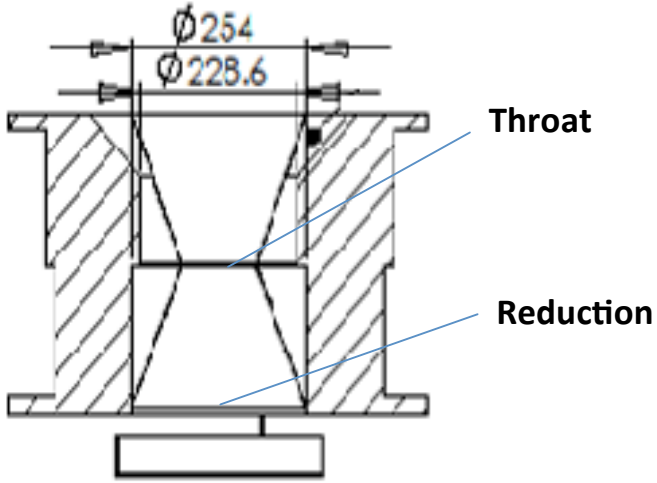


7. 1.Gasifier Temperature Profile





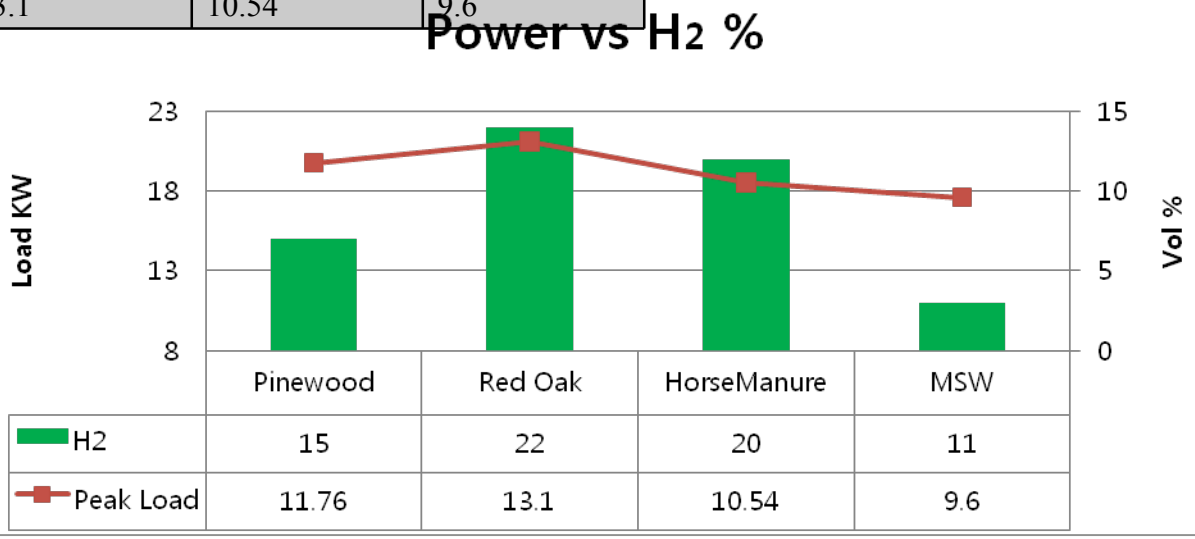
- Temperature readings indicates that gasification temp is high enough for tar cracking in the throat & reduction zone
- High Temperatures also reduces the formation of CO2



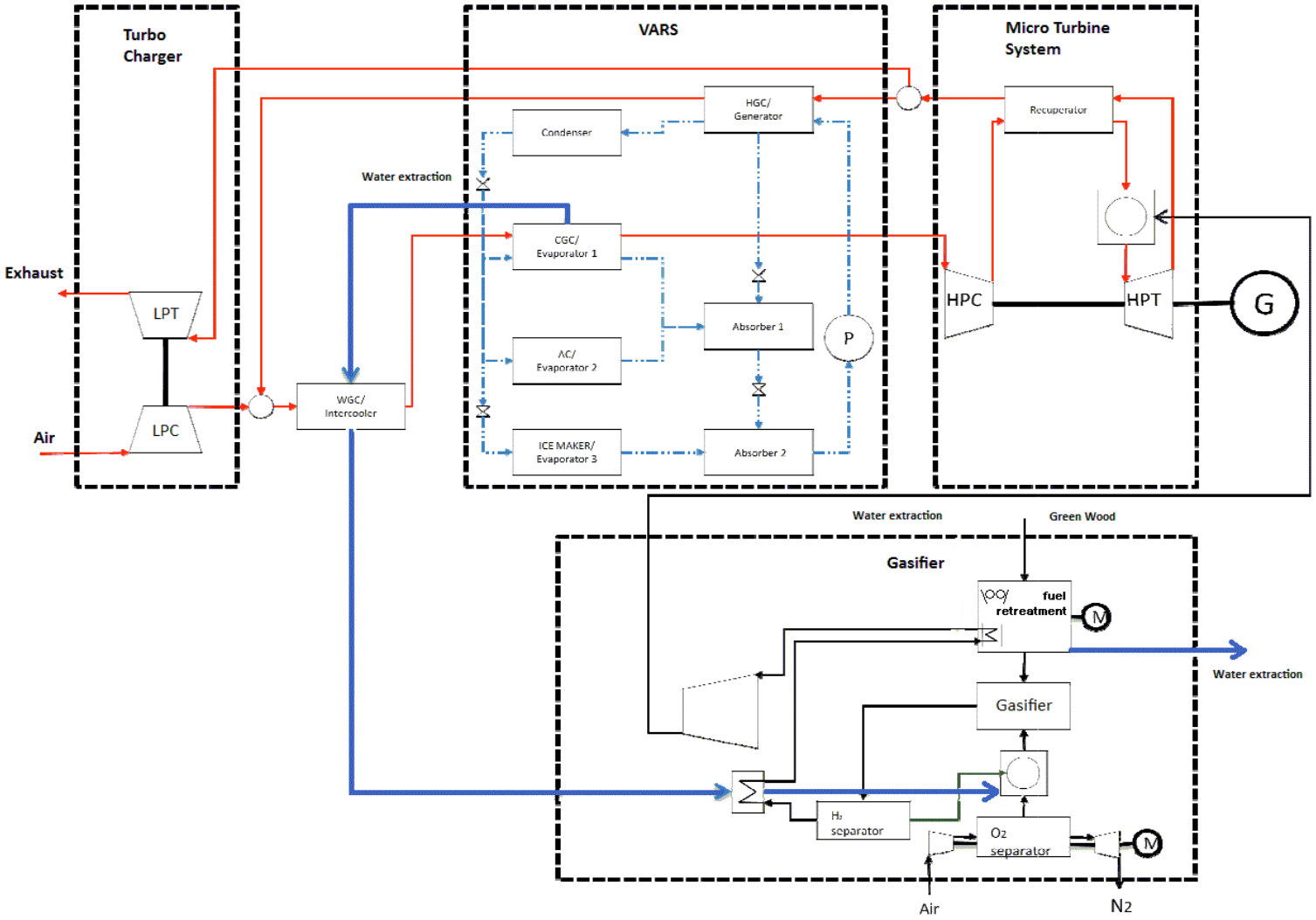
7. 2.Experimental Data Acquired

Datasets Measured	Pinewood	Red Oak	HorseManure	MSW
Throat Temp(Avg)	820	840	900	900
Air Feed (fpm)	1290	1235	1326	1891
Biomass Feed (lb)	15.68	16.42	18.86	13.14
Moisture Content (%)	12.2	15.3	18.33	12.6
ER	0.26	0.29	0.34	0.31
Gas Composition (Vol %)				
H2	15	22	20	11
CH4	5	2	3	2
Peak Load (KW)	11.76	13.1	10.54	9.6

- Red oak has highest H2 yield and maximum power output of the 4 choices
- Significant Tar in gas stream, using Horse Manure



8. Integrated System Modeling



8.1 Methodology

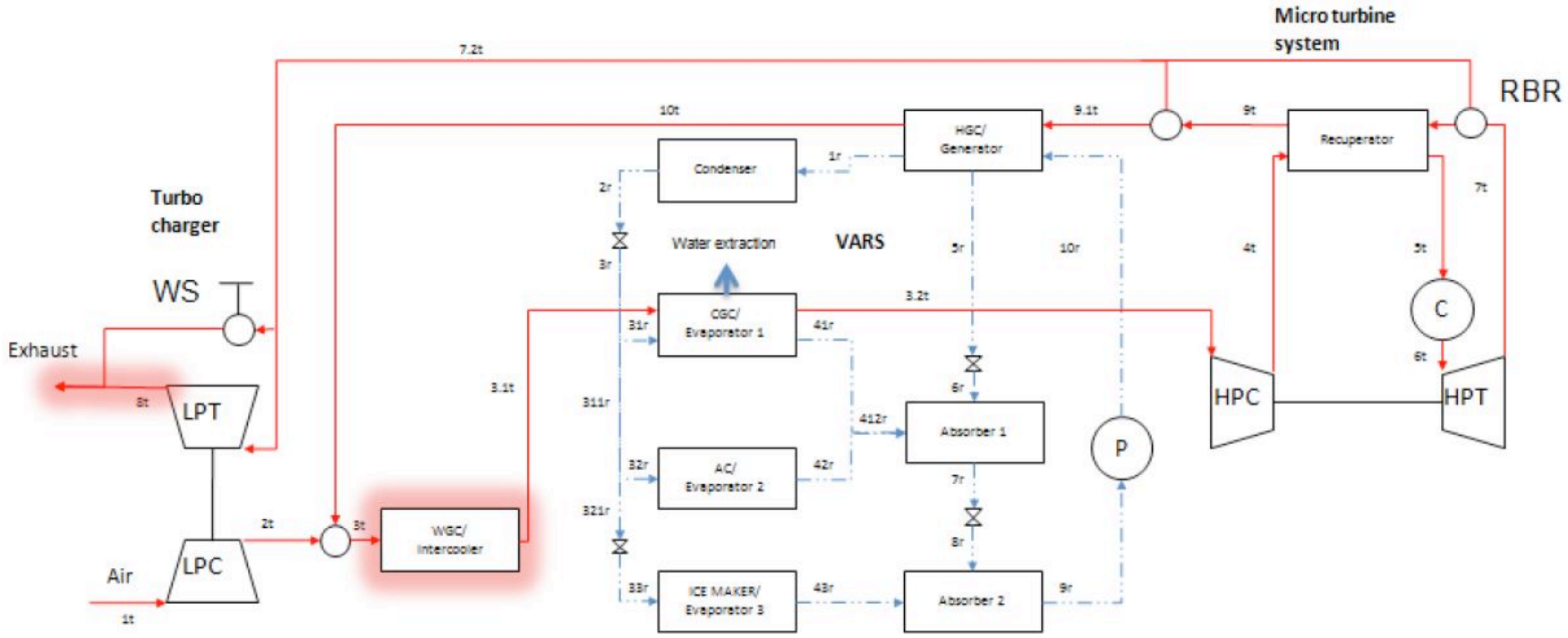
Approach: develop/validate subsystem models, integrate

- Gas turbine cycle (Turbo charger and micro turbine system)
- Vapor Absorption Refrigeration System(VARS)
- Gasifier

➡ **Combine to produce simulation, optimization, and design tools**

8.2 Gas Turbine and VARS simulation

- Multiple models developed, partially validated
  - Steady, design-point
  - Steady, off-design
  - Dynamic (for advanced controls development)



8.3 Gasifier Simulation

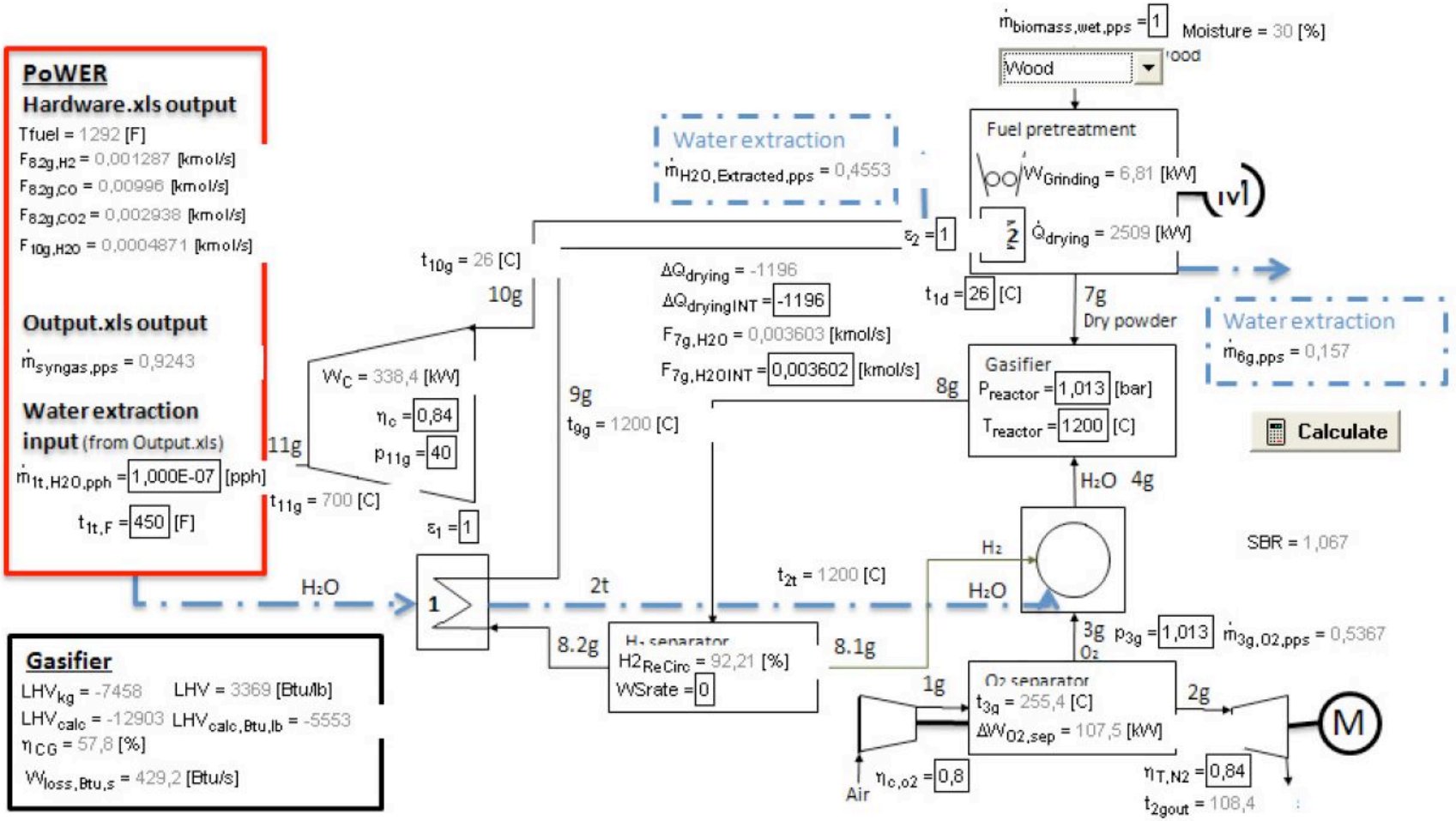
1. Input

- Biomass content; wt% (dry basis of C, H, O, ASH and moisture content
- Biomass flow rate
- Reactor design temperatures
- Component efficiencies
- PoWER system water extraction

2. Output

- Expected temperatures, pressures and flows
- Energy consumed
- Syngas flow, temperature and composition

Screenshot of simulation program



- Perform experiments and integrated system modeling by using MATLAB™ and C++
- Integrated system model, utilizing component models
- Model chemical kinetics of reactions in gasifier using equilibrium approach
- Highly non linear set of equations are solved using MAPLE
- Composition of Syngas at equilibrium temperature is estimated

9. Conclusions

- **Model construction**

-Semi-closed cycle gas turbine and VARS models (PoWER)

-HiTS preliminary model

- Initial structure of integrated HiTS/PoWER model

- **Facility improvement**

- Gas turbine installation in progress (80%)

-Microturbine (Capstone C60), Gas Booster(Copeland) , Load Bank(Merlin Simplex)

- Newly modified UF Gasifier

- **Preliminary Gasification Tests**

- Performed base tests by using modified Gasifier

10. Future Work Plan

- **Component/subsystem research**
  - Component-level models of PoWER engine, gasification system
  - Integrated system model, utilizing component models
  - Development of high temperature gasifier fueled externally
  - Comparative economic evaluation of system designs, including liquid fuel option
  - Integration of gasifier with gas turbine
  - Demonstration of PoWER operation on syngas from demonstration gasifier plant
  - Characterization of syngas suitability for liquid fuel production via conventional technology and via high temperature membrane separator
  - Validation of system models using data from demonstration unit
- **Long range goal: integrated system demonstration**