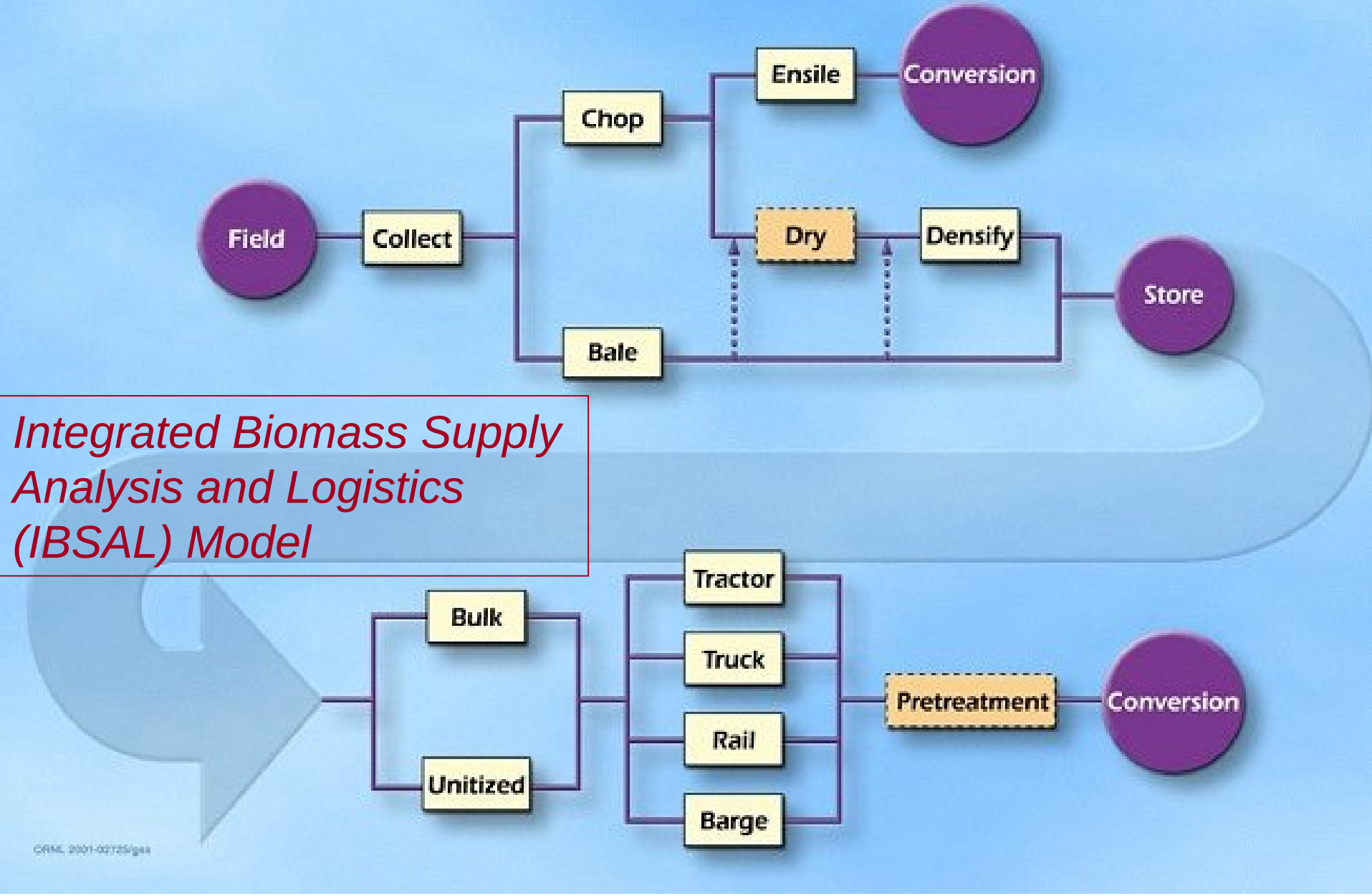
Development and simulation of a dynamic logistics model for supply of biomass for biofeuls IBSAL

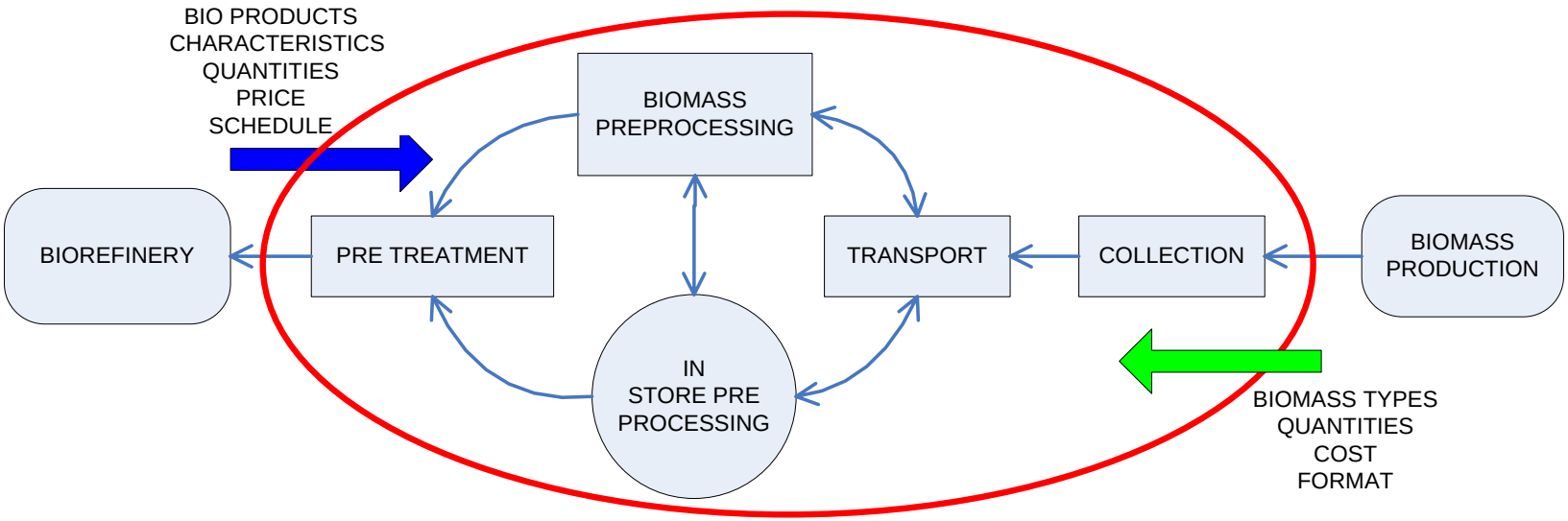
Shahab Sokhansanj

August 29, 2006



Integrated Biomass Supply Analysis and Logistics (IBSAL) Model

Motivation



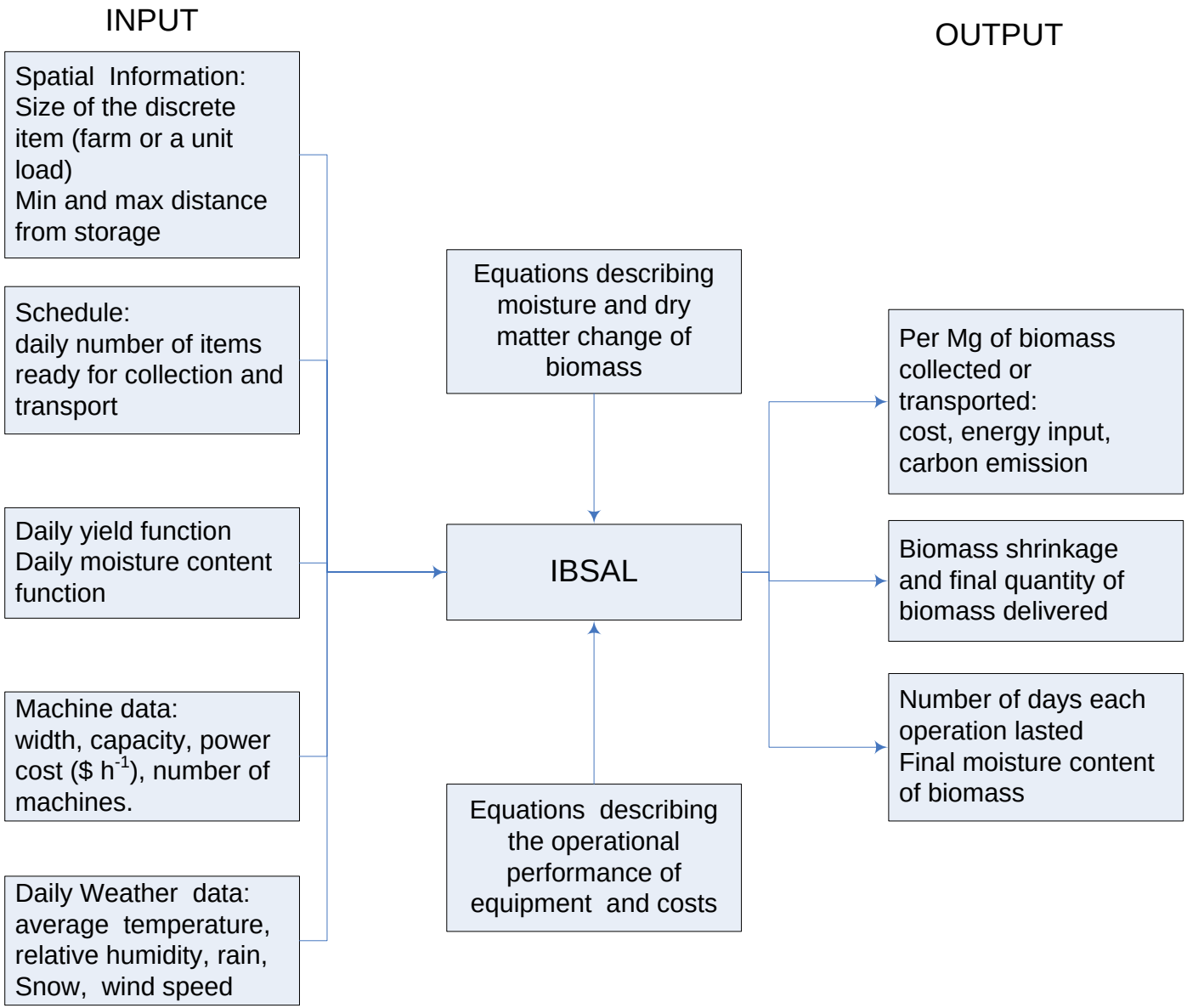
Two underlining goals drive this task:

1. Provide an accurate account of engineering requirements and infrastructure for on-time delivery of biomass to a biorefinery, and
2. conduct risk analysis on cost variations due to inherent biomass availability and quality.

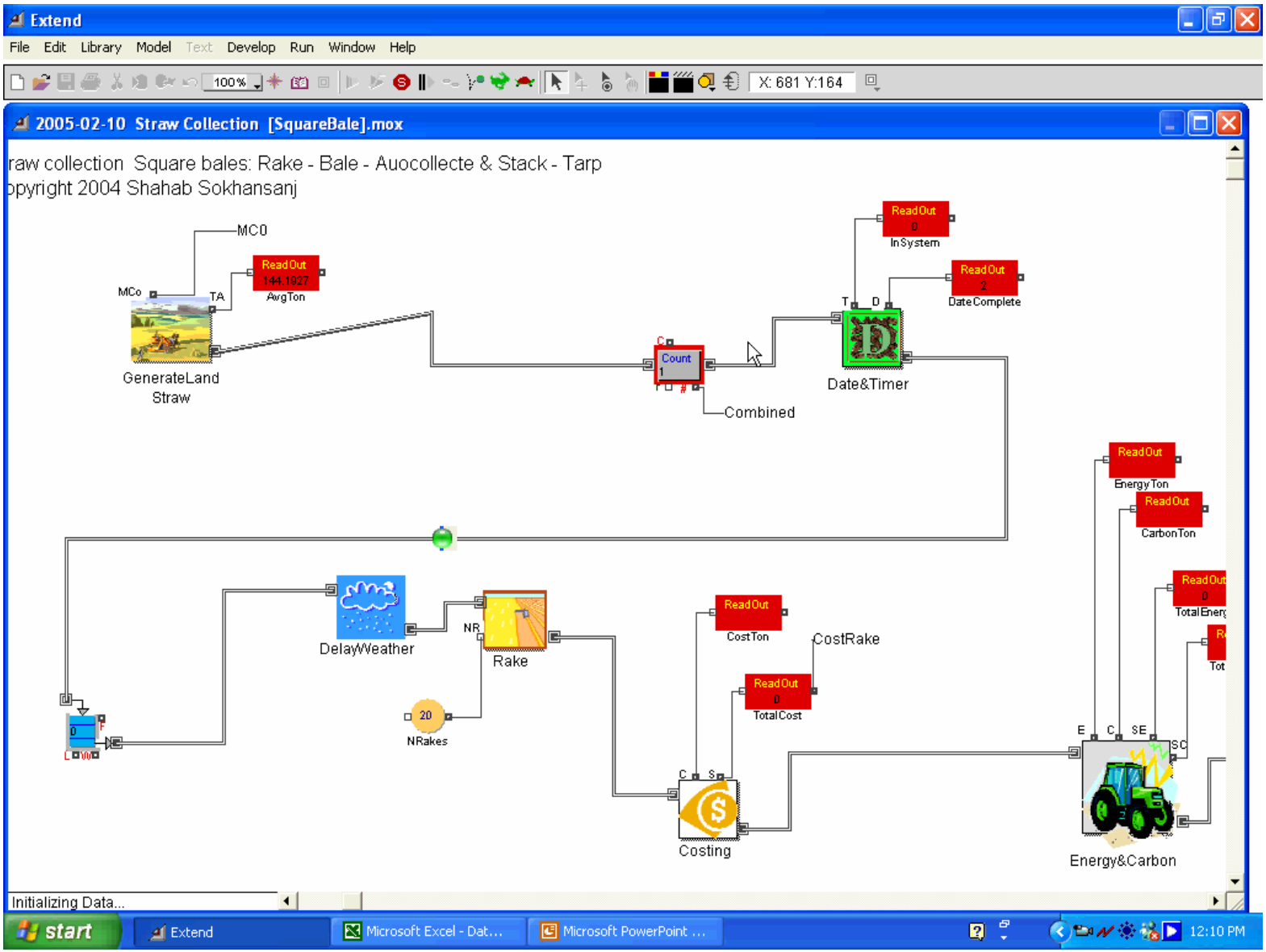
Integrated Biomass Supply Analysis (IBSAL) model - Description

- Simulates the physical flow of biomass through the entire supply chain.
- Simulates biomass acquisition operations; i.e. harvest, on farm/forest store, and transport based upon equipment performance functions.
- Simulates depot operations; i.e. storage, size reduction, fractionation, densification.
- Calculates the delivered biomass quantity, cost, and energy flows subject to yield, harvest window, weather, and geographical distribution of biomass.
- Calculates changes in moisture content and dry matter changes for biomass.
- The model is modular, can be assembled and optimized for various supply chain configurations.

IBSAL Structure



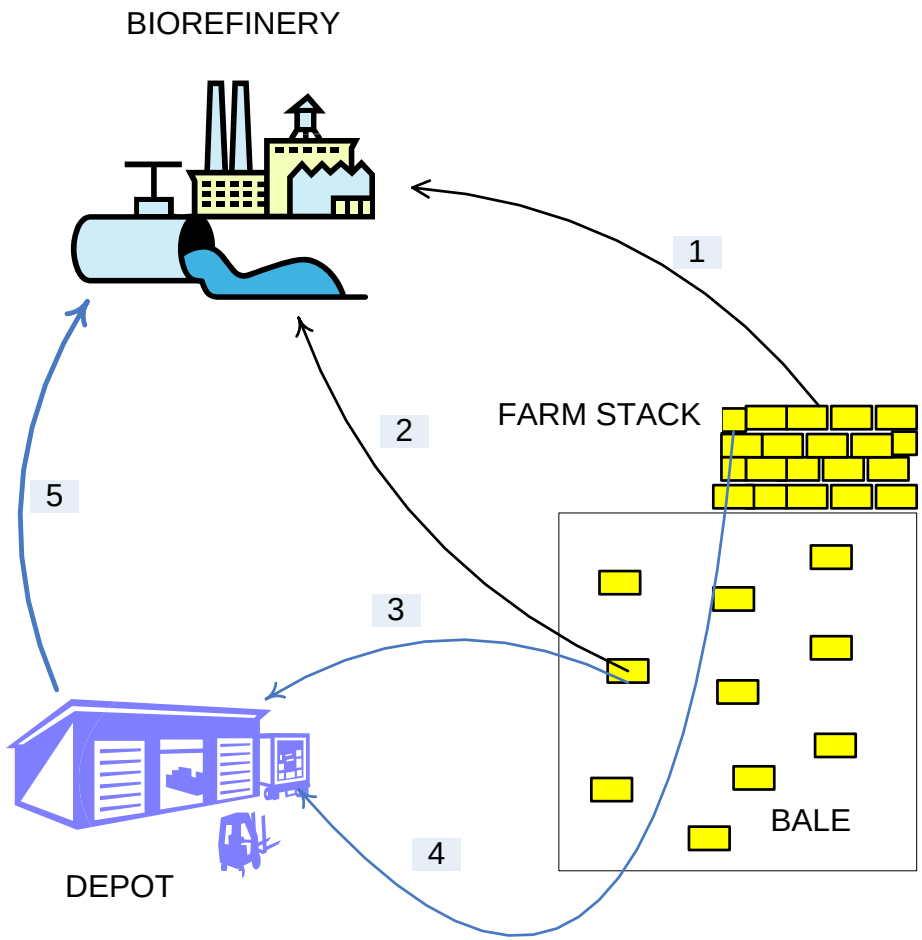
IBSAL Implementation on EXTEND



Storage & transport logistics

Determining factors:
- Economics
- Seasonality
- Agronomic practices
- Developmental stage

Multi modal transport systems
- Truck
- Train
- Waterways
- Pipeline



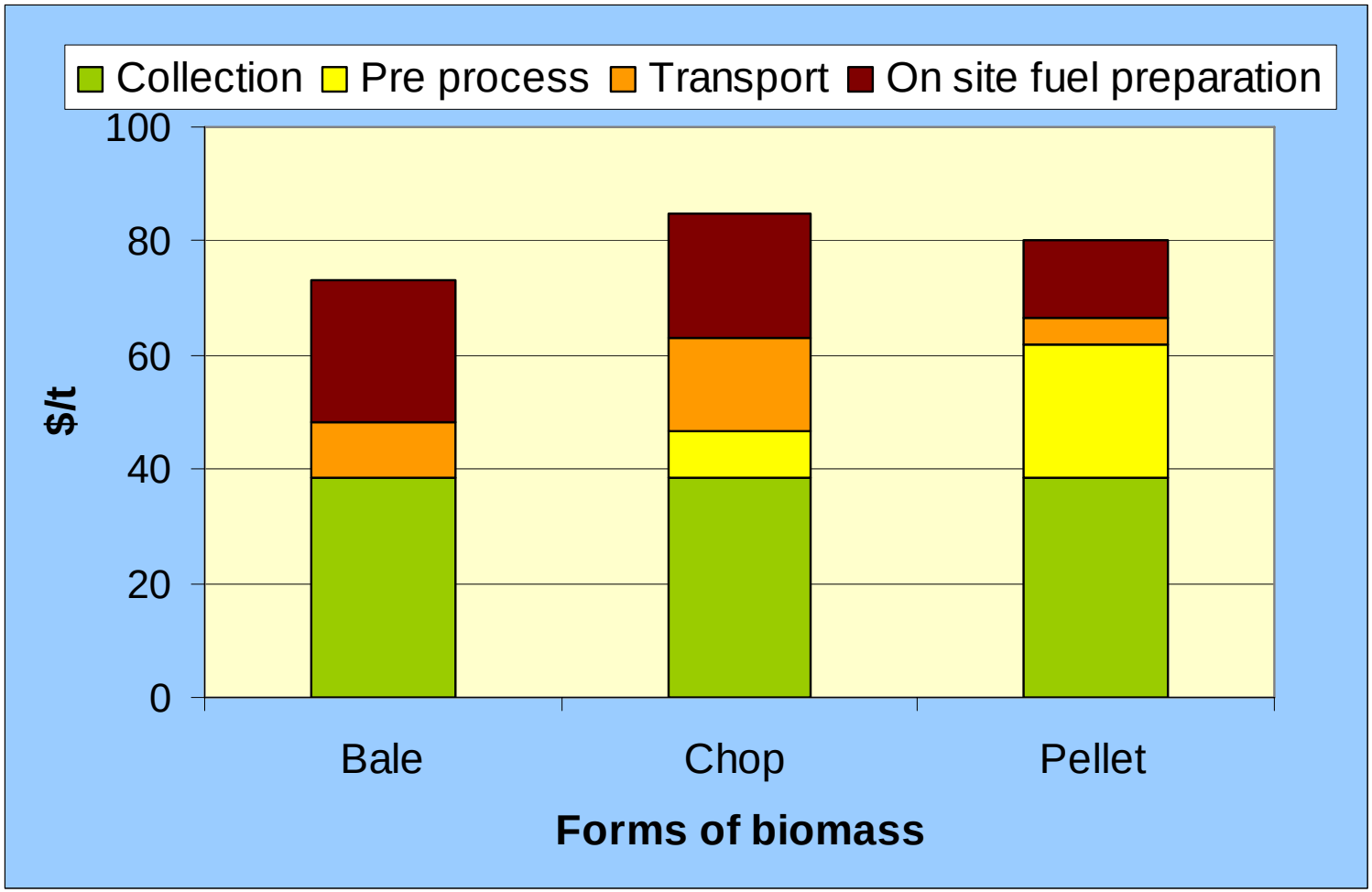
- Integration– dry systems

The costs include
- **$10 to producer**
- **15% profit to supply**

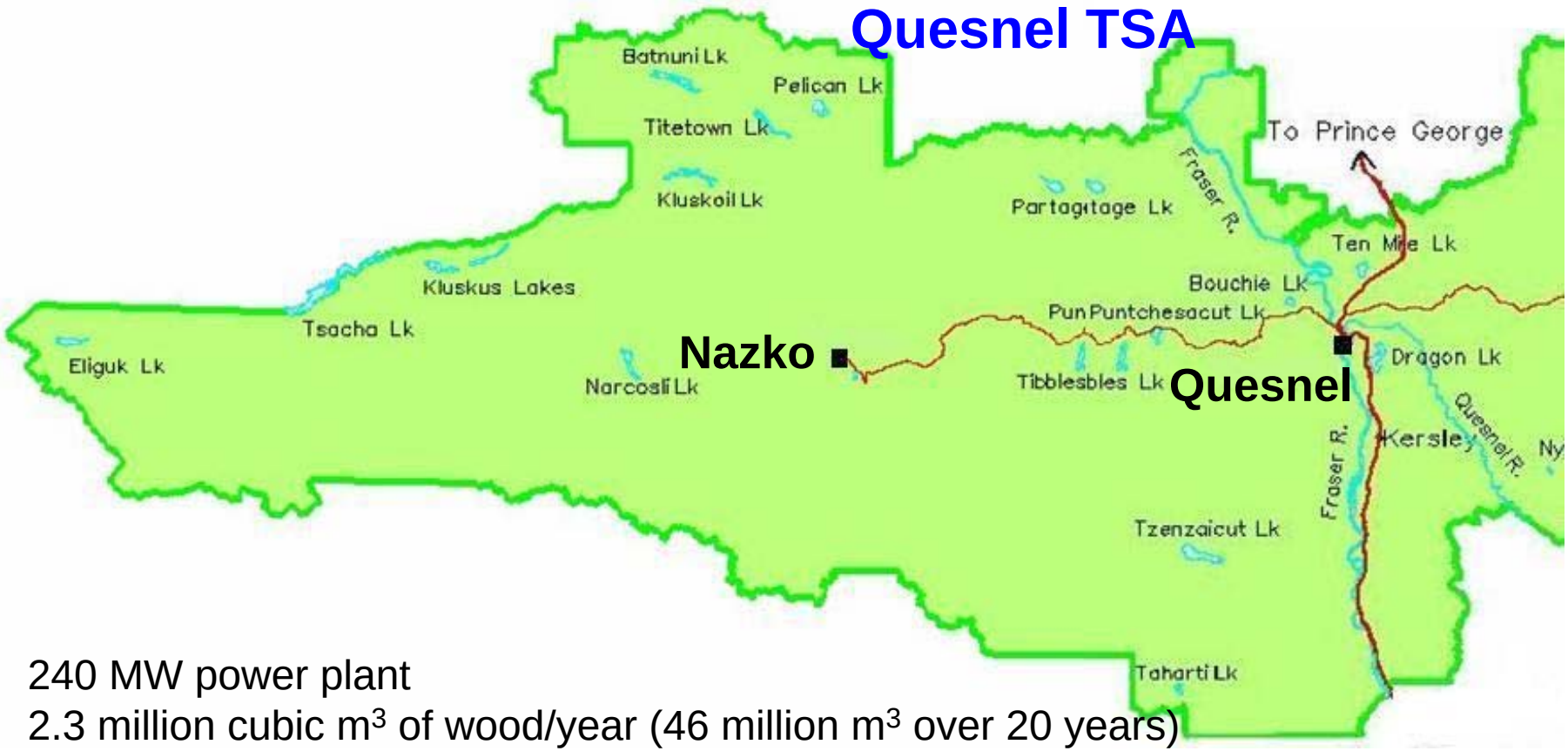
			Transport options ($/dT)		
			Bales	Grinds	Chops
	Collection		13.7	15.45	14.26
	Format	$/dT	Overall cost $/dT		
Stover	Baling	26.02	41.77	43.79	
	Loafing	21.85		39.61	
	Chopping	37.88			54.28
Straw	Baling	29.02	44.78	46.79	
	Loafing	26.81		44.58	
	Chopping	46.51			62.91
Switch grass	Baling	28.17	43.93	45.94	
	Loafing	23.31		41.07	
	Chopping	40.67			57.07

Source: IBSAL

Example of IBSAL to calculate the cost of delieverd biomass (stover) to a CHP plant

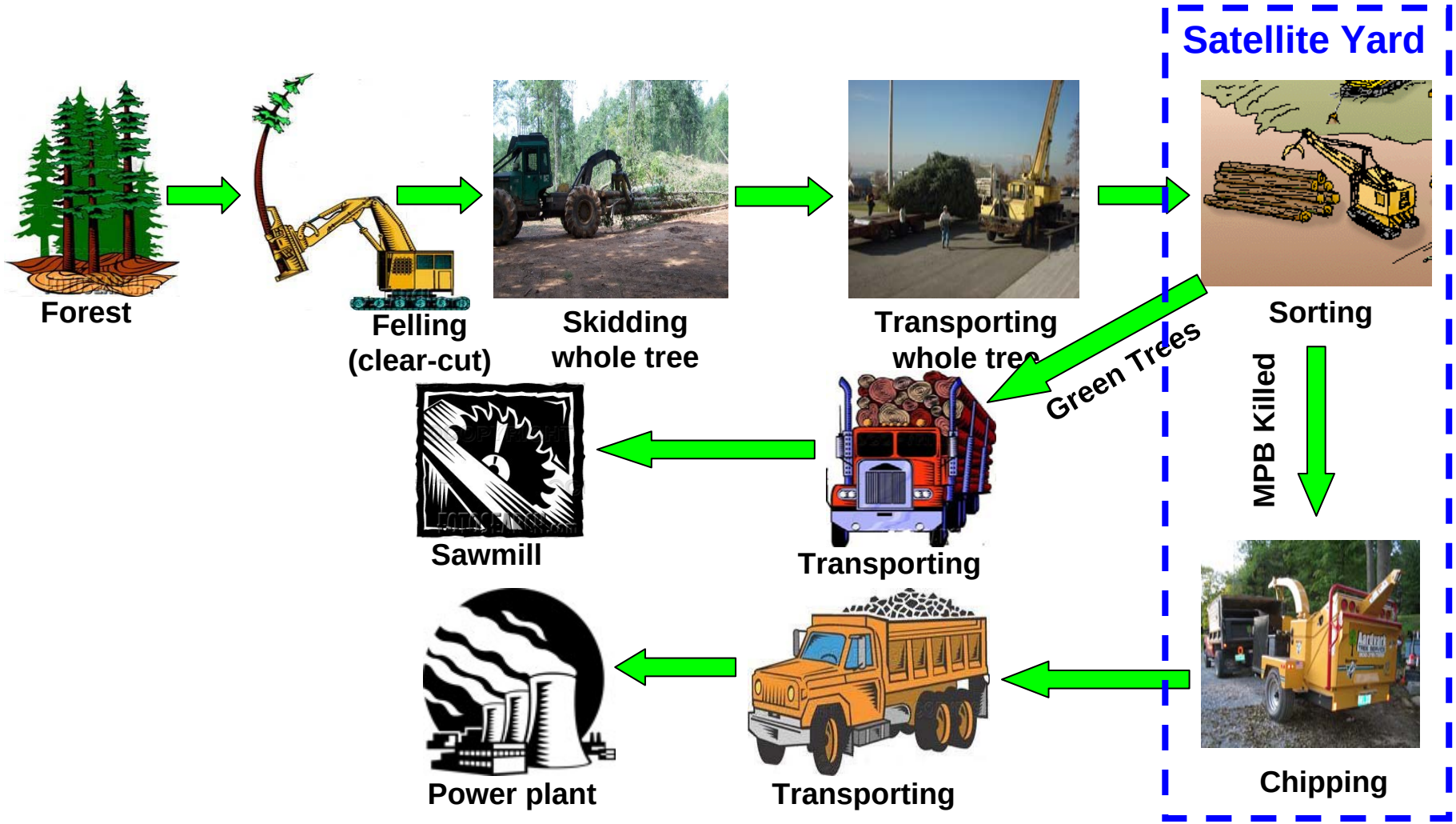


IBSAL for supply of Mountain Pine Beetle infested wood to a proposed power plant

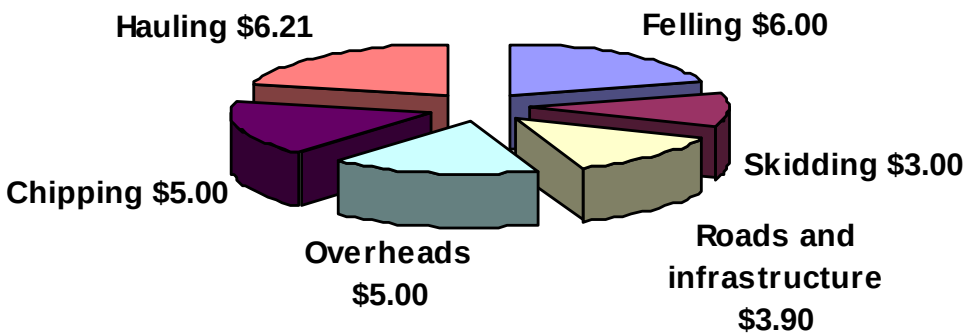


240 MW power plant
2.3 million cubic m^3 of wood/year (46 million m^3 over 20 years)
Concentration of lodge pole pine is 37 to 64 m^3/ha (gross ha)
Average moisture content 13%

Modeling the flow of biomass supply system for Mountain Pine Beetle infested wood



Initial estimates of the cost of supply (Static analysis)



Kumar et al. (2005)

Concluding remarks

- The IBSAL model simulates the flow of biomass from field to biorefinery subject to biological and climatic constrains that affect biomass quality, quantity and costs.
- The model evaluates multitude of biomass supply scenarios and identifies the most competitive supply options (assemblies).

Acknowledgement

- Funding and support for this project:
  - DOE's Office of Biomass Program through Oak Ridge National Laboratory
  - Natural Sciences & Engineering Research Council of Canada
  - BIOCAP and NRCAN

- The project collabotaors are
  - Dr. Anthony Turhollow – ORNL
  - Drs. Sowlati (UBC Forestry), Mani, BI, Lim (UBC CHBE), Kumar (UA ME).
  - Jack MacDonald, Tony Sauder (FERIC)
- And many students and post doctoral fellows