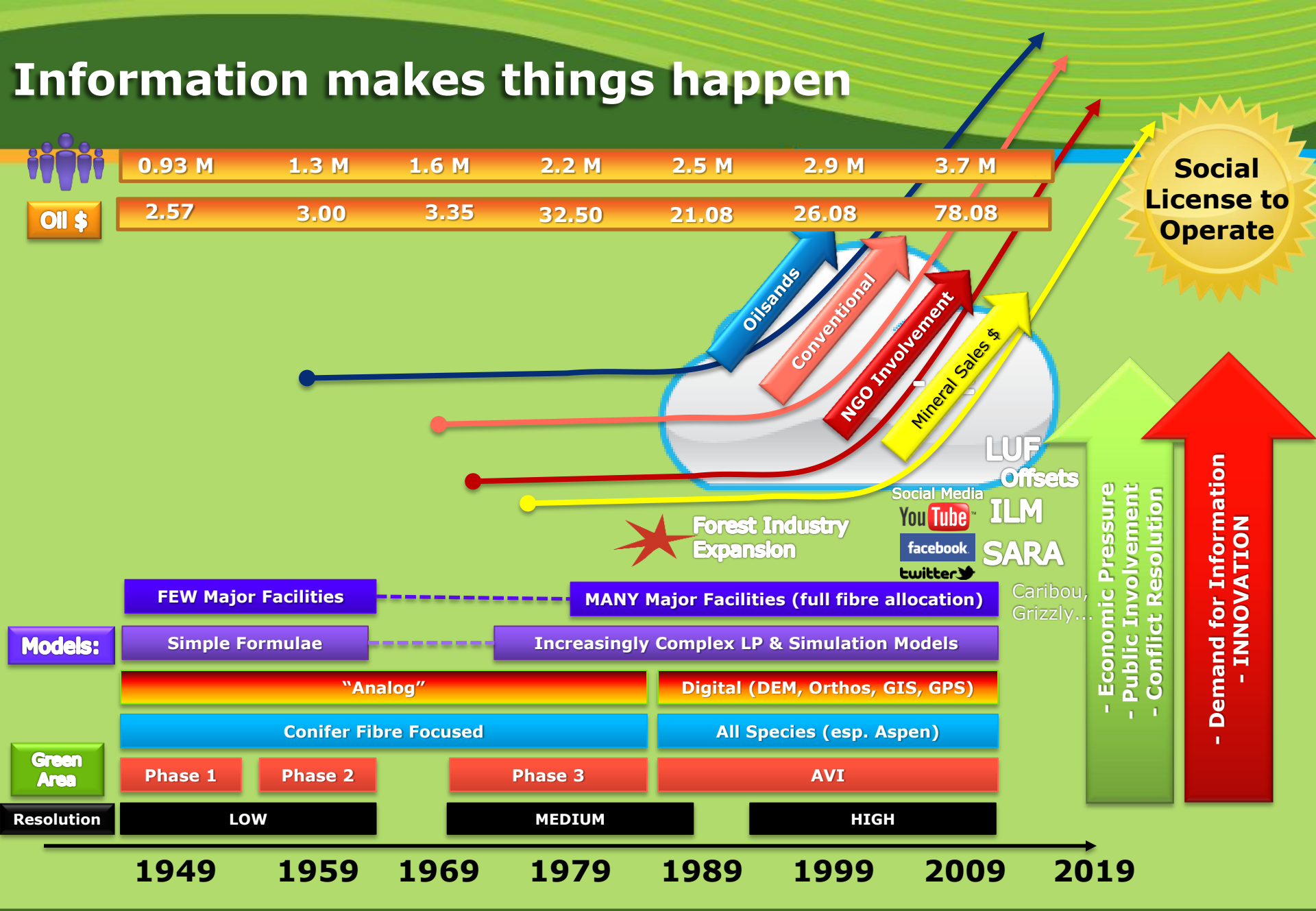
Bio-Resource Information Management System (BRIMS) Project Phase 1 Summary

March 5, 2013

Agenda

- Original questions and concepts
- Phase 1 project activities
- Setting the stage
  - Current science and data
  - Gaps
- Data
- Outcomes
- Next steps

Information makes things happen



Biomass as a component of ecosystem services

Context

- Proponents approaching industry
- Government interested in economic diversification and development
- Alberta Innovates facilitating innovation

What's missing

Dependable, investment-grade information about:

- How much biomass exists?
- Where it's located?
- What are its components and quality?
- Costs, commitments and constraints associated with its extraction?
- Environmental implications?

In a perfect world…

- Wouldn’t it be nice to be able to generate a prospectus of available biomass feedstocks for a user-defined area – across all land tenure and ownership types?
- Extend this to all ecosystem services and products?

Value proposition

Encourage investment in the bio-industrial sector by:

- Providing real numbers
- Reducing uncertainty of supply
- Providing a framework to share data
- Providing tools for scenario analysis (and let market forces operate)
- Facilitating collaboration between sectors

Overarching objectives of BRIMS Phase 1

Objectives:

- Evaluate current status of science and data of biomass inventory
- Identify gaps, strengths and weaknesses in current data
- Provide overview of trends in biomass supply pool – using available data
- Develop business plan for on-going data procurement
- Determine a home for data and distribution

The Team

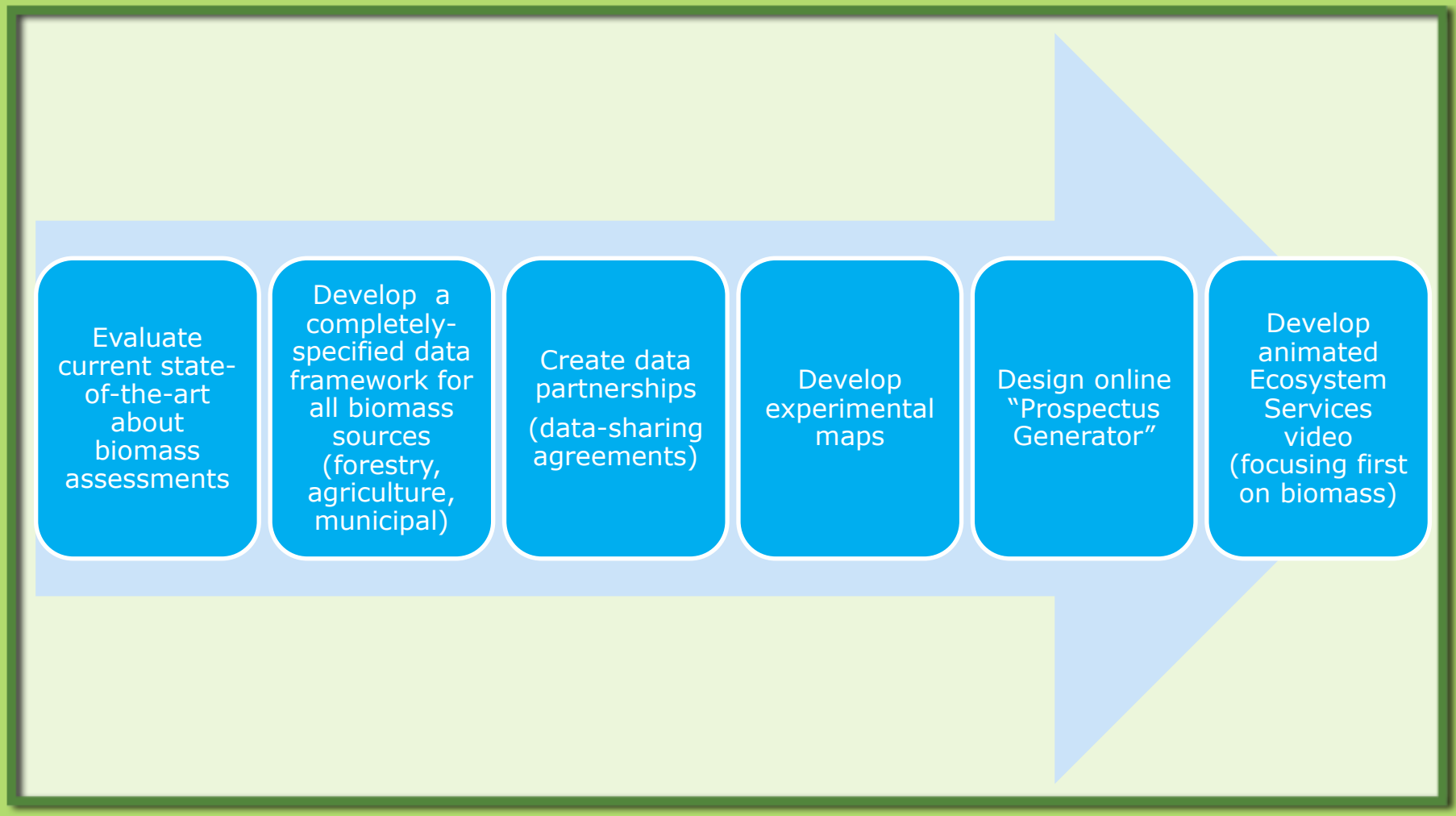
Silvacom Ltd (*Data is our core business™*)

- Project management
- Geospatial data management
- Analytics
- Communications
- Industry networking

Green Analytics Corp (*Measuring environmental values*)

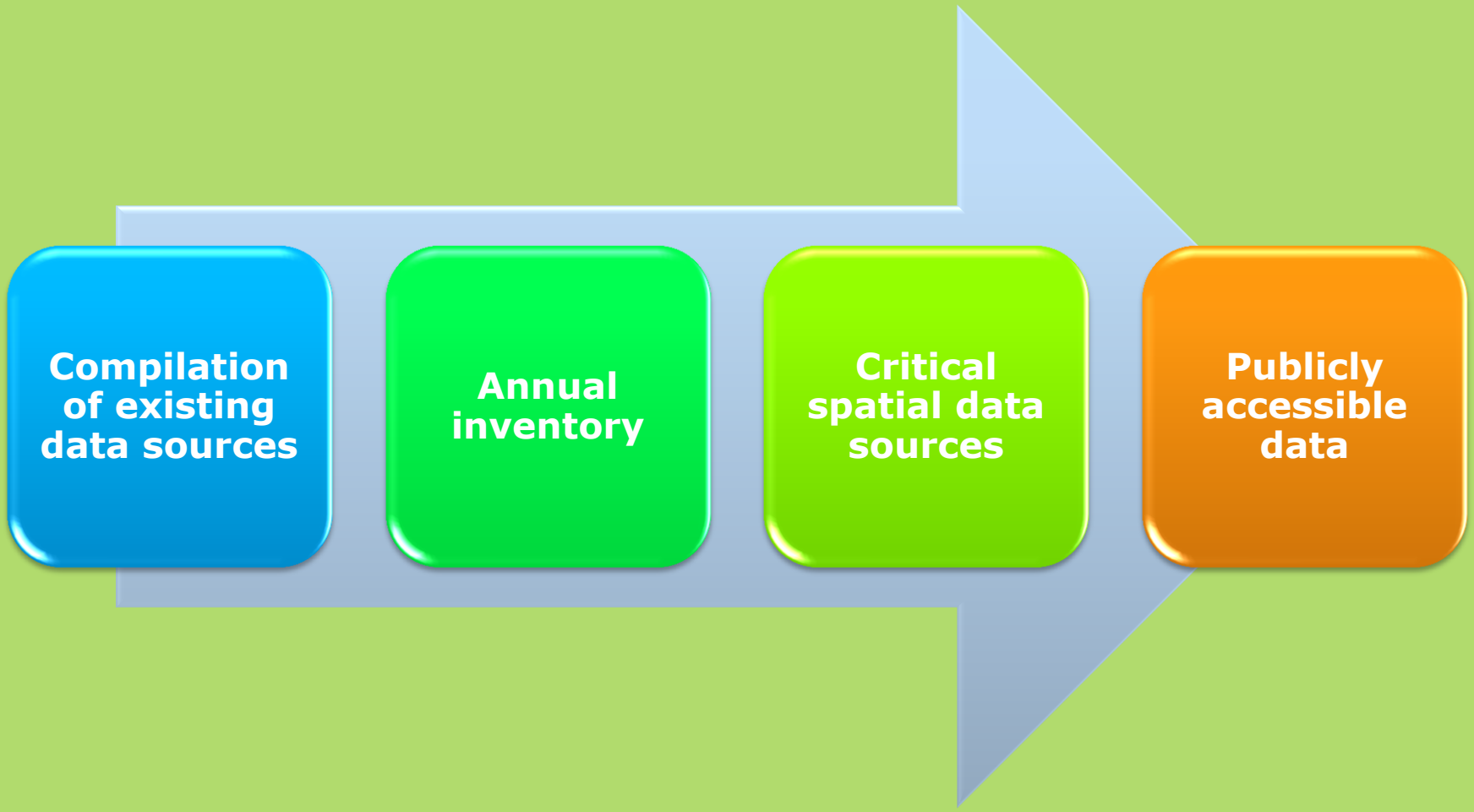
- Subject matter content
- Analytics
- Reports
- Government and ENGO networking

The Approach



BRIMS – a foundation for organization

Vision for BRIMS



Technical report overview

- Measuring biomass potential
- Types of biomass potential
- Resource assessment methodologies
- Measuring biomass potential
  - Forestry, agriculture and organic waste
- Jurisdictional review of assessments

Biomass assessment potentials

Type	Description
Theoretical potential	The maximum amount of biomass available for production within fundamental bio-physical limits
Technical potential	The fraction of the theoretical potential that is available given current technological capabilities
Economic potential	The share of the technical potential that can be economically, or in other words profitably, produced
Sustainable implementation potential	The fraction of the economic potential that can be produced within a certain time frame and given socio-political realities, including economic, institutional and social constraints and policy incentives

Resource assessment methods

- Statistical
  - Resource focused, theoretical potential
- Spatially explicit
  - Resource focused, theoretical potential
- Cost-supply
  - Demand driven, technical potential
- Energy and economics modelling
  - Demand driven, technical potential
- Integrated
  - Resource and demand driven, technical and theoretical potential

Biomass from Forestry

- Forestry biomass
  - Stem wood
  - Residues
  - Short rotation plantations
- Measurement Technique
  - Field surveys
  - GIS
  - Remote sensing

Biomass from Agriculture

- Agriculture biomass
  - Energy crops
  - Residues
  - Livestock waste
- Measurement Technique
  - Satellite imagery
  - Allometric equations
  - Remote sensing
  - Sonar and digital imagery

Biomass from Municipal Solid Waste

- Organic waste
  - Biodegradable municipal solid waste
  - Construction and demolition wood
  - Sewage sludge
  - Used fats and oils
- Measurement Technique
  - Population based
  - Survey

Global scan- scope

- Scope: global scan of leading jurisdictions in the world
  - Europe
  - North America
  - Asia
  - Latin America
  - Africa
- Recent studies (2001 onward)

Global scan- scope of investigation

- 7 studies were captured covering 38 countries
- Studies ranged across a variety of assessment potentials and methodologies
- Rigour and quality of assessments vary
- Data resolution is at a high level

Information derived from global scan

- Study capture criteria:
  - Type of biomass potentials
  - General approach
  - Methodology
  - Timeframe
  - Geographic coverage
  - Types of biomass
  - Units and conversion factors
  - Key assumptions
  - Sources of data
  - Sustainability parameters
  - Limitations and uncertainties

Study Title – Biofuel feedstock assessment for selected countries		
Study Author/s – Keith L. Kline, Gbadebo Oladosu, Amy Wolfe, Robert Perlack, Virginia Dale and Matthew McMahon.		
Year of Publication – 2008		
Overview - The primary purpose of this study was to create biomass feedstock supply curves for selected countries and feedstocks. The analysis identified the capacity to potentially double or triple feedstock production by 2017 in some cases. A majority of supply growth is derived from increasing the area cultivated (especially sugarcane in Brazil). This is supplemented by improving yields and farming practices.		
General Approach	Resource focused ✓	
	Demand driven ✓	
	Integrated	
Methodology	Statistical ✓	
	Spatially explicit	
	Integrated	
	Cost supply - ✓	
	Energy-economics	
Timeframe of analysis – Supply curves were derived for 2012, 2017 and 2027.		
Geographic coverage - Argentina, Brazil, Canada, China, Colombia, India, Mexico, and the Caribbean Basin Initiative (CBI)		
Biomass type –	Forestry ✓ (residues)	
	Energy crops ✓ (sugarcane, corn, wheat, soybeans, and palm oil)	
	Agriculture residues ✓	
	Organic waste	
Relevant units/conversion factors – Metric tonnes converted to gallons of gasoline equivalent		
Key assumptions - The methodology assumes that recent growth trends for yield and harvested area at a state level will continue into the future within a set of defined parameters. Only states producing in the base year were assumed also to be producing over the projection period. The approach assumes that the price/value structure for producers in each state remains the same as the year on which the projections are based (i.e. 2005 in most cases) throughout the period of study.		
Status of data - Key sources of information for this analysis include online resources from the U.S. Department of Agriculture (USDA), the Food and Agriculture Organization of the United Nations (ProdStat, FAO Stat, PriceStat, TerraStat, REsourceStat), the U.S. Department of Energy, and the International Energy Agency, as well as national agricultural services and organizations in the countries studied.		
Sustainability parameters – The report discusses a range of social, economic, institutional, and environmental factors that may affect the types and quantity of feedstock or biofuel that can be supplied for future export to global markets. General trends and examples are cited from the countries studied related to soil, water, land use, policies and social factors. This study attempted to make reasonable supply projections while considering and acknowledging these issues in the methodology and individual country analyses.	Biodiversity	
	Climate change	
	Soil ✓	
	Water ✓	
	Air ✓	
	Land availability ✓	
	Deforestation ✓	

Findings by source

- United States
- China
- European Union
- Australia

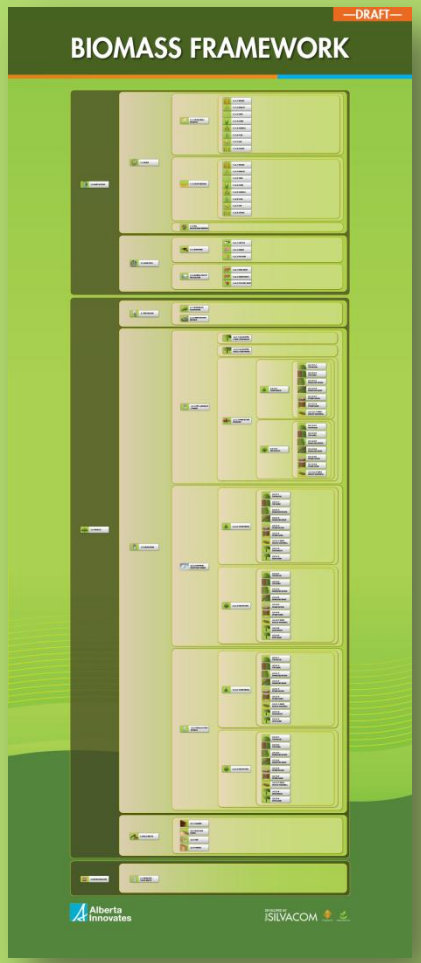
Key gaps identified in global scan

- Lack of harmonized guidelines
- Disaggregated data compilation
- Small proportion of assessments are spatial.
- Scientific research exercises and increasingly industry led initiatives.
- Modelling based data approaches vs. empirical data collection
- No publicly available, spatially reference decision support tools

New bio-resource data framework

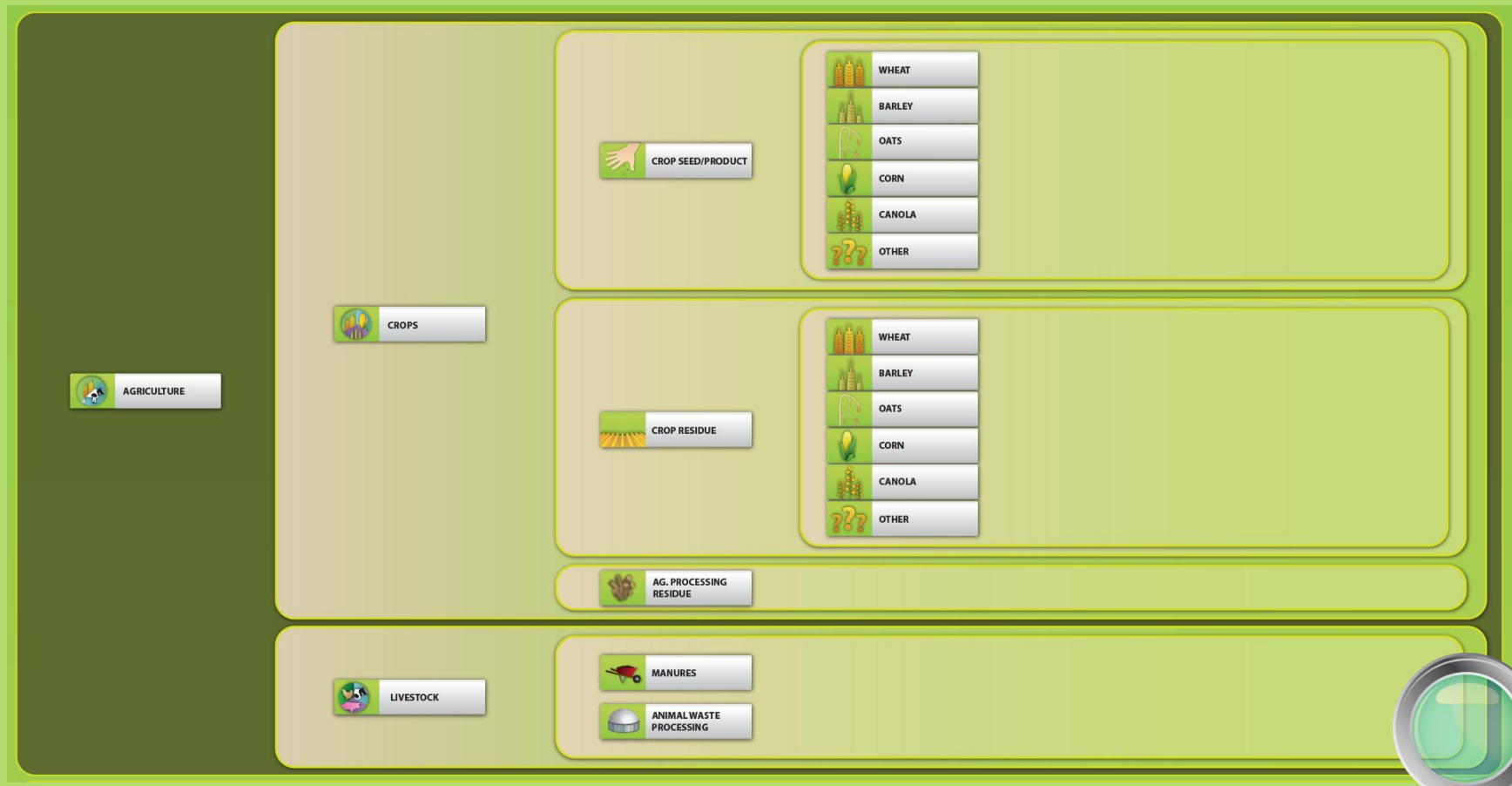
A fully specified data model provides a breakdown of all biomass pools, sources, biomass types and resolutions from:

- Forested land
- Agricultural land
- Municipal sources
- Industrial/processing facilities

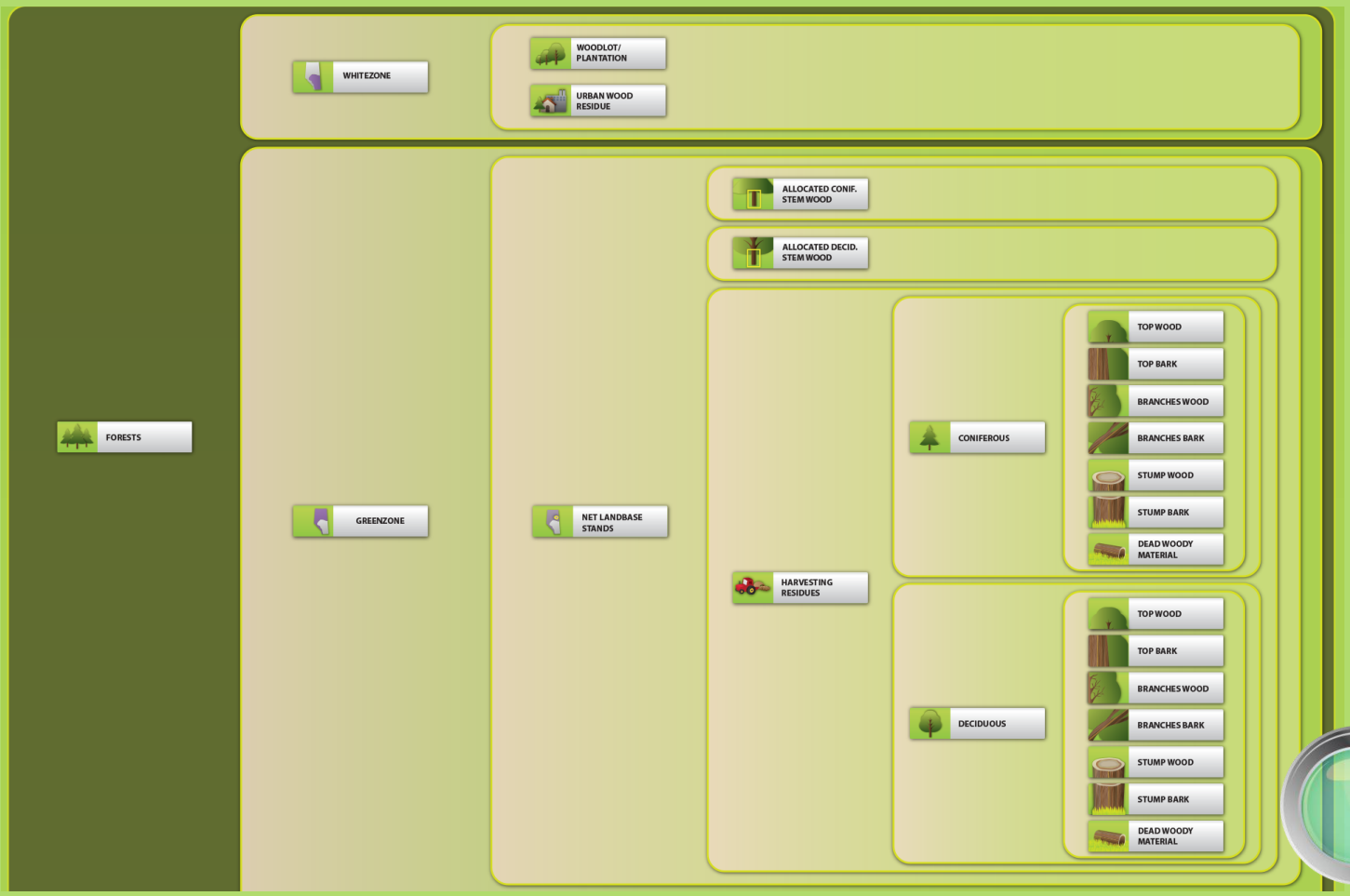


Biomass framework – data model

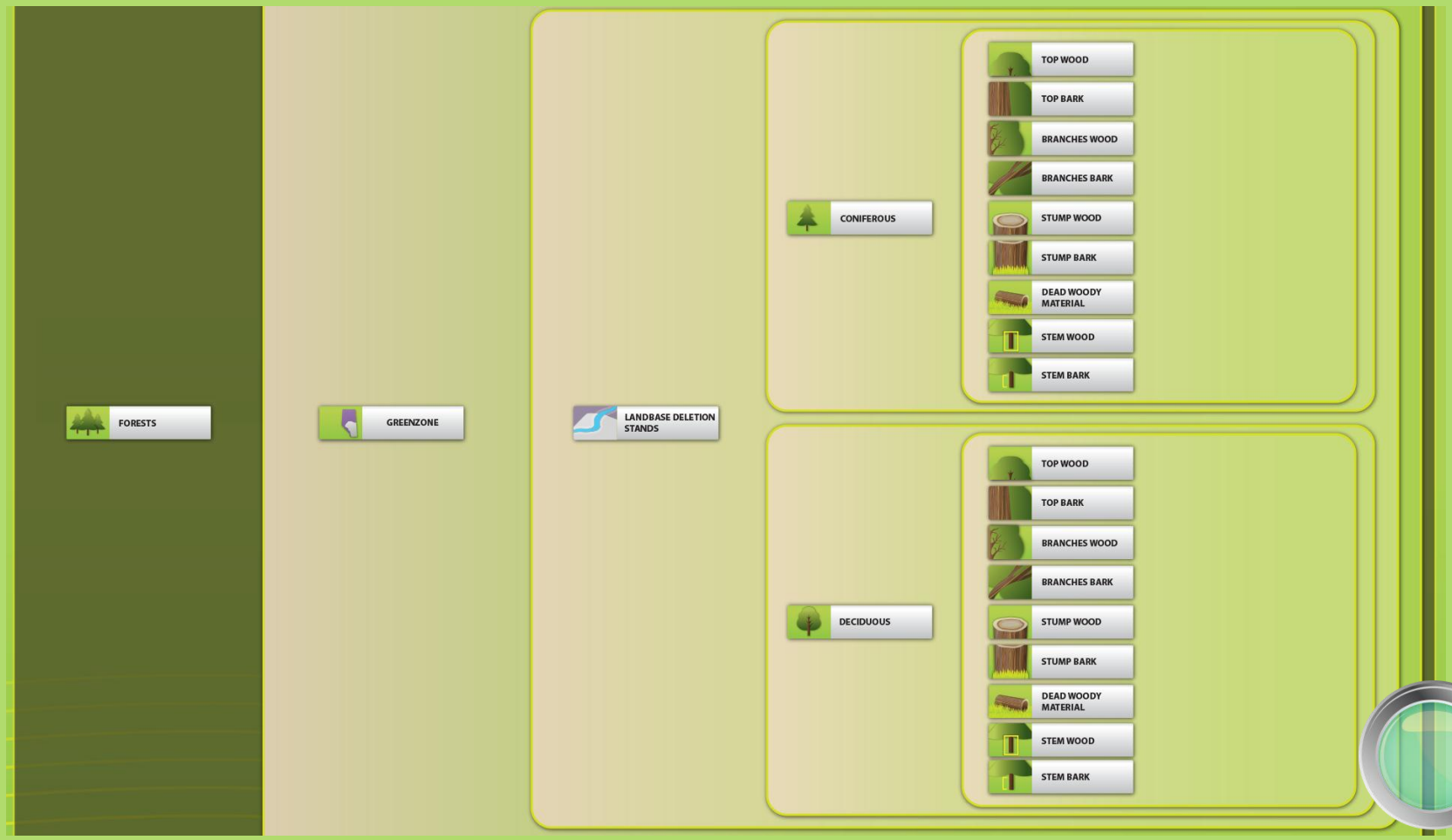
Biomass framework - agriculture



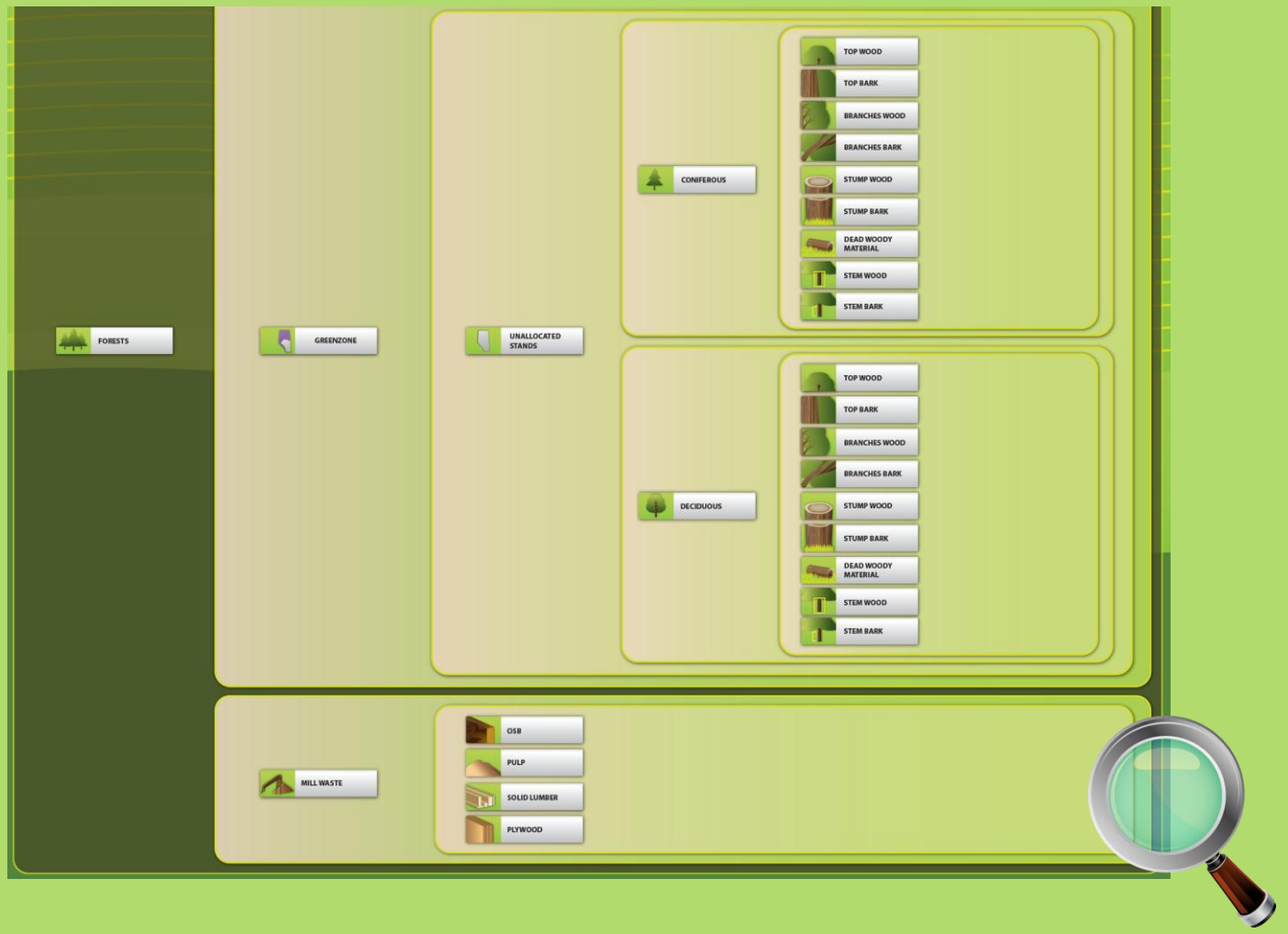
Biomass framework: White zone & net land base stands



Biomass framework: land base deletion stands



Biomass framework: unallocated stands & mill waste



Stem wood data example

2.2.2.1.4 Stem Wood

Forests>Green Zone>Land Base Deletion Stands >Conifer>**Stem Wood**

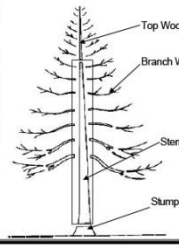
Component Introduction:

Forest biomass includes all parts of the tree, not only the stem but also the **top wood**, top bark, the branches, stump wood, stump bark, the needles or leaves, and even the roots. **Stem wood** refers to the non bark portion of the main axis of a tree that is distinct from branches, tops or stump. Typically, the stem wood is defined by the utilization standard, which varies from species to species and according to the end use of the logs. In general, trees can be topped down at an 8 to 10 cm top diameter at a stump height of 0.3 m from the ground level in normal operations and a minimum stump diameter of 15 cm diameter. In general, trees more than 4.88 m in length can be utilized. Currently stump wood is used in the production lumber, plywood, veneer, pulpwood, OSB etc. Potentially stem wood can be converted into wood chips and wood pellets which can then be used as feedstock for biofuel and bio-product.

Data Source:

Input data for estimating tree biomass, comes from the **Alberta Vegetation Inventory** (AVI)[184] and **Temporary Sample Plots**. AVI is a vegetation inventory system that provides the information base to prepare forest management plans, classify wildlife habitat, and undertake integrated resource management planning (Nesby 1997).[185] Data collected for the AVI is based upon photo interpretation of medium-scale aerial photographs that define similar stands of vegetation with respect to species composition, height, crown closure, age, and productivity (Nesby 1997). **AVI information is used to estimate tree volume.** Volume information is usually obtained by installing large numbers of ground-measured temporary sample plots within stratified AVI cover types. AVI data comes from individual forest companies.

Temporary sample plot (TSP) data collected from all sampling programs are used in the construction of growth trajectories for estimating individual **tree volume and stand volume over time**. Sampling programs will vary in data collection procedures depending on the end use of the collected data. Many sampling programs are focused on collecting data in the net productive forest area and therefore, stands less than 7 m in height, cutblocks, burns, and horizontal stands delineated in the AVI as well as unmerchantable stands are typically excluded.



[184] http://srd.alberta.ca/LandsForests/documents/AVI-ABVegetation3-InventoryStan-Mar05.pdf

[185] Nesby, R. "Alberta vegetation inventory version 2.2," *Alberta Environmental Protection*, Edmonton, Alta. 1997.

Biomass Estimate Formulas:

The process of estimating **the biomass** of dead woody material, involves **two main steps**. The **first step** involves determining the stem volume.

Individual tree volumes are calculated using Kozak's variable taper equation (Equation 2.70).[186] This equation, its coefficients, and the methods used to estimate individual tree volumes in Alberta are detailed in Huang's report.[187] The following step summarizes the process:

Determine the **merchantable bole length** (ML) for each tree using an iterative technique applied to Kozak's taper model to calculate the height at which the specified minimum top diameter inside bark occurs based on specified utilization. Once the merchantable length has been measured, gross merchantable volume can be calculated through a four-step procedure.

a. Divide merchantable length into 10 equal sections.
b. Compute the height (h_i) above the ground from the middle and the top for each section, where $h_i = [(i \times ML) \div 20] + SH$; since there are 10 sections, $i = 1, 2, \ldots, 20$; and SH is the stump height.
c. Diameter inside bark at the middle and top of each section are calculated using the taper equation, expressed as:

Equation 2.70

$$d_i = a_0 D^{a_1} a_2^{D} \left[\frac{1-\sqrt{h_i/H}}{1-\sqrt{p}}\right]^{b_1 (h_i/H)^2 + b_2 \ln\left(\frac{h_i}{H+0.001}\right) + b_3\sqrt{h_i/H} + b_4 e^{h_i/H} + b_5 (D/H)}$$

where D = outside bark diameter at breast height (cm); H = total tree height (m); d_i = inside bark diameter at h_i height from ground (cm); and $a_0, a_1, a_2, b_1 \ldots, b_5$ = regression coefficients. Diameter inside bark at the top of the stump, termed d_0, is also predicted from the taper equation with height h_i equal to the stump height.

d. Merchantable volume is calculated using Newton's formula[188]. There are 21 inside bark diameters located at intervals ML/20 m, from top of stump to the point where minimum top diameter, $d = d_{20}$. Three diameter are required to compute the volume for each section of $2 \times ML/20$ (= $ML/10$) length. Thus, using Newton's formula, the gross total merchantable volume of the tree is the summation of the volume from 10 sections:

Equation 2.71

[186] Kozak, A." A variable-exponent taper equation." *Can. J. For. Res.* 18: 1363-1368 .1988

[187] Huang, S. "Individual tree volume estimation procedures for Alberta: Methods of formulation and statistical foundations." *Land and Forest Service, Alta. Env. Prot. Tech. Rep. No. T/288*, Edmonton, Alta., Canada. 80 p. 1994.

[188] Husch, B., Miller, C.I., and Beers, T.W.," Forest Mensuration, third ed." *Ronald Press Co, New York*, NY, p. 402.

$$V_m = \frac{ML/10}{6}(0.00007854)(d_0^2 + 4d_1^2 + d_2^2) + \ldots + \frac{ML/10}{6}(0.00007854)(d_{18}^2 + 4d_{19}^2 + d_{20}^2)$$

where V_m is the merchantable volume (m^3).

The **second step** is to calculate the biomass of the **dead woody material** using Equation 2.72.

Equation 2.72

$$Biomass\ (tonnes) = V_s \times specific\ gravity$$

Data/Science Limitations and Gaps:

1. AVI data may not be available for all townships.

Phase 1 Interim Methodology

Due to data availability, limitations and gaps, the following data sources and procedures were used for the initial calculations of provincial biomass:

Data: Phase 3 Inventory

Steps:

1. Volumes were calculated for each of the volume sampling regions of Alberta.
2. Overstory lead species height was used to calculate dbh from a height-diameter equation (Haung and Titus, 1992) for use in calculating individual tree volume.
3. Volumes (step1) were divided by individual tree volumes to obtain density (number of stems per hectare).
4. Canadian national tree aboveground biomass equation (Lambert et al., 2005) was used to calculate total wood biomass for individual trees (tons/hectare). To obtain wood biomass for the province it was then multiplied by the density (number of trees/ha) and total area (ha).
5. CBM-CFS3 merchantability assumptions were used to calculate the stem wood volume from the total tree volume.

Note: It is assumed that land base deletion stands is 40% of the gross forested land.

Cattle manure data example

Livestock >Manure > **Cattle Manure**

Component Introduction:

As of July 1, 2010, total cattle and calves on Alberta farms were estimated at 5.5 million head, 4.9 % smaller than at July 1, 2009[57]. Inventories were down for all cattle classes with the exception of milk cows which remained unchanged. Among the factors contributing to the lower inventories were favourable cattle prices and increased marketing. Among provinces, Alberta ranks first in cattle and calves inventory.

Manure[58] is a by-product of raising livestock and is a source of many valuable crop nutrients. Nitrogen and phosphorus, in particular, are important nutrients for crop production. Manure is also a source of organic matter, which can help reduce soil erosion and improve soil's water-holding capacity. Manure can be used to produce Biogas which can be used to produce electricity and heat.

Data Source:

To estimate the total quantity of biomass (tonnes), annual combined total of "cattle" and "calves" produced from each Census Division in Alberta is used. This data can be obtained from Statistics Canada and Agriculture Statistics Yearbook. The data in the Yearbook was compiled by Statistics and Data Development Branch of Alberta Agriculture and Rural Development. It reports livestock production from 2001 to 2010 but not by Census Divisions. The only available data by Census Divisions was reported by Statistics Canada in 2006 (Table 1.6 and Table 1.7).[59]

Table 1.6: Number of cattle in thousand heads (excluding calves) for each Alberta Census Division, in 2006

Census Division	1	2	3	4	5	6	7	8	9	10
# of Animals	152.5	809.1	253.4	232.8	393.1	304.2	315.3	341.8	69.5	362.7
Census Division	11	12	13	14	15	16	17	18	19	Total
# of Animals	249.5	184.6	305.4	52.8	17.0	0	103.4	43.0	124.8	**4,314.9**

Table 1.7: Number of calves in thousand heads for each Alberta Census Division, in 2006

Census Division	1	2	3	4	5	6	7	8	9	10
# of Animals	76.0	237.7	123.6	117.7	142.5	189.7	173.6	177.1	42.3	182.3
Census Division	11	12	13	14	15	16	17	18	19	Total
# of Animals	136.5	111.5	158.9	24.9	7.4	0	57.8	22.7	68.5	**2,050.7**

[57] 2010 Agriculture Statistics Yearbook
[58] For the purposes of this study, manure consists of livestock feces.
[59] http://www.statcan.gc.ca/pub/95-629-x/2007000/4123855-eng.htm

Biomass Estimate Formulas:

Cattle manure values can be obtained by first taking the **Census Division** production for the combined total of "cattle" and "calves" for the year 2001and sub-dividing this total into 68% cattle and 32% calves. Then, dry manure values of **2.50 kg/cow day** and **0.63 kg/cow day** for the respective cattle (**360** kg) and calves (**90.7** kg) can be multiplied to the sub-category totals and added to get the overall production of dry manure.[60] Jaycor (1990)[61] determined that on average cattle on farm is confined 10% of the time and that the manure is **65%** collectible, giving an overall collection rate of **6.5%.** However, statistics show that on average throughout the year **18%** of the total cattle are housed within feedlots where collection was assumed to be 97% collectible.[62] Thus, the overall combination of collections within on farm and feedlot locations for the life of the cow is assumed to be **22.8%.**

Equation 1.14

$$CM_T = \left\{ \frac{([CC_i \times 0.68] \times 2.50 \times 365) + ([CC_i \times 0.32] \times 0.63 \times 365)}{200} \right\} \times 0.228$$

where CM_T is tonnes of Cattle manure; CC_i is the total number of cattle in a Census Division; and C_i is the number of calves.

Data/Science Limitations and Gaps:

3. Data is coarse:
   - The aim is to get the data to the township level but what is reported is at the Census Division level;
   - Data is not spatially explicit to the level of resolution;
4. Up to date data by Census Divisions is not available

[60] USDA, (1985), Midwest Plan Service, Livestock Waste Facilities Handbook, Ames, Iowa, ISBN 0-89373-063-7.
[61] Jaycor (1990) Regional Assessment of Non-forestry-Related Biomass Resources, Summary Volume, Report # 684-0035a/90, Southeastern Regional Biomass Energy Program, Muscle Shoals, AL, March
[62] NRC, (1983), National Research Council Committee on Animal Nutrition, Underutilized Resources as Animal Feedstuffs, The National Academy of Sciences.

Urban wood residue data example

2.1.2 Urban Wood Residue

Forests>White Zone >**Urban Wood Residue**

Component Introduction:

Urban wood Residue are used in a variety of ways, with much variation among cities. Most commonly, these wastes are ground into mulch for land application, dumped into landfills, or incinerated along with municipal solid waste or construction and demolition debris. The diversion of urban wood waste from these uses into bioenergy uses could generate significant amounts of biopower and biofuels. Urban wood waste encompasses a variety of wood resources such as wood-based municipal solid waste, wooden pallets, and wood debris from construction and demolition. Urban wood residue also includes right-of-way clearings, tree trimmings, and other land clearing. In some areas, these can be huge amounts and are often banned from land-fills, or charged a substantial fee for disposal. Urban wood residue can be found in the **White Zone Areas** of Alberta. This area is primarily suited for agriculture and settlement.

Studies carried out in Australia and other parts of the world suggest that there is a direct relationship between **urban wood residue** and **municipal solid waste disposed**. A published data from the Victorian Recycling Industries Annual Survey 2006 – 2007[86] suggest that **7%** (by weight) of the waste stream is **urban wood residue** sent to landfill. Published statistics on the composition of solid waste in Singapore indicate again that the percentage of wood and timber in the waste stream remains fairly constant over time, with gradual shifts up and down.[87] Bai and Sutanto (2002) cite the Singapore Ministry for the Environment statistics in which **urban wood residue** constituted 8.9% of the solid waste composition from 1997 to 2000.

Studies have shown a correlation between **urban wood waste** and **population**, with the most populated counties producing the greatest quantities of **urban wood residue**.[88] Differences in the **urban wood residue** between counties may be explained by other factors such as per capita disposal of waste, relationship with population growth and economic activity. Further study may enable more accurate forecasting and modelling of **urban wood residue** generation and disposal rates in the future.

Data Source:

Input data for estimating biomass from urban wood residue, comes from Statistics Canada and Alberta Environment.

Biomass Estimate Formulas:

Based on the literature review presented in the introduction section, biomass from urban wood waste will be estimated based on a two-step process.

The first step is to estimate the amount of **wood residue** from the total **municipal solid waste disposed** in Alberta. In 2008, Statistics Canada reported that Alberta disposed a total municipal solid

[86] Sustainability Victoria (2008). Victorian Recycling Industries Annual Survey 2006 – 2007. Sustainability Victoria, Melbourne, Australia.
[87] Bai, R. and Sutanto, M. (2002). The practice and challenges of solid waste management in Singapore. Waste Management, 22, 557-567.
[88] Venice 2010, Third International Symposium on Energy from Biomass and Waste

waste of about **4.8 million tonnes**. This data which is collected every two years is yet to be updated for 2010.[89] Based on the 2008 study in Australia, it can be assumed that **7%** (by weight) of the municipal solid waste produced is **urban wood residue**.

Equation 2.1

$$Total\ Urban\ Wood\ Residue = 7\% \ x\ Total\ Municipal\ Solid\ Waste$$

The second step is to determine the urban wood residue by Census Division. Since studies have shown that there is a correlation between **urban wood waste** and **population,** weighting can be used to determine the amount of urban wood residue by Census Division.

Table 2.1: 2010 Total population of Alberta by Census Divisions[90]

Census Division	1	2	3	4	5	6	7	8	9	10
Population (P_i)	82,921	158,301	39,195	10,868	55,636	1,338,241	42,027	196,859	22,010	93,357
Census Division	10	11	12	13	14	16	17	18		19
Population (P_i)	1,218,447	68,229	70,735	29,404	38,754	66,898	64,504	15,126	109,434	**3,720,946**

Equation 2.2

$$UWR_i = \left[\frac{P_i}{P_T}\ x\ UWR_t\right]\ x\ 0.80$$

where UWR_i is the urban wood residue for census Division i; UWR_t is the total urban wood residue; P_i is the population for census Division i; and P_T is the total population for Alberta (3,720,946). A moisture content of 20% is assumed to determine total dry matter.[91]

Data/Science Limitations and Gaps:

1. Data for urban wood residue produced in Alberta is lacking.
2. Application of a statistic derived from a study in Australia as opposed to Alberta.
3. Unable to assess if all of the wood waste is suitable for conversion to bioenergy, disregarding any contamination issues.

[89] http://environment.alberta.ca/02864.html
[90] Government of Alberta, Finance and Enterprise. Alberta Population Projections, 2011-2050.
[91] USDA, (2002), U.S. Department of Agriculture, National Nutrient Database for Standard Reference, October 2002, http://www.nal.usda.gov/fnic/foodcomp/Data/SR15/reports/sr15page.htm.

Data Compilation and Integration

Tasks:

- Scoured existing data sources
- Documented data formats and attributes
- Standardized attribute data from multiple sources
- Georeferenced information to provide spatial links
- Visualized to provide provincial-scale maps

Forest land:

- Biomass calculated from above-ground biomass equations (stem, bark, tops etc.)

Agricultural land:

- Biomass calculated from crop-to-residual estimates

Provincial maps:

- Biomass was compiled from multiple sources and standardized for 5,845 individual townships (Green Zone: 4,355, White Zone: 1,490)
- 200 separate databases
- 4M polygon records

Proof of concept analyses

Area:
- 85,000 ha forest area and agricultural area

Illustrates:
- Base inventory input for calculation of biomass (forest species group and agriculture area seeded)

Data:
- Alberta Vegetation Inventory
- Temporary sample field plots
- Alberta Agriculture Rural Development: Agriculture Statistics Yearbook 2010
- Canadian aboveground forest biomass equations
- Crop grain to residual ratios

Analysis:
- Assigned age and species group condition by forest polygon using inventory attributes
- Assigned forest polygons to the productive land base and non productive land base
- Calculated area seeded by township

Tonnes of biomass – local estimates

Area:
- 85,000 ha forest area and agricultural area

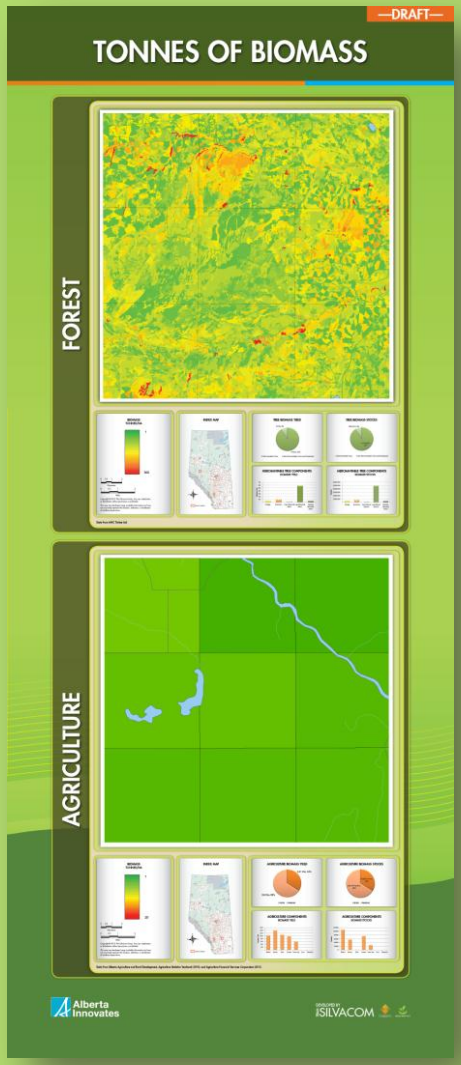
Illustrates:
- Biomass yield by forest stand and agriculture land township.
- Biomass metrics by various pools

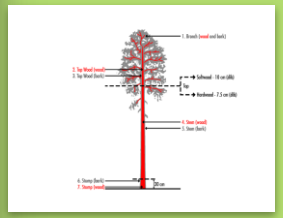
Data:
- Canadian aboveground forest biomass equations
- Crop grain to residual ratios

Analysis:
- Used forest inventory stand attributes and temporary sample plot data to calculate biomass by tree component

  $Biomass = \beta_1 Diameter^{\beta 2} Height^{\beta 3}$
- Used area seeded and grain production statistics to calculate grain yield by township.
- Applied crop grain to residue factor to calculate total yield.

  $Total = Grain * Crop\ Residue\ Factor$





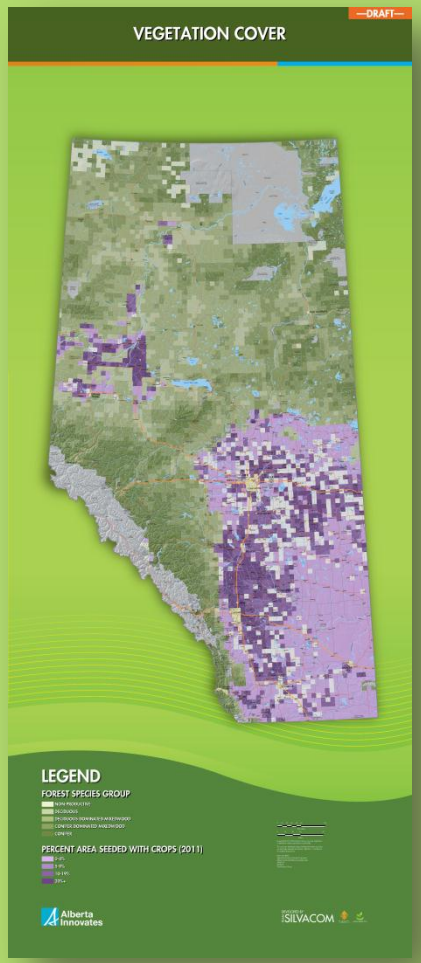
Provincial vegetation cover

Area:
- Entire province

Illustrates:
- Forested townships by average forest species group
- Agricultural townships by crop area seeded

Data:
- Provincial base features
- Alberta Sustainable Resource Development: Phase 3 Forest Inventory
- Alberta Agriculture Rural Development: Agriculture Statistics Yearbook 2010

Analysis:
- Calculated average species group condition by township using inventory attributes
- Calculated area seeded by township



Provincial biomass distribution (by township)

Area:
- Entire province

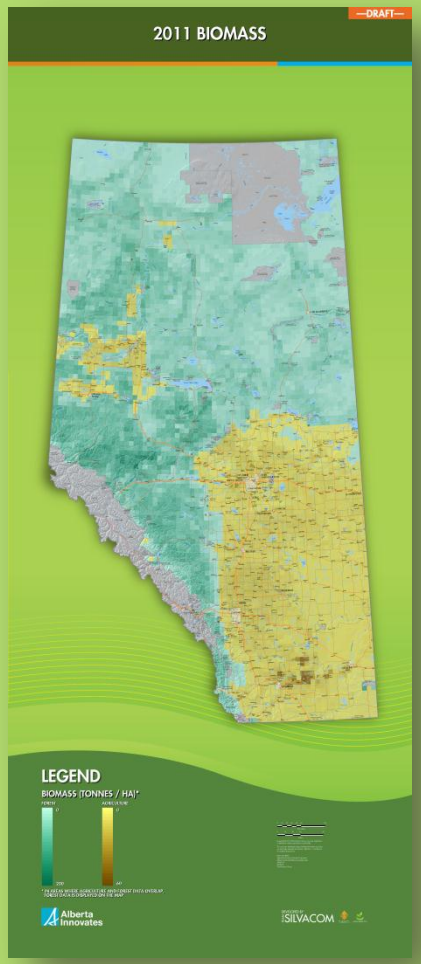
Illustrates:
- Forest biomass productivity and agricultural crop biomass productivity by township

Data:
- Alberta Sustainable Resource Development: Phase 3 Forest Inventory
- Alberta Agriculture Rural Development: Agriculture Statistics Yearbook 2010
- Canadian aboveground forest biomass equations
- Crop grain to residual ratios

Analysis:
- Used forest inventory stand attributes and aboveground biomass equations to calculate tree biomass

  $Biomass = \beta_1 Diameter^{\beta 2} Height^{\beta 3}$
- Used area seeded and grain production statistics to calculate grain yield by township
- Applied crop grain to residue factor to calculate total yield

  *Total = Grain*Crop Residue Factor*



Location of biomass producing and consuming facilities

Area:

- Entire province

Illustrates:

- Location of current facilities in Alberta that consume or produce biomass

Data:

- Alberta Sustainable Resource Development: Biomass producing and consuming facility locations

Analysis:

- Geospatial proximity analysis

Transportation cost surface

Area:

- Entire province

Illustrates:

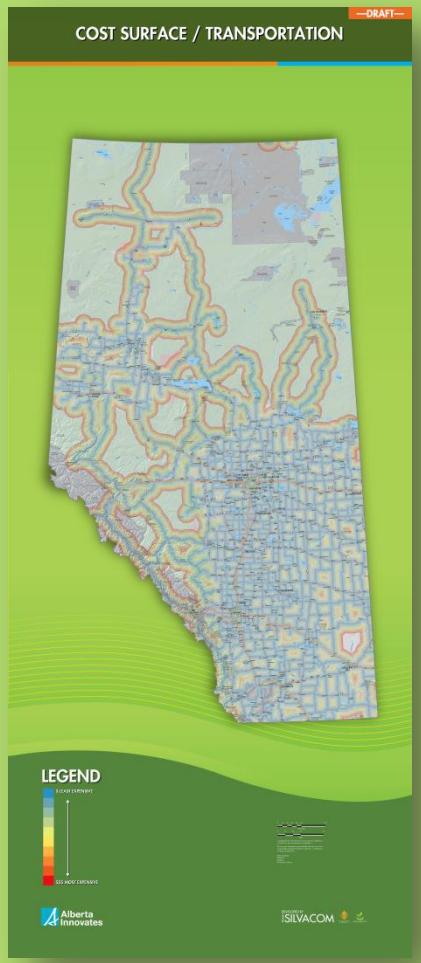
- Relative proximity of areas to the major transportation infrastructure network in Alberta

Data:

- Alberta transportation network

Analysis:

- Geospatial proximity analysis



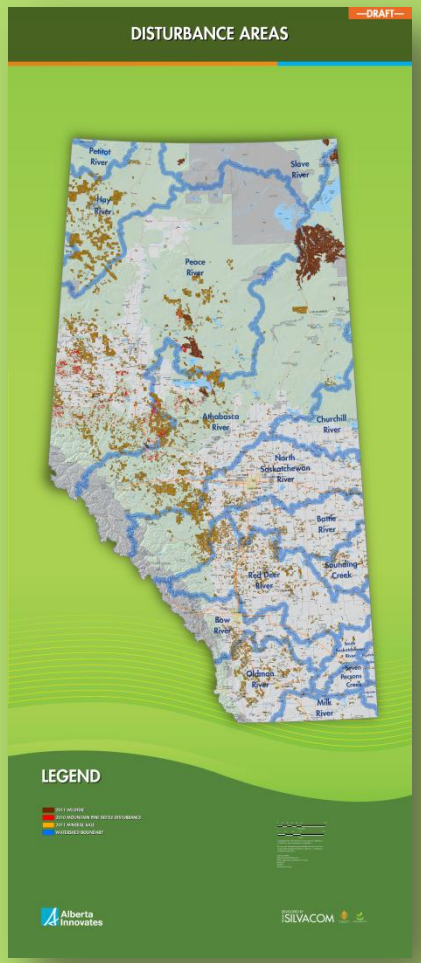
Anthropogenic and natural disturbance areas

Area:
- Entire province

Illustrates:
- Location of potential biomass sources as a result of anthropogenic and natural disturbance areas

Data:
- Alberta Sustainable Resource Development: 2011 Forest Fires
- Alberta Sustainable Resource Development: 2010 Mountain Pine Beetle Disturbance
- Alberta Energy: Petroleum and Natural Gas Sales

Analysis:
- Aggregation and map visualization



Provincial land tenure

Area:

- Entire province

Illustrates:

- Land tenure distribution

Data:

- Provincial base data
- Alberta Environment and Sustainable Resource Development

Analysis:

- Aggregation and map visualization

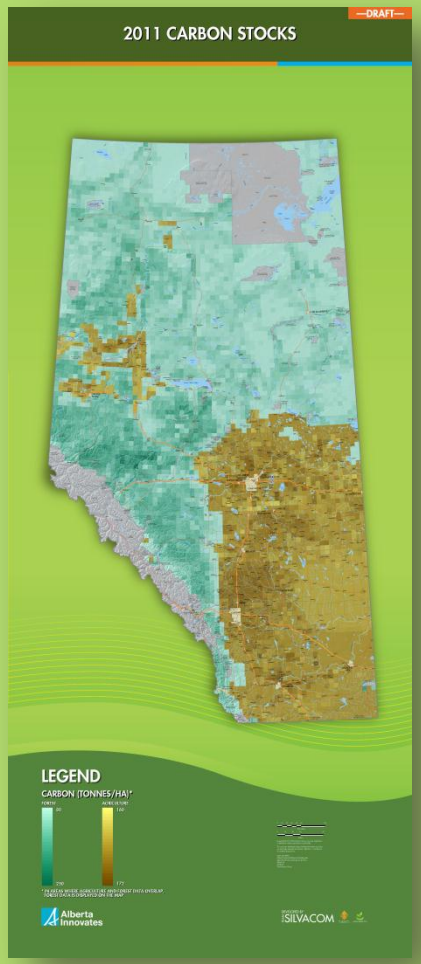
Carbon stock distribution

Area:
- Entire province

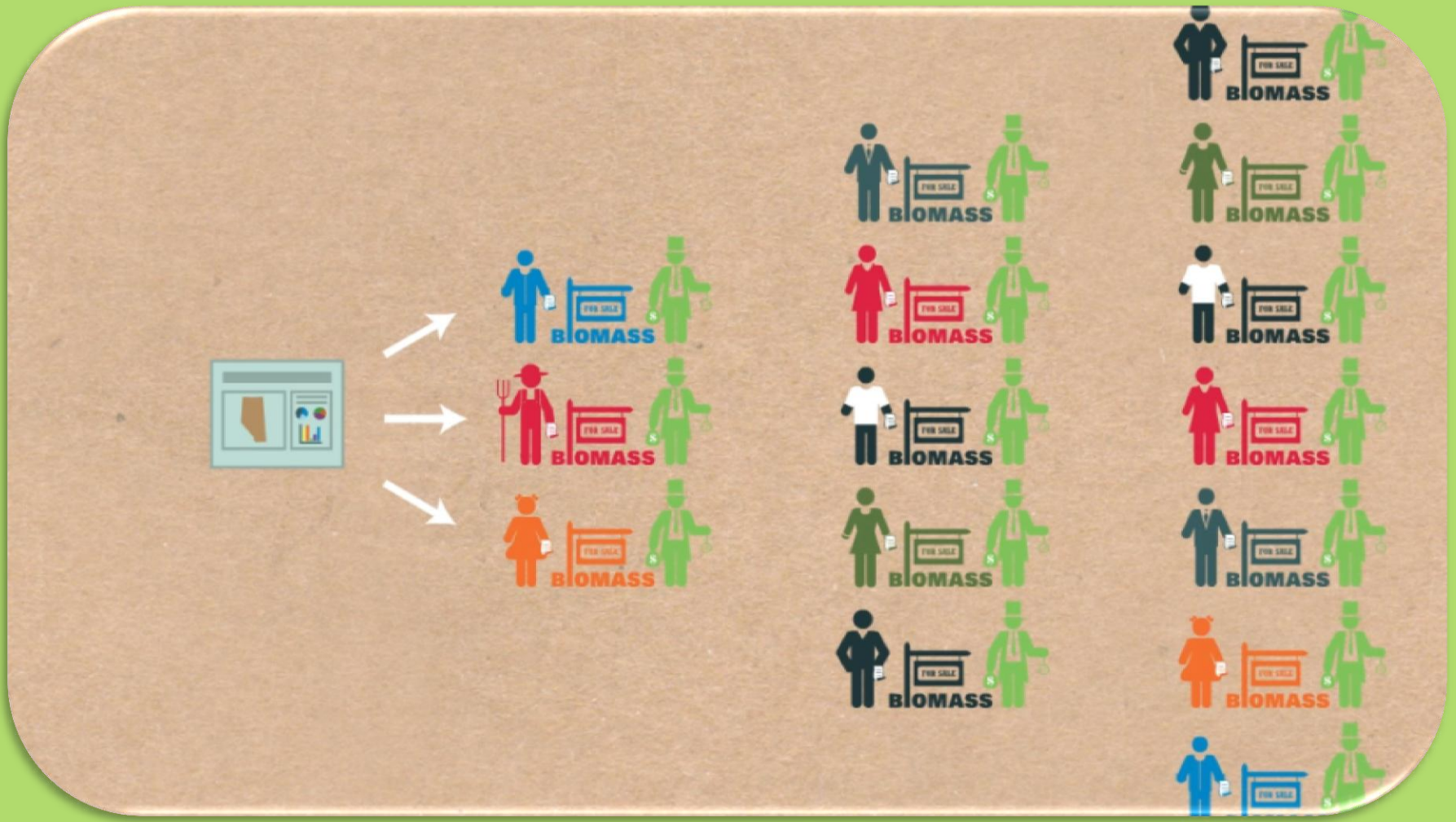
Illustrates:
- Carbon stock yield by township for forests and agriculture lands

Data:
- Alberta Sustainable Resource Development: Phase 3 Forest Inventory
- Alberta Agriculture Rural Development: Agriculture Statistics Yearbook 2010
- Canadian aboveground forest biomass equations
- Crop grain to residual ratios
- Published biomass to carbon ratios and soil carbon estimates

Analysis:
- Calculated carbon yield by multiplying estimated biomass yield by township by the biomass to carbon ratio
- Added soil carbon values to the vegetation carbon estimates



BRIMS – from a business perspective



Buyers and sellers collaborate and develop opportunities using online tools

"Prospectus Generator"

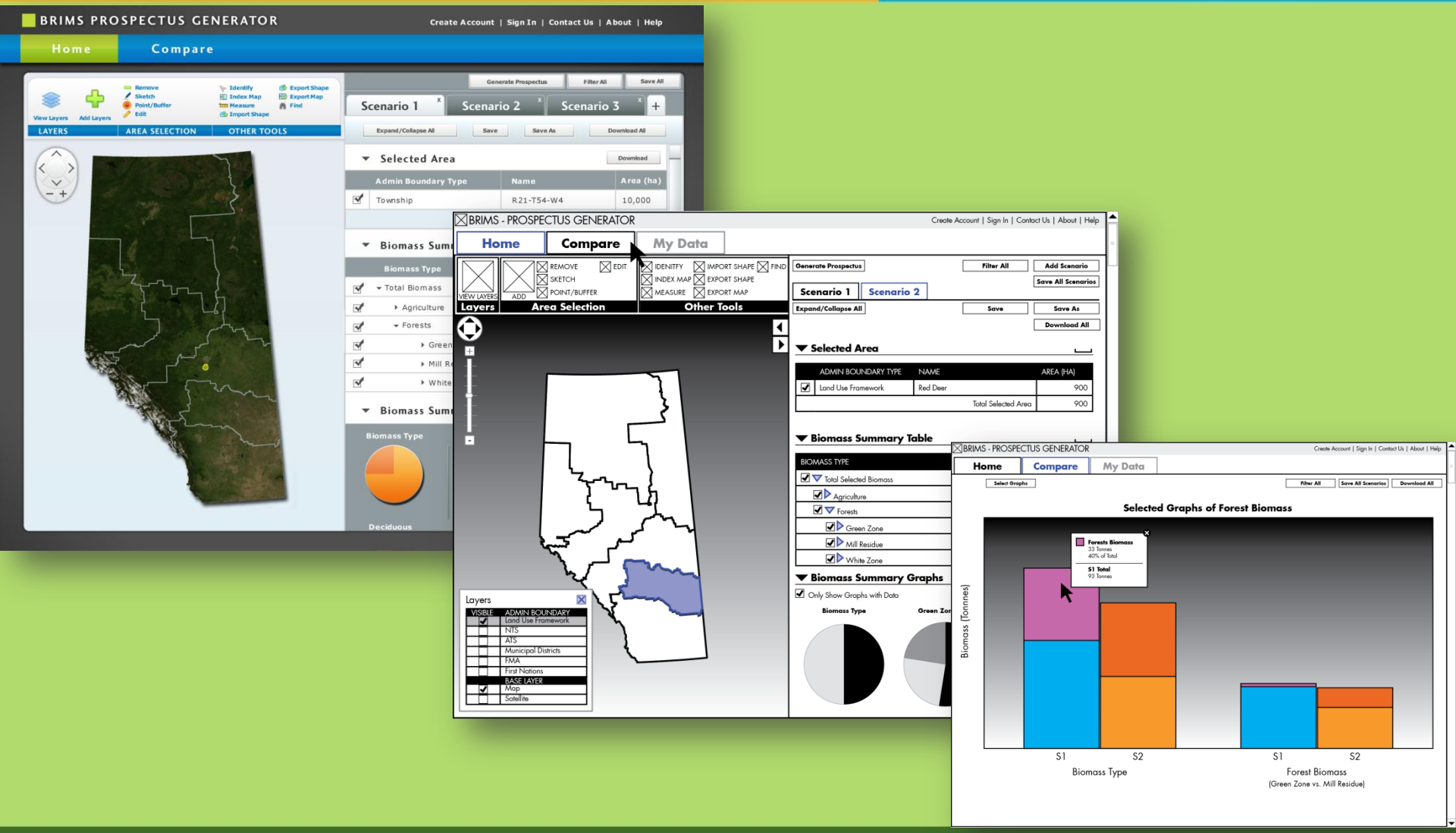
Innovative web-based approach for:

- Data capture, management and distribution
- Display and scenario analysis of biomass for user-defined areas
- Extension and inclusion of other ecosystem services

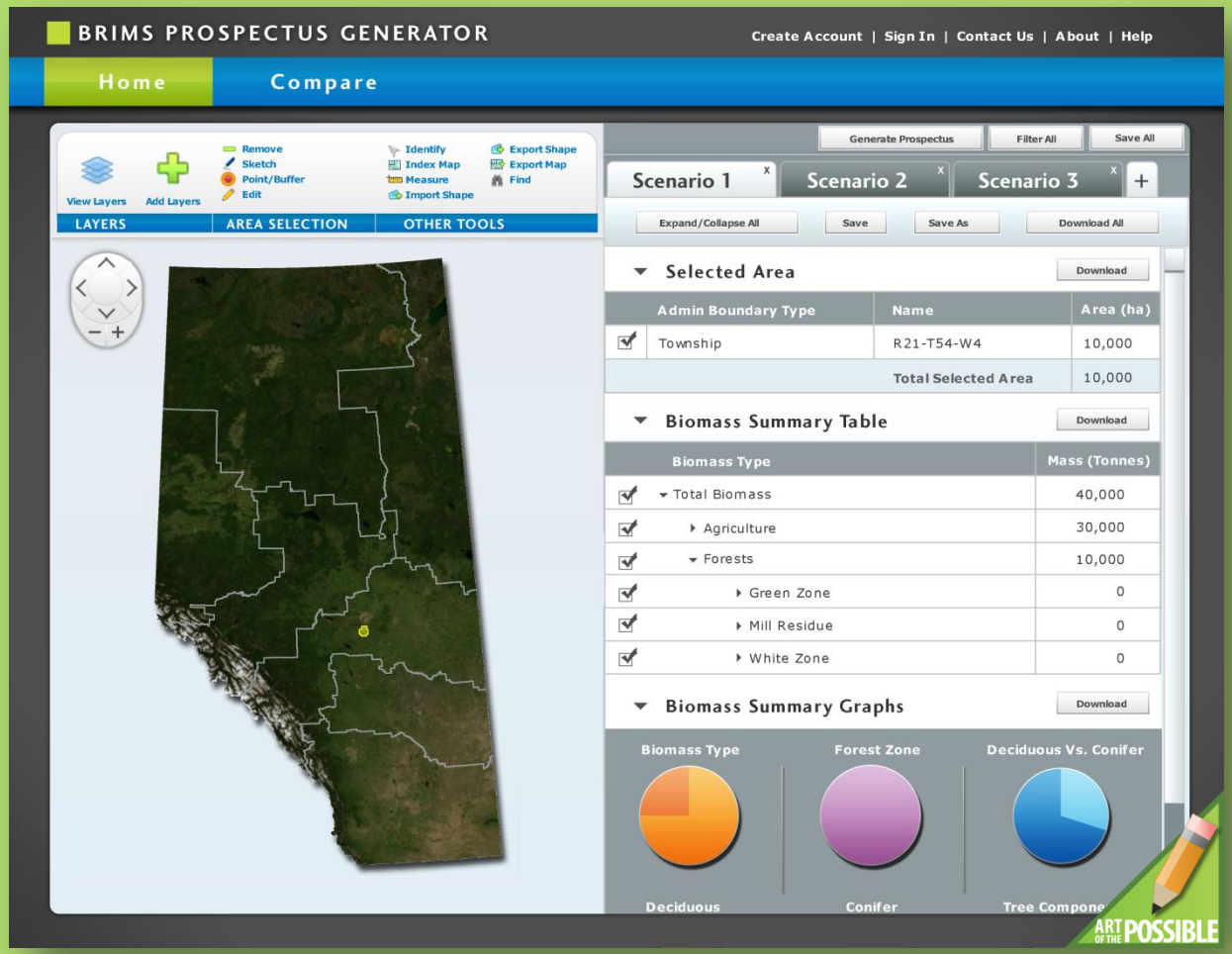
Functionality includes:

- Data organization and storage
- Analytical tools to evaluate business opportunities related to forest and agriculture biomass aggregated at varying resolutions:
  - Local (e.g. township)
  - Regional (e.g. county or municipal district)
  - Provincial

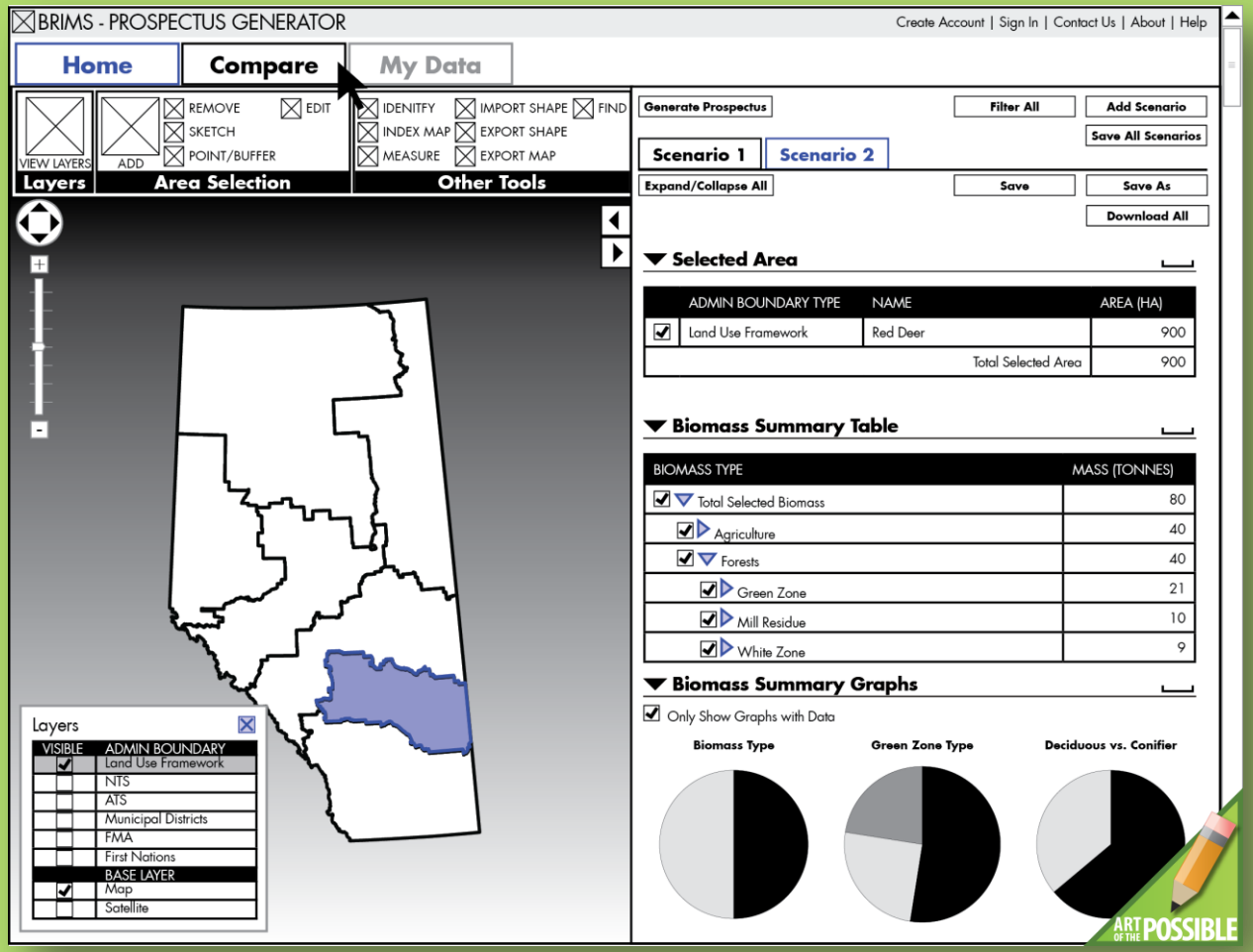
BRIMS "Prospectus Generator"



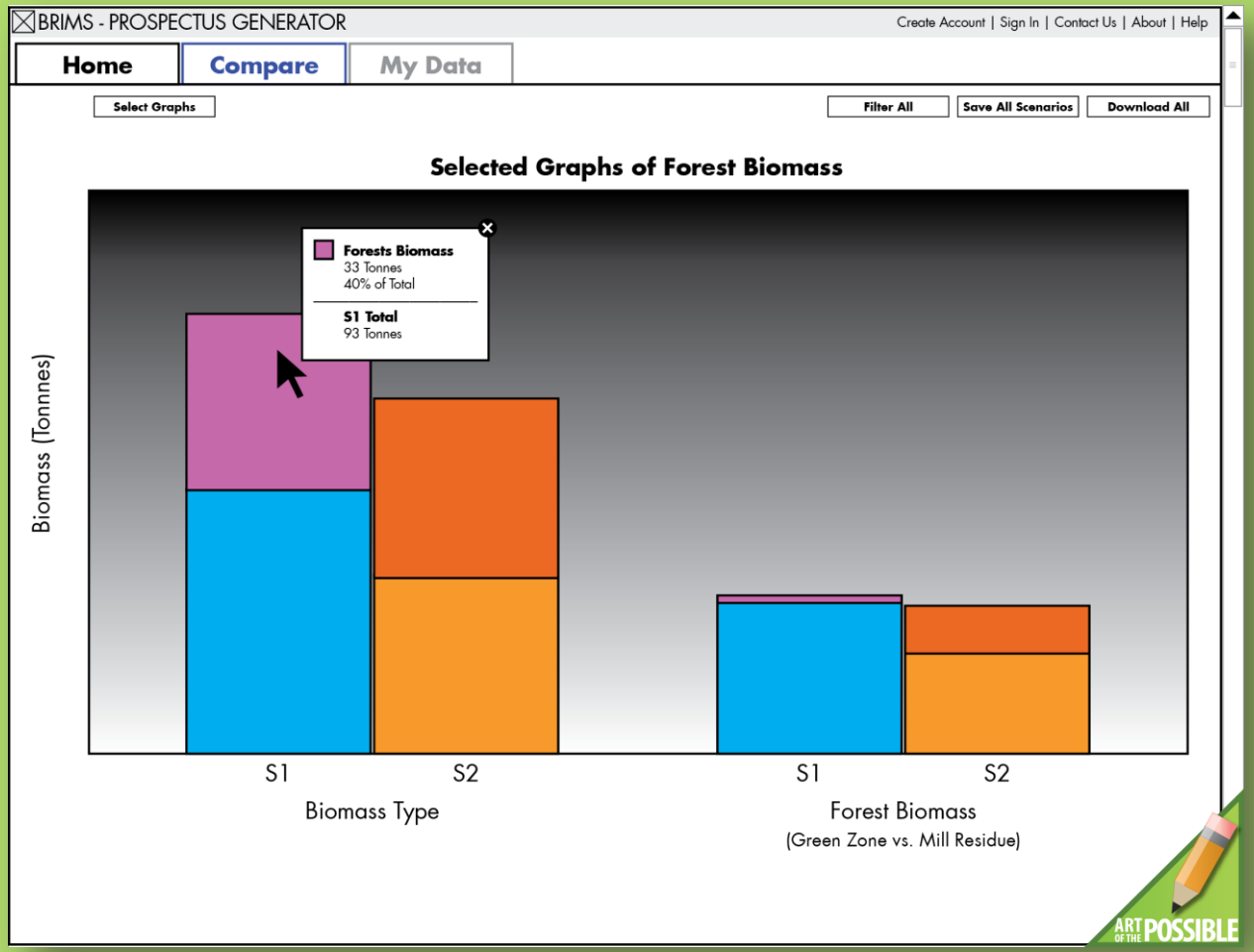
BRIMS Prospectus Generator



Easy to navigate & Generate Prospectus'



Compare and drill down



Communication strategy

Animated video describing Ecosystem Services and the importance of Alberta Innovates' BRIMS initiative:

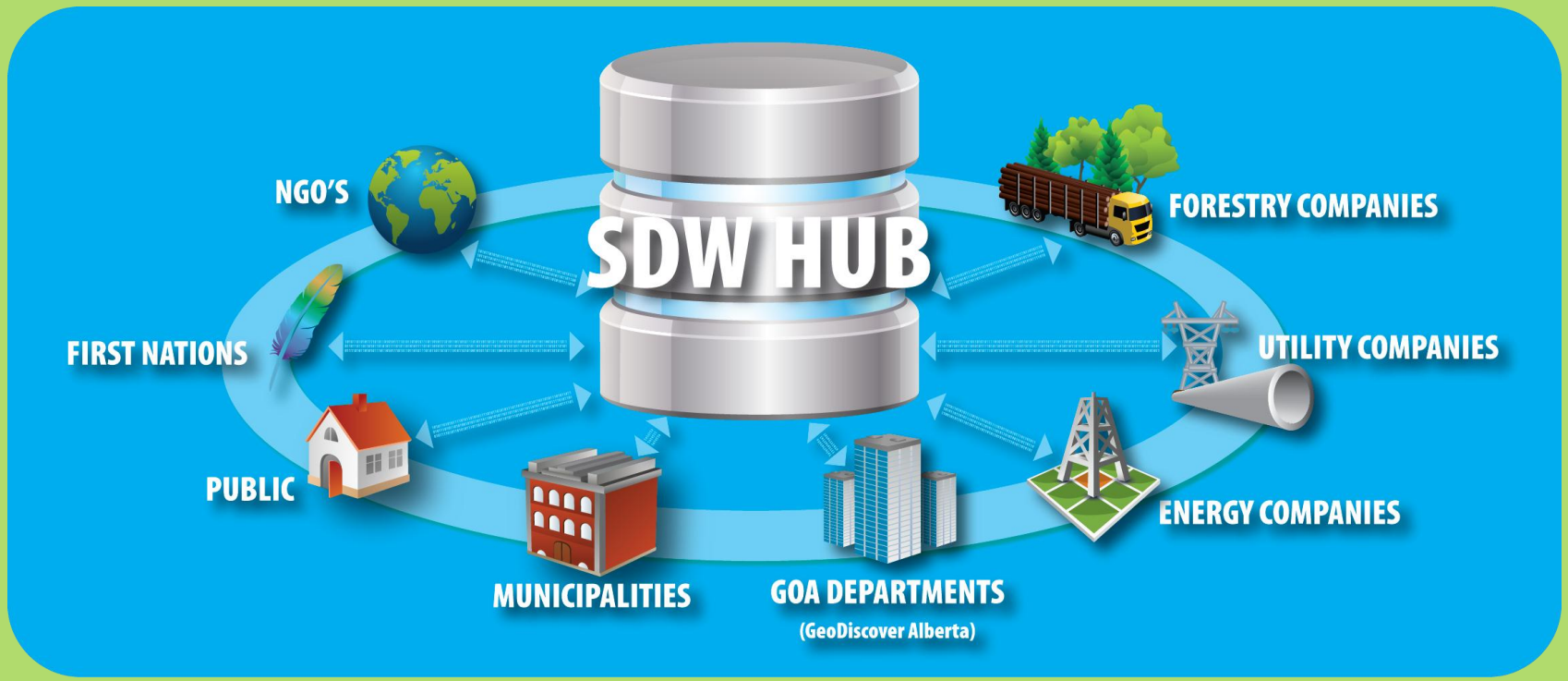
Check it out on Youtube at:

http://www.youtube.com/watch?v=-Jw9dPYVT_Y

BRIMS Phase 1 accomplishments

- Identified best practices for biomass inventories through a comprehensive literature review and jurisdictional scan
- Established working relationships and data-sharing agreements with corporate, provincial and federal sources of forest and agricultural biomass information
- Defined a comprehensive and data-centric framework for biomass information
- Provided a clear blueprint for standardizing and integrating large, complex data sets spanning forested and agricultural land bases
- Designed an innovative web portal for:
  - Generating user-defined biomass prospectuses
  - Analyzing business scenarios
- Formulated a workable distribution and sustainment model
- Introduced a new way of communicating complex ideas about ecosystem services through an animated video

Sustainment using Spatial Data Warehouse - The Information HUB for Geospatial Data in Alberta



Spatial Data Warehouse Layers

Current SDW/AltaLIS Data Sets

- DIDS Mapping (Crown Land Disposition Polygons)
- Titles Mapping (Extent of Ownership Polygons)
- Cadastral Compiled Plans of Survey

- 1:250,000, 1:1m and 1:2m topo maps
- Original Cad Topo Mapping Files
- GIS Topographic Data Set (Access and Hydrology Layers)

- GIS Polygons for Townships, Sections, Quarter Sections, LSDs and Road Allowances

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- Official Alberta Township Grid (Survey Monuments)

Extended Value-Added Layers

Environmental Features:
- Automated Anthropogenic Updates
  - Disturbance Updates
  - "As - Builts"
- Cumulative Effects
- Biodiversity Values
- Environmental Risk (sensitive sites, rare plants)
- BRIMS biomass products/services
- Vegetation Inventory
- Physiographic Features
- Water Features (basin, wetlands, navigable watercourse, fish-bearing streams)
- Environmental Inspections
- Agricultural Classification

Social Features:
- Community/Municipal Assets
- First Nation Traditional Use Areas
- Protected Areas
- Recreational Areas (parks, wilderness)
- Viewsheds
- Health/Epidemiology

Economic Features:
- Surface Resources (water, forestry, agriculture, biomass)
- Sub-Surface Resources (oil, gas, gravel)
- Industrial Activity
- Transportation Assets
- Tourism Features
- Municipal Assets
- Airsheds
- Registries

Additional Foundational Information

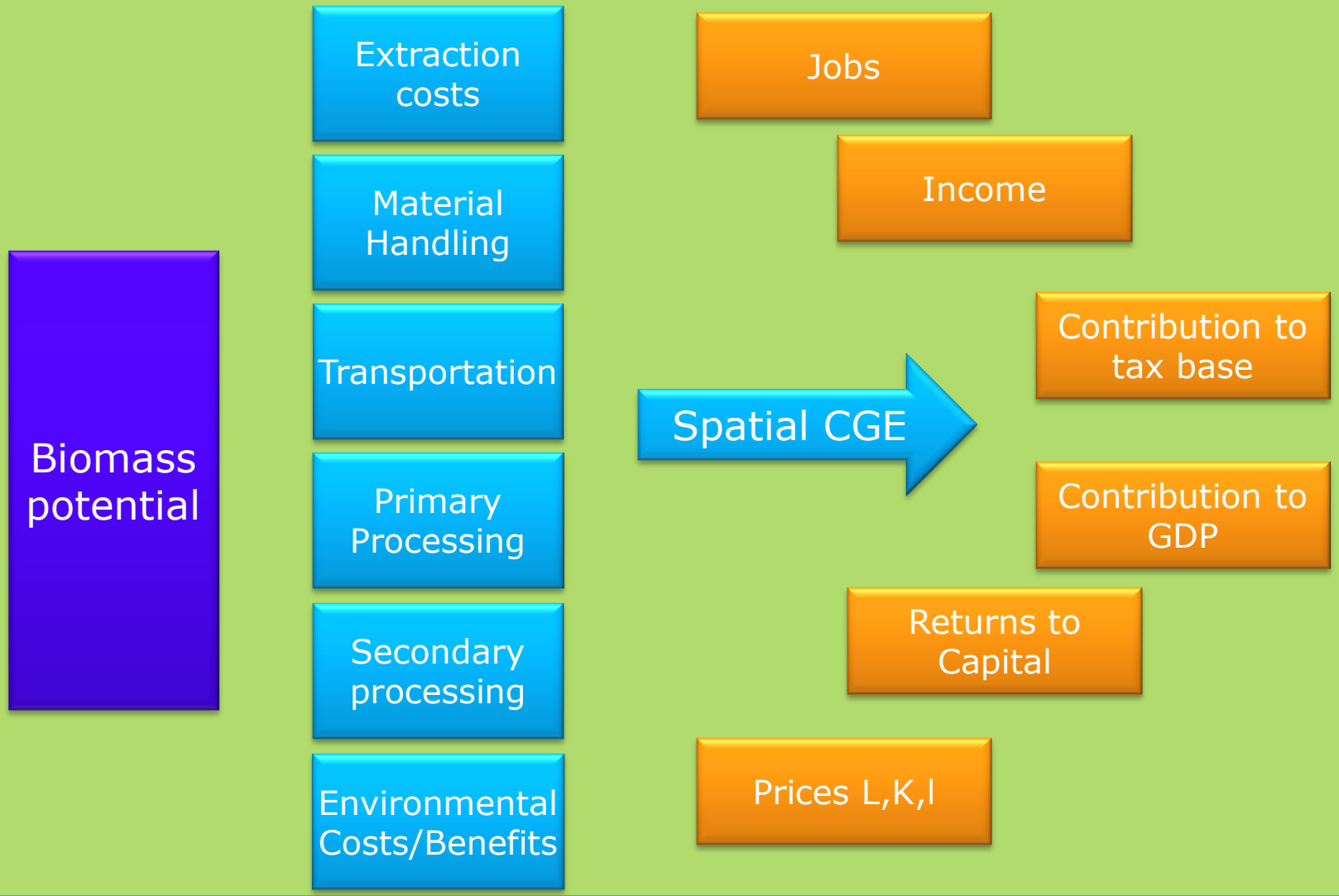
- High Resolution Multispectral imagery
  - Orthophoto
  - Stereo-pairs (soft copy interpretation)
  - Information Cloud (4 band digital surface model)
- LiDAR
- High Resolution DEM (digital elevation model data)

Foundational Data Sets Already Managed and Distributed by SDW/AltaLIS

Next Steps: BRIMS Phase 2

- Extend and formalize working relationships and data-sharing agreements with provincial and corporate biomass information sources in the forestry, agricultural and municipal sectors
- Capitalize on proof-of-concept designs and data visualization to:
  - Operationalize the collection, distribution and analysis of biomass feedstocks from multiple sources
  - Build and deploy BRIMS' online Prospectus Generator
  - Leverage new science related to feature identification from high resolution multispectral imagery
- Extend BRIMS data information and distribution approach to additional Ecosystem Services

Looking forward: socio-economic assessment



Ecosystem service assessment & trade-off tool

Acknowledgements

- Alberta Innovates Bio Solutions
- Alberta Newsprint Company
- Agricultural Finance Services Corp
- Agriculture and Agri-food Canada
- Alberta Environment and Sustainable Resource Development
- Alberta Enterprise and Advanced Education