# Forecasting & Measuring Outcomes of Energy Efficiency & GHG Emission Reduction Initiatives

Newfoundland Labrador

## Macro Models and Data Review

June 10, 2011

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# Agenda

| | |
|---|---|
| 1. Review and Overview | 9:00 - 9:15 |
| 2. Macro Models – Multi-fuel, multi-sector | 9:15 – 10:15 |
| 3. Break | 10:15 -10:30 |
| 4. Data Issues, Sources and Development | 10:30 -11:30 |
| 5. Next Steps & Discussion | 11:30 to Noon |

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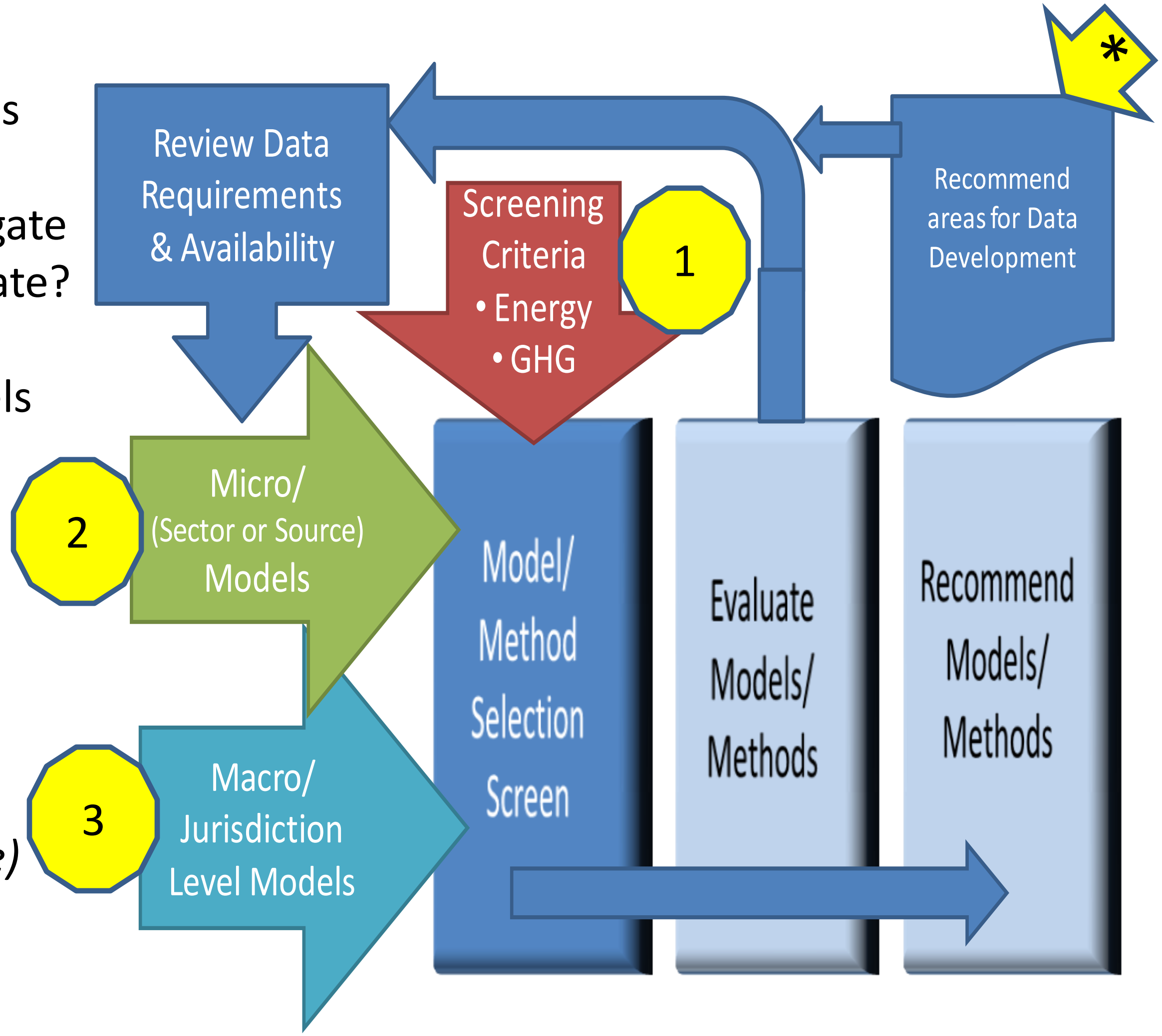
# Review & Overview

# Proposed Review Process

1. CCEEET Objectives/criteria
2. Identify/review Micro models
   - Identify/Screen
   - Present list (5-6) to investigate
   - Review -Applicable? Accurate?
   - Data requirements/issues
3. Identify/review Macro models
   - High level inventory
   - Identify/summarize
   - Linkages to micro?
   - Review/compare using CCEEET criteria/objectives.
   - "Fit" with current tools?
   - Identify data needs/issues

   *(expect data to be a key issue)*
4. Develop Draft/Final Reports

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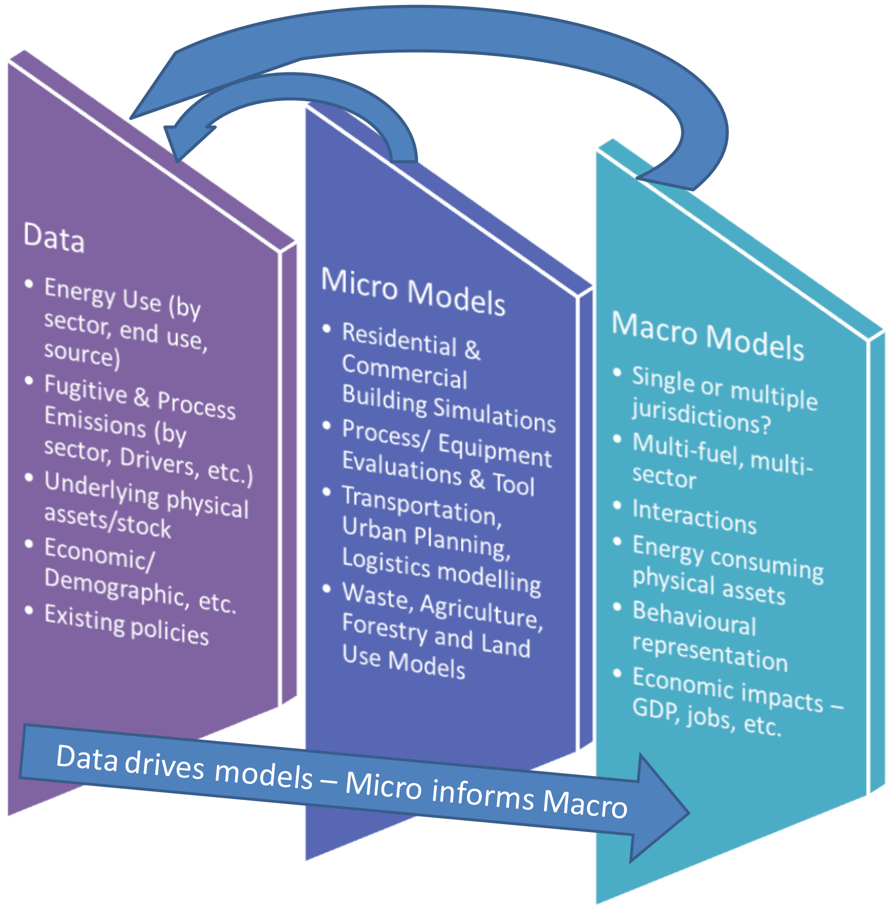
# Model & Data Interactions

- ✓ Macro/jurisdictional level models provide 'big picture'.
- ✓ Micro models fill in the details - more specialized and granular.
- ✓ Quality and appropriateness of data determines realism of model results.
- ✓ Interactions important at both micro and macro levels.
- ✓ Data availability may limit model effectiveness.
- ✓ Need to ensure consistent data/assumptions between micro and macro models.

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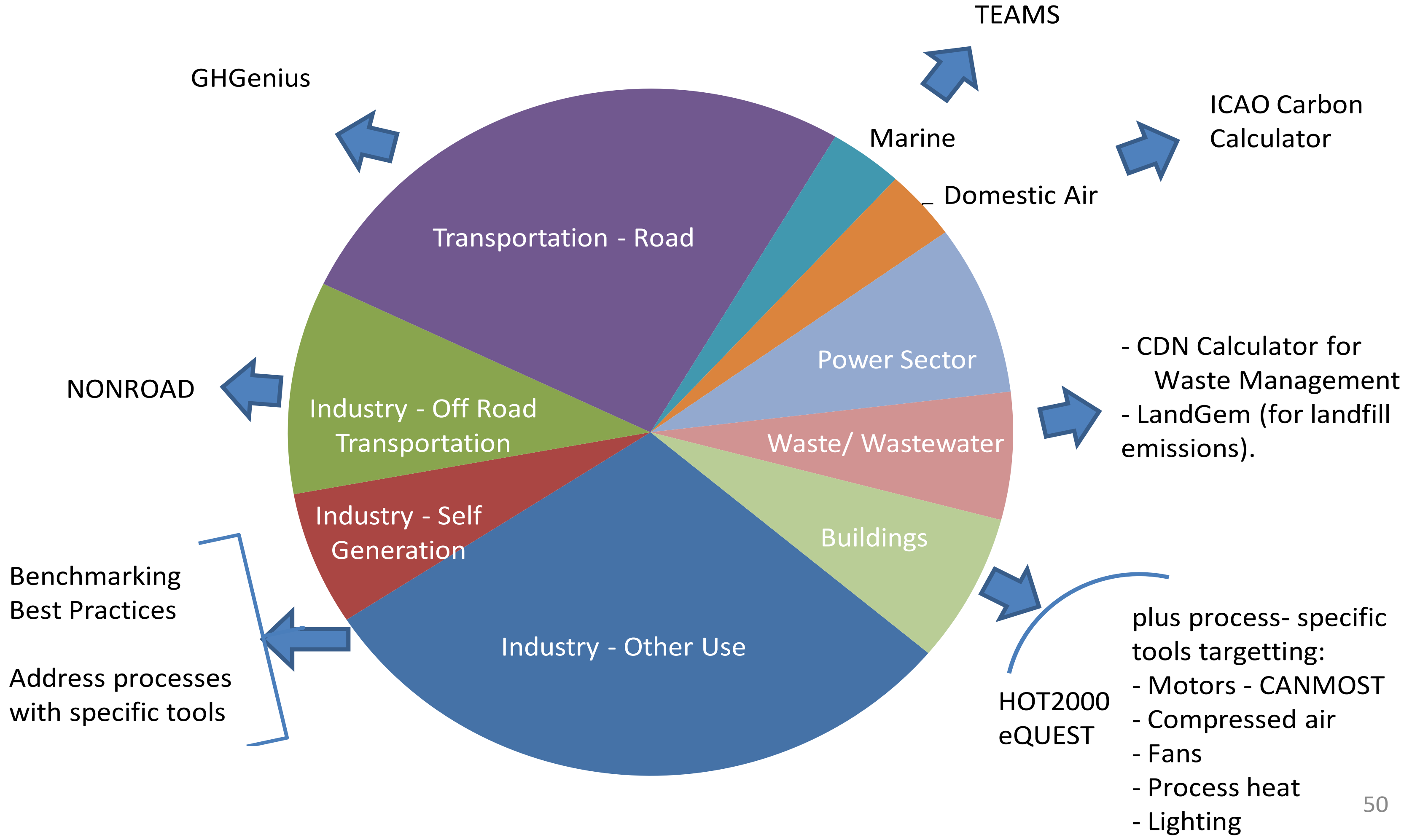
# Recommended Micro Models – Mapped to NL Emissions

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# Feedback from Other Governments

| Level of Government | Models Used |
|---|---|
| Federal | • Natural Resources Canada's Office of Energy Efficiency has developed or adapted a number of energy models that are available from their website. A number of these are referenced in the discussion of Micro models.<br>• Environment Canada uses several macro level models to review energy and emissions impacts of policies affecting different sectors, including **ENERGY2020**, and **Maple-C**. ENERGY2020 is run as an integrated package with TIM (The Informetrica Model) referred to as E3MC. |
| BC | • Economic forecasting – Informetrica and DGEEM<br>• Have used both **CIMS** and **ENERGY2020** for energy forecasts/scenarios. CIMS has also been used to analyze transportation energy policies. DGEEM (*Dynamic Computable General Equilibrium Emissions Model*)has been used for both macro-economic and energy modelling.<br>• Also used DGEEM for modelling effects of carbon pricing. DGEEM developed by MKJA for use with CIMS model.<br>• Have also used **HOT2000** and **RETScreen**. |
| AB & MB | • No response to-date. |
| SK | • Several "micro" models used, including **HOT2000, RETScreen, EE4, eQUEST, GHGenius** and WindPRO (*described as significantly more detailed commercial program for wind project evaluation*).<br>• In-house macro economic model (called *Ernie*) used by SK Finance and Enterprise Saskatchewan (I/O model).<br>• **ENERGY 2020** used by SK Energy and Resources<br>• **Markal** (last updated 2002)<br>• CIMS model has been used to do some GHG policy modelling.<br>• O&G Production forecasts from private sector forecasters and In-house models of oil and gas supply which track production by field.<br>• SaskPower currently uses Excel-based models for energy forecasting, **PROMOD** and MARS (Multi-Area Reliability Simulator) for reliability modelling. |

# Feedback from Other Governments

| Level of Government | Models Used |
| --- | --- |
| ON | • Economic forecasting – Ontario Multi-Sector Economic and Government Analysis Model (**OMEGA)** used by Ministry of Finance (in-house model).<br>• Energy forecasting – OMEGA used by Finance and **EnerPrise** Market Analytics (Ventyx software) used by Ontario Finance Authority.<br>• Known to have used **ENERGY2020** for policy modeling and as part of WCI.<br>• Building Energy – **HOT 2000**<br>• Renewable Assessments – **RETScreen**<br>• Transportation – MOBILE 6 (M. of Env.) and **GHGenius** (M. of Energy)<br>• W & WW – **CanWet** (Canadian Nutrient and Water Evaluation model).<br>• Power sector – EnerPrise Market Analytics and OPG Pricing Model (PRIMO – an in-house model).<br>• OPA reports using **C4SE**, **Informetrica, CIMS, HOT2000** and **RETScreen**. Power sector-specific models used include **UPLAN** and **MARS**. The OPA also uses a number of self-developed spreadsheet models and is developing an energy demand forecasting model. |
| QU | • Economic forecasting – use Informetrica and DOE projections for oil and gas prices.<br>• Energy Forecasting – **In-house model** for energy demand by sector (transportation, buildings, industry, etc.) which also covers GHG emissions (covers both energy and non-energy emissions).<br>• Power Sector – Govt. departments don't do supply side forecasting. Use utility forecasts submitted to *Régie de l'énergie.* |

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# Current Energy Models Used in NL

- Dept. of N. Resources - econometric energy model
- Department of Finance - macroeconomic model
- NL Hydro - electricity forecast
- Newfoundland Power - electricity forecast

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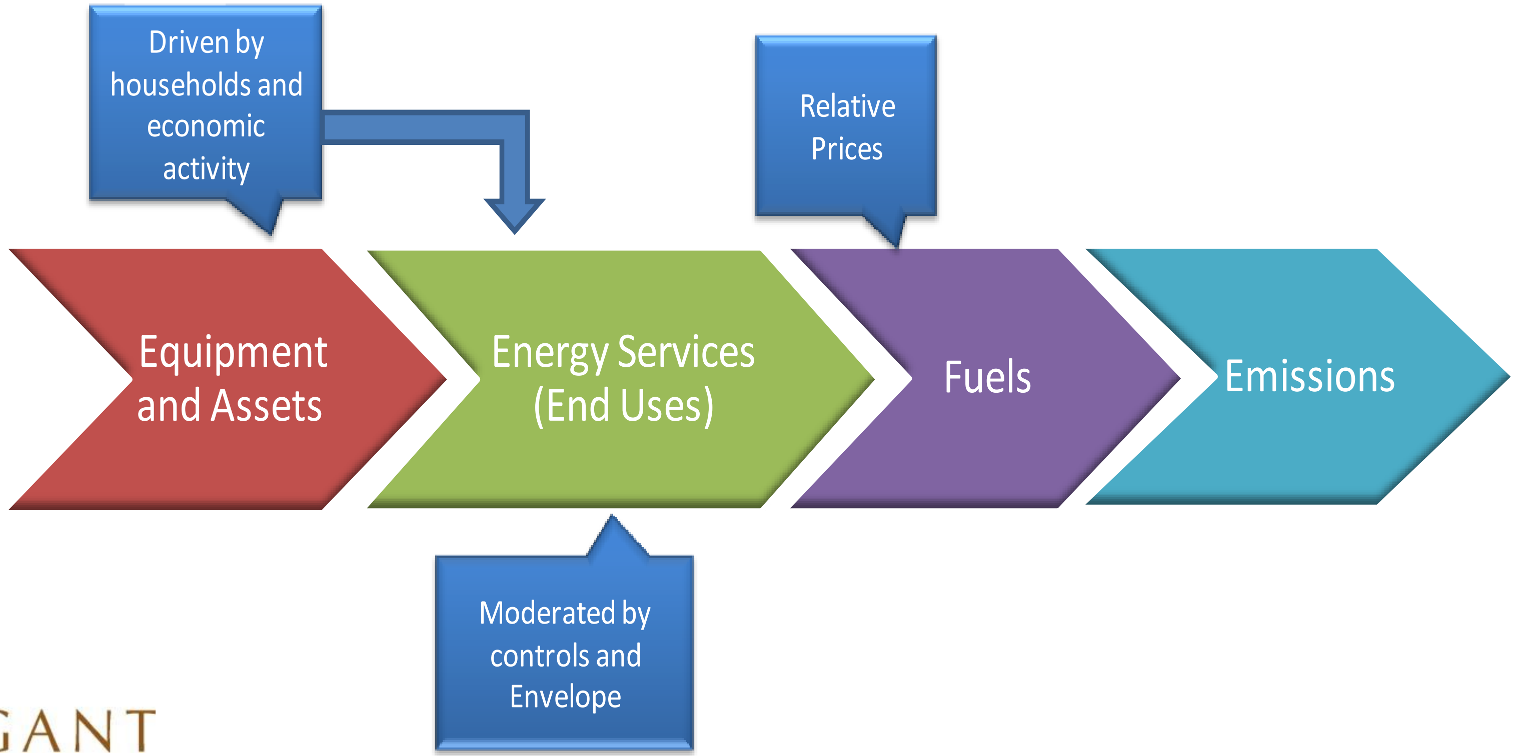
# Macro Models

## *Multi-Fuel Multi-Sector Models of Energy Supply and Demand*

# Macro Models

- Models are attempts to represent energy use and key drivers/influences. Level of representation differs between models. Key elements shown below.

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# Macro Models - Limitations

- What models can (*and can't*) do
  - Model *will NOT* accurately predict the future - provides realistic framework for comparing policy impacts.
  - Allows testing of alternative scenarios.
  - Won't reliably predict behaviour of individual players ("Large Industry" (LI) challenge).

*Recommend:*

- *Scenario approach – rather than 'forecast' - given large uncertainties in LI sector*.
- *Individual consideration of LI's – model can provide some guidance*.

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# Macro Models – Value

- Project how energy use will change as trends unfold, assets turnover, and economic, demographic and other factors interact over time
- Estimate impact of alternative policies on levels of energy use (and emissions) – may provide impact on investments, prices, revenues, employment, etc..
- Calculate effect of policy interactions (i.e. vehicle efficiency, personal travel and fuels).
- Indicate counter intuitive or unexpected impacts (i.e. truck speed).
- Repository/organizing framework for data.
- Common model/framework could be used for policy analysis, energy/electricity forecasting and CDM assessments.

# Forecasting Best Practices

- Hybrid energy-economy models found most effective in projecting GHG forecasts.
- Adequate resourcing to keep data current.
- Single agency to coordinate; with authority to question forecasts.
- Regular review and evaluation.
- Transparency and clarity w.r.t. assumptions and methods.

# Macro Model Dimensions

## Approach

- Structure
  - *Top Down*
  - *Bottom Up*
  - *Hybrid*
- Decision Making Framework
  - *Realistic*
  - *Economic*
  - *Optimal*
- Forecast vs. Scenario

## Scope & Coverage

- Geographic
- Demand
  - *Sectors/End Uses/ Technologies*
- Supply/Power Sector
- Non-Energy Emissions
- Carbon Trading
- Temporal (*granularity and period modelled*).

## Ease of Use & Transparency

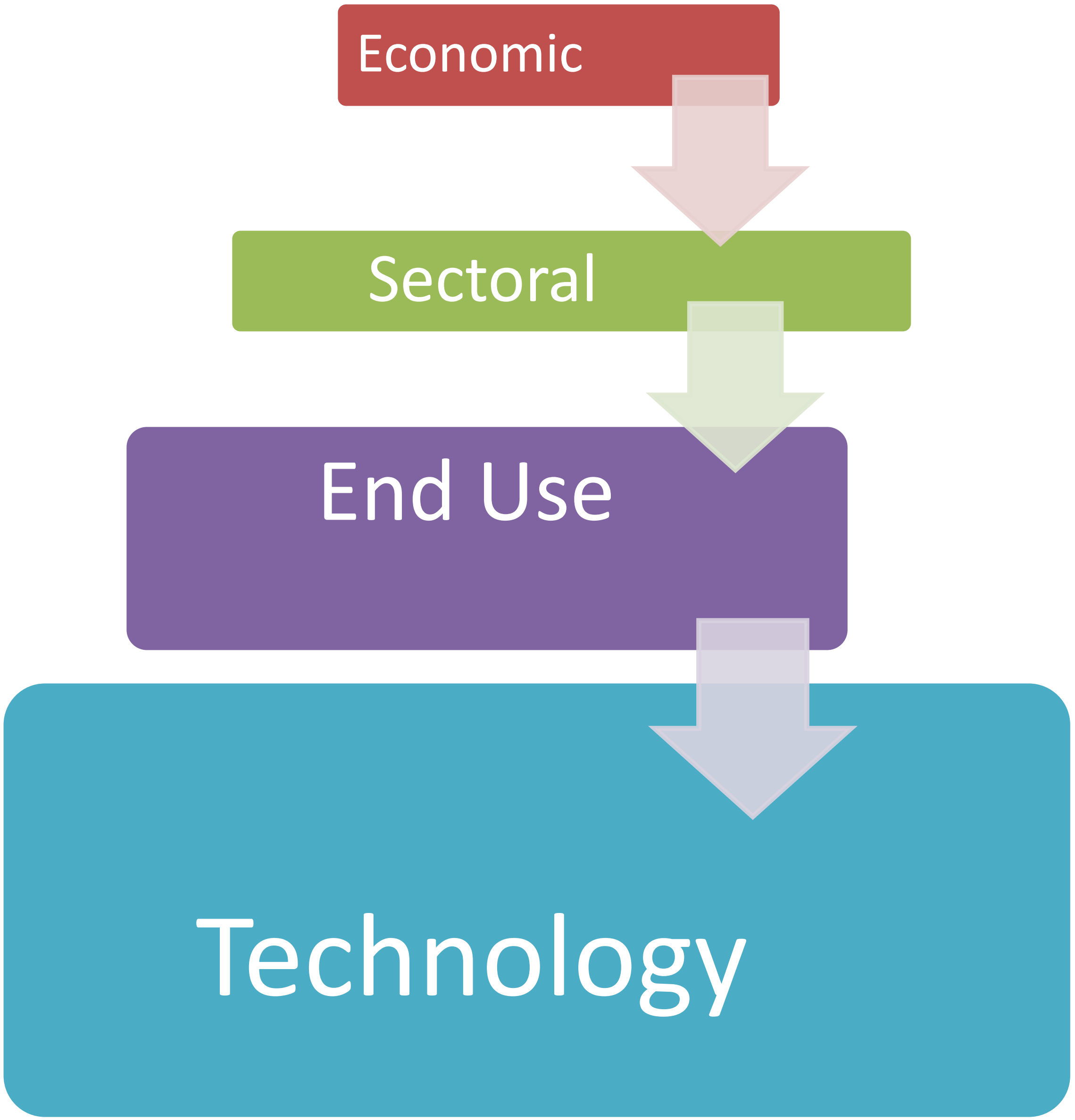
- Operating System/Software
- Ease of Operation
- Form and content of outputs.
- Documentation.
- Transparency – model structure & assumptions.

## Cost & Resources

- Licence Fees
- Cost for Custom NL Model
- Training required.
- Cost to operate and maintain model.

**Warning:**

Data requirements increase dramatically as modelling extended to more detailed representation of energy use and energy consuming physical assets.

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# Macro Models

- Reviewed models used in Canada & US/ Internationally – on dimensions listed earlier:

| Multi-Sector Energy & Emissions Models | |
|---|---|
| **Models Applied in Canada:** | **US & InternationalModels**<br>(not applied in Canada) |
| CIMS | IPM (IPM+) |
| CanESS | LEAP |
| ENERGY2020 | NEMS<br>(National Energy Modelling System) |
| MAPLE-C | |
| MARKAL | |

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# Macro Models

- Report recommends three models for consideration (*in alphabetic order*):
  - ✓ CanESS /whatIf? Technology
  - ✓ CIMS / M K Jaccard and Associates
  - ✓ ENERGY 2020 /Systematic Solutions Inc.
- Not recommended:
  - X Maple-C – 11 region model, costly to maintain for NL,
  - X Markal - optimization model not appropriate to NL needs,
  - X NEMS and IPM+ - not available for Canada,
  - X LEAP – tool rather than a model, no CDN applications.

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| Model | CanESS | CIMS | ENERGY2020 |
| --- | --- | --- | --- |
| **Background & Approach** | | | |
| **Developer** | ***whatIf? Technologies***<br>Ottawa, Ontario<br>Founded in 1989 (as Robbert Associates).<br>Contact: Michael Hoffman, Principal | Energy and Materials Research Group (EMRG) at Simon Fraser University *and* ***M.K. Jaccard and Associates(MKJA)***<br>Contact: Mark Jaccard, President, MKJA. | ***Systematic Solutions, Inc.***<br>*(SSI), Fairborn, Ohio*<br>*Founded 1985*<br><br>*Contact: Jeff Amlin, President*<br>Now located in Xenia, Ohio |
| **Model Description** | A **scenario** model with rich representation of physical assets which drive energy consumption. Based on software platform designed for model development and scenario analysis. | *A technology-vintage model that* ***forecasts*** *emissions via the turnover of energy-using and energy-supplying technology stocks. CIMS models consumers' choices of new technologies .* | *A technology-vintage model that* ***forecasts*** *emissions via the turnover of energy-using and energy-supplying technology stocks. ENERGY2020 models consumers' choices of new technologies.* |
| **Modelling Approach** | **Bottom up scenario model** of energy demand and supply. CanESS keeps track of the physical stocks and flows of energy feedstocks and fuels, the stocks of capacity for producing energy and the stocks of artefacts such as vehicles, hot water heaters, HVAC systems, and appliances that use energy in the production of services.<br>The model is calibrated with historic data from 1976 to 2006 to ensure model is aligned with historic stocks and flows and runs in 1 year steps to 2100. | **Hybrid** – top down equilibrium economic model with macro-economic demand feedback and demand-dependent supply and energy trade. Assumptions built into model w.r.t. changing urban planning/land use and impacts on energy demand. | **Hybrid** – bottom up representation of demand and supply sectors with QCT-based behavioural/decision making framework and optimized power system dispatch. Economic feedback provided by linking to macro-economic model. |

| Model | CanESS | CIMS | ENERGY2020 |
| --- | --- | --- | --- |
| **Decision-making Representation** | Representation of physical energy using assets intentionally modelled separate from behaviour and decision-making. Modeller can exogenously determine future market choices under different scenarios or apply alternative behavioural/decision-making frameworks to marginal changes in physical assets. | Models technology choice based on approach used in predecessor ISTUM[1] models; simulating purchase decisions based on "observable" and intangible costs and risks[2]. | Qualitative Choice Theory (QCT) used to provide realistic representation of consumer and business decision making. |
| **Past Canadian Clients** | • Alberta Department of Energy<br>• Alberta Energy Research Institute<br>• Natural Resources Canada<br>• Energy Futures Network<br>• National Research Council<br>• Pembina Institute<br>• Transport Canada (CanTEEM model; predecessor of CanESS) | • BC Climate Action Secretariat<br>• BC Hydro<br>• Alberta Energy/ Alberta Environment<br>• Alberta Innovates<br>• NWT Government<br>• NRTEE<br>• Natural Resources Canada<br>• Environment Canada<br>• Canadian Gas Association<br>• NL CCEEET<br>• SK Ministry of the Environment<br>• The Pembina Institute<br>• The David Suzuki Foundation<br>• Ontario Power Authority<br>• Ontario Power Generation<br>• Atlantic Canada Opportunities Agency. | • Environment Canada<br>• National Energy Board<br>• Ontario Ministry of Environment<br>• National Round Table on the Environment and the Economy<br>• Province of Alberta<br>• SK Energy and Resources |

[1] ISTUM – Intra-Sector Technology Use Model
[2] See Appendix B. From SFU EMRG CIMS website: http://www.emrg.sfu.ca/Our-Research/Policy-Modelling .

| Model | CanESS | CIMS | ENERGY2020 |
| --- | --- | --- | --- |
| **Scope & Coverage** | | | |
| **Geographic Coverage** | Model broken out into 10 regions (provinces) with territories aggregated with BC. | *Seven regions: BC, AB, SK, MB, ON, QC, aggregation of Atlantic Provinces.* | Covers all 10 Canadian provinces, and 3 territories (aggregated with BC), and 50 US States as well as Mexico. Can be configured to model a single province or region. |
| **Adaptable to NL** | CanESS has a representation of NL based on a combination of national and available provincial level data. Much of information for NL is confidential in national sources, so data currently in model represents a best estimate. A stand -alone NL-specific model could be created and the model re -calibrated using NL specific data if better data is available. | Yes.<br>*NL-specific model does not exist but is possible.* | *Yes.*<br>*No NL-specific model exists but company claims it can produce a custom-tailored NL.*<br>ENERGY2020 models are often built for specific jurisdictions or regions as required. |
| **Demand Sector Representation** | Detailed representation of demographic and economic drivers, and physical stocks of energy consuming equipment.<br>• Residential – 3 dwelling types and 100 thermal archetypes.<br>• Commercial – 10 building types.<br>• Industrial - 9 sub-sectors (2-digit NAICS) plus separately modelled energy producing sectors (8 - 10).<br>• Transportation – split by passenger and freight, 6 modes. | Four demand modules:<br>• Residential – 4 housing types<br>• Commercial – 10 sub-sectors<br>• Industrial – 7 sub-sectors; plus 4 energy producing sectors.<br>• Transportation- split between passenger and freight. Five modes represented with sub-sets for some modes (i.e. light duty and transit passenger vehicles). | • Residential – 3 classes<br>• Commercial – 16 sub-sectors<br>• Industrial – 10 sub-sectors (23 in US)<br>• Transportation – 7 modes (on/off road, rail, marine, air, bus, etc.).<br>• Split between passenger and freight. |

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| Model | CanESS | CIMS | ENERGY2020 |
|---|---|---|---|
| **Detailed End-Use** | Yes | *Yes* | *Yes* |
| **End Use Representation** | • Residential – 16 heating systems, 46 water heaters, 6 air conditioners, 15 major and 8 minor appliances and 7 types of lighting (all vintaged).<br>• Commercial – 6 end uses<br>• Industrial – no end use representation for non-energy producing sectors. Energy production sectors are modelled from extraction to production of energy 'currencies'.<br>• Transportation – 5 road vehicle sizes, 22 engine types, 20 fuels. | • Residential – 7 end uses<br>• Commercial – 7 end uses.<br>• Industrial – 4 end use categories.<br>• Transportation - Small and large cars and light trucks, buses light/medium freight trucks, heavy freight trucks.<br>• 7 fuels for on-road; 3 fuels for off-road and specific choices for rail, marine and air transportation. | • Residential – 8 end uses<br>• Commercial -6 end uses.<br>• Industrial – 4 end use categories.<br>• Transportation – 3 classes of vehicles modelled for passenger and freight on-road vehicles.<br>• Up to 6 fuels modelled for each end use. |
| **Supply Sector Representation** | All forms of energy production are represented in the model; including power sector, oil and natural gas production, oil sands and petroleum refining. Bio-ethanol and bio-diesel sectors have been modelled for the National Research Council. Each sector is modelled from resource extraction to production of energy products (i.e. electricity, gasoline or ethanol fuels for consumption). | • Power sector based on spreadsheet model of supply<br>• Electricity and petroleum refining modules can be replaced by MARKAL. | • Power sector<br>• Oil and gas – including oil sands (3 segments - in-situ, mining and upgraders).<br>• Refineries represented as industrial sector.<br>• Bio-fuels – limited representation. |
| **Power Sector Representation** | Archetype generation technology types are dispatched to 8760 hour load shapes. Dispatch logic uses dispatch order to represent realistic generation dispatch. | Model uses spreadsheet model of electricity supply to find least cost solution (not linear programming). | Model can be run with unit-level representation or archetype plants. Uses LINDO linear optimization process to optimize dispatch. |

| Model | CanESS | CIMS | ENERGY2020 |
|---|---|---|---|
| **Non-Energy GHG Modelling** | Non-energy related GHG emissions from industrial processes, land use, solid waste and agriculture are all modelled. | Non-energy GHG emissions from solid waste, agriculture, ammonia and hydrogen production, natural gas formation CO2, venting and flaring in oil and gas, methane leaks in coal, oil and gas are re presented as process emissions related to a physical amount of some process represented in the model (e.g. per tonne of ammonia or tonne of cement clinker produced). Non -energy emissions release during the synthesis of adipic acid and nitrous acid are not included. | Represents industrial process emissions at sub-sector level, LULUCF, waste and wastewater non - energy emissions. Less detailed structure than for energy. Projected emissions related to relevant drivers for each sector. |
| **Macro-economic Feedback** | Macro-economic inputs are used as drivers in the model, but there is currently no feedback based on energy use or investments. | *Simplified; MKJA continues to develop Dynamic General Equilibrium Emissions Model (DGEEM) that is linked to CIMS*. Model is run in 2 phases; first phase models final demand for goods and services; 2nd phase then calculates energy demands. If prices change by more than a threshold amount, model runs iteratively to solve. | Has been linked to various macro - economic models. Environme nt Canada runs model with TIM (the Informetrica Model).<br>Economic impacts are estimated by iteratively feeding changes in prices, investments, etc. from ENERGY 2020 back to macro model until convergence achieved. Should be able to run with NALEM. |
| ***Emissions Trading Capability*** | Not included in current version of model. | Model has been used to simulate Canadian carbon trading systems and carbon taxes, and alternate allocations of carbon revenues. | Yes. Model has been used by Environment Canada, Ontario MOE, Western Climate Initiative and several US states to model potential cap -and-trade systems. |

| Model | CanESS | CIMS | ENERGY2020 |
|---|---|---|---|
| **Ease of Use & Transparency** | | | |
| **How is Model normally applied** | *what If?* recommends development process start a design workshop in which WIT staff meet with client to review and customize model. Model may be operated by client or hosted by whatIf? Technologies.<br>Client may operate the model to run scenarios, make changes to the model, or use WIT to do either. Model may be hosted by client or WIT. | MJK reports that some clients possess the model used for their analysis as a data/assumption store, but none operate it in-house.<br>Working to put elements of CIMS into user-friendly community energy and emissions model. Resulting product is to be publicly available and will be operated by local/municipal governments. | For most clients, SSI develops and operates the model and delivers results to client. |
| **Clients currently operating software** | New model not hosted by any clients. Clients operate comparable models built on whatIf? platform.<br>• **Transport Canada, Sustainable Development Division** (Transport Canada Transportation Energy and Emissions Model) - operate the model.<br>• **National Energy Board** – Operate but do not make changes to the model.<br>• **Natural Resources Canada, Office of Energy Efficiency, Energy Demand and Policy (**Energy end use and Technology data base) –staff operate the model.<br>• **Commonwealth Scientific and Industrial Research Organization**, Australia. CSIRO used WIT software to build a stock & flows energy model for Australia similar to CanESS.<br>• **Regional Mun. of Waterloo** –Operate/ build scenarios - land use model. | None. Model is operated by MKJA, not currently available in a form that can be operated by clients. | • **Environment Canada** – Operates model linked to Informetrica model and make changes to model.<br>• **California Air Resources Board (CA ARB)** – Operate model to run scenarios but do not make model changes.<br>• **NEB** – Run and modify the model with SSI support.<br>• **Bonneville Power Administration (BPA)** – Run and modify BPA version of model.<br>• **Northwest Power & Conservation Council (NWPC)** – runs model and does some manipulation with SSI support.<br>*(all but ARB long term clients)* |

| Model | CanESS | CIMS | ENERGY2020 |
|---|---|---|---|
| **Data Inputs & Requirements**<br><br>(Note: Data requirements reflect level of detail and breadth of coverage in each model). | • StatsCan CanSIM (Demographics, GDP, Agriculture, Land Use)<br>• OEE RESD & OEE DPAD<br>• National GHG Inventory<br>• EPA Mobile 6 Model & Database<br>• Electric Power Statistics, CanPlan National Energy Board (NEB)<br>• LCA models (GREET/ GHGenius)<br>• Scientific Reports (Sandia Labs, Battelle, USDA, …) and anecdotal data .<br>WIT recommends starting with a needs analysis and discussion of what data is available in order to most effectively focus data collection efforts. | *Uses data from: Statistics Canada, NRCan, the Canadian Industrial Energy End-Use Data and Analysis Centre and the National Energy Board.*<br><br>Reportedly requires detailed information on technologies that comprise existing building and equipment stocks and information on how the equipment stocks change over time. | *Initial energy demand, supply and prices, as well as unit-by-unit generator data (if unit-level representation used). GDP, gross output per sector and income from a linked macroeconomic model or other forecast source. Projected fuel prices and technology costs and performance. Availability and costs of offsets.*<br><br>Inputs and assumptions used in several past modelling exercises for various US states and the WCI are available on-line[1]. |
| **Documentation** | Approach to model development uses linked structural diagrams to represent model relationships. *Computer Aided Software Engineering* (CASE) used for model development provides self documentation. Reference manual produced for model includes hierarchy diagram showing model components and structure with descriptions of each variables, units of measure, dimensions and data sources. User can view structure and drill down to specific variables and data. | Available documentation presented in Appendix B. | Model documentation updated in past few years. Documentation for the model has been posted on California Air Resources Board site as part of it's Scoping Plan[2].<br><br>The assumptions and data inputs used in several ENERGY 2020 modelling exercises are also available on-line. For example, the "*2009 Assumptions Book*" for the CA ARB modelling is available from the same link noted above for the documentation. |

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[1] For example the Inputs and Assumptions used in modeling for the WCI (which included several Canadian Provinces, can be found at: http://www.westernclimateinitiative.org/component/remository/Economic-Modeling-Team-Documents/Updated-ENERGY-2020-Inputs-and-Assumptions

[2] Energy 2020 Documentation available at: http://www.arb.ca.gov/cc/scopingplan/economics-sp/models/models.htm

| Model | CanESS | CIMS | ENERGY2020 |
|---|---|---|---|
| **Model Outputs** | Interactive.<br>User can interactively run model and produce graphic or tabular scenario results to compare several scenarios. Allows user to 'drill down' into model to review factors behind changes, investigate relationships and review data. | Batch operation.<br>Model results for multiple scenarios are organized and compared in an excel spreadsheet. | Batch operation.<br>Model outputs are produced in Excel compatible form. Standard reports are available or they may be customized to user needs. Differences between scenario runs are normally compared in Excel spreadsheets. Model run times vary depending on model complexity. |

# Macro Models – Pros and Cons

| Model | Key Advantages | Limitations |
|---|---|---|
| **CanESS** | • Modern software/architecture with interactive interface.<br>• Transparent structure, easy to understand model relationships.<br>• Existing representation of NL; adjustable to more detailed NL data.<br>• End use structure/flexible level of representation.<br>• Provides database/structure for data as it is developed. | • Decision making and behaviour represented through user inputs/scenarios.<br>• Limited representation of economic impacts.<br>• Relatively new model with limited track record. |
| **CIMS** | • Lengthy track record in Canada.<br>• Attempts to reflect uncertainties and imperfect information in decision making.<br>• Has been used to model carbon trading and carbon taxes.<br>• Provides some indications of economic impacts of policies. | • Must be used through MKJA; not available in a form to run in-house.<br>• Batch model with results comp arison in Excel.<br>• Limited transparency – appears to rely heavily on economic decision making.<br>• Includes some built-in assumptions (i.e. w.r.t. changing urban planning/land use and impacts on energy demand). |
| **ENERGY 2020** | • Lengthy track record in US and Canada .<br>• Some track record of predicting actual market behaviours.<br>• Has represented NL in past models; can be adapted to improved NL data.<br>• Provides some indications of economic impacts of policies. | • Behavioural model difficult to explain and understand.<br>• Complex model to operate; most clients rely on SSI for model operation.<br>• Batch model with results comparison in Excel. |

# Macro Models

- Best choice depends on:
  - ✓ Requirement for in-house capability.
  - ✓ Policy focus – types of policies considered.
  - ✓ Operational considerations – ease of use, transition, transparency, data housing, etc..
  - ✓ Cost/Resource considerations.
- Suggest:
  - ✓ Seeking a model that can house/ provide structure for data developed.
  - ✓ Consider ease of using/updating and transparency.

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# Data and Data Development

# Data and Data Development

- Understand data maintenance costs have negatively affected past modeling efforts
- NL faces a number of issues in obtaining province-specific energy data.
- Existing data sources should enable a 'first estimate' of energy use by sector/end-use.
- Keep eye on "big picture" and avoid "familiarity" effect *(i.e. heat rates for CHP).*

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# Data and Data Development

- Stock has considerable inertia.
- If representation of physical stocks of energy using equipment are 'right' projections of future energy use will be reasonable/realistic.
- If objectives include CDM assessment then some technology representation required.
- *Caveat - Stock turnover models may not represent behavioural/operational changes.*

# Data Types Required

| Information Required (Demand Side) | Historic | Projected |
|---|---|---|
| Energy use and intensity by sector and end use | ✓ | |
| Characteristics of energy consuming stock (number of devices, efficiency, etc., both engine and drivers | ✓ | |
| Demographic/Economic drivers (housing, GDP/GO, etc., including factors affecting operations – VMT, TKT) | ✓ | ✓ |
| Energy prices | ✓ | ✓ |
| Codes/standards and policies affecting energy use. | ✓ | ✓ |
| | | |

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# Data and Data Development

Suggested principles:

- Leverage existing data sources where possible (OEE, StatsCan, NL Departments (vehicle license data, land registry, etc.), and utilities. Estimate NL where reasonable.
- Choose sources with consistent history and expectation of continued availability – *may need to apply reasonable adjustments to apply to NL.*
- Focus data development investments on areas of *"difference which make a difference".*

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# Estimating Data – Example 1

Commercial sector (No NL-specific data)

- Are end uses (*auxiliary motor loads, office equipment loads or lighting)* significantly different in a department store or office building in NL vs. NS or NB?
- Is activity level *(GDP, floor area, employment, etc. by sub-sector)* known for NL?
- If so, then estimate energy use by end use by sub-sector.
- Uncertainties – may need to use estimate relationship between employment & floor area, use judgment to adjust for energy source for non-captive electric loads (ie. space/water heating, cooking, etc.), etc..

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# Estimating Data – Example 2

Industry sector (no NL-specific data)

- Information is available on energy use/intensity by specific industry type *(Illustrative data series for fish processing industry on next slide).*
- Use activity data for NL industry (available from CANSIM, Dept. of Finance?).
- Build up estimate based on industry energy intensities for NL industries (*some estimation for fuel types may be needed*)
- Estimate end use breakdown  based on Marbek or other sources (*alternatives - MECS, baseline/potential studies from other jurisdictions*).

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# Data and Data Development

| 311700 Food Manufacturing , Seafood Product Preparation & Packaging | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Product:** | Fish and seafood products | | | | | | | | | | |
| **Note:** | Gross Output, GDP in $2002 million. | | | | | | | | | | |
| | | | | | | | | | | | |
| **Notes:** 'XX' refers to confidential values, the sum of which appears on the 'Confidential' line. | | | | | | | | | | | |
| All units are in terajoules (TJ). | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Units: TJ** | **1990** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Total | | | 3,517 | 2,803 | 2,728 | 2,730 | 2,978 | 3,028 | 3,162 | 3,049 | 3,533 |
| Electricity | | | 1,532 | 1,624 | 1,693 | 1,716 | 1,747 | 1,741 | 1,860 | 1,743 | 2,487 |
| Natural Gas | | | XX | XX | 145 | 94 | 109 | 133 | 182 | 213 | 203 |
| Heavy Fuel Oil | | | XX | XX | 422 | 446 | XX | 442 | 435 | XX | XX |
| Middle Distillates | | | 806 | 649 | 393 | 411 | 445 | 632 | 599 | XX | XX |
| Propane | | | 202 | 145 | 48 | XX | XX | 80 | 86 | XX | XX |
| Steam | | | | | 29 | XX | | | | | |
| Wood Waste | | | | | | | 123 | | | | |
| Confidential | | | 977 | 385 | | 64 | 553 | | | 1,093 | 844 |
| | | | | | | | | | | | |
| **Activity Data** | **1990** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Physical Units (kilotonne) | 549 | 331 | 378 | 390 | 399 | 389 | 412 | 389 | 373 | 357 | 335 |
| Gross Output | 3,747 | 3,720 | 4,045 | 4,710 | 4,493 | 4,427 | 4,336 | 3,249 | 3,141 | 3,324 | 2,837 |
| GDP | 838 | 864 | 869 | 951 | 1,011 | 1,010 | 943 | 950 | 884 | 939 | 812 |
| | | | | | | | | | | | |
| **Intensity** | **1990** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Energy (TJ) / Unit (kilotonne) | | | 9.3 | 7.2 | 6.8 | 7.0 | 7.2 | 7.8 | 8.5 | 8.5 | 10.6 |
| Energy (TJ) / Output | | | 0.9 | 0.6 | 0.6 | 0.6 | 0.7 | 0.9 | 1.0 | 0.9 | 1.2 |
| Energy (TJ) / GDP | | | 4.0 | 2.9 | 2.7 | 2.7 | 3.2 | 3.2 | 3.6 | 3.2 | 4.4 |

# Data and Data Development

- Standardize process for easy/ consistent replication when data updated.
- Compare/calibrate results to other available sources (i.e. estimates of electricity sales, fuel use, information from other jurisdictions).
- Scenario model can help refine and focus on key data:
  - Run using assumed/estimated data,
  - Estimate impact of changes to that data,
  - If difference is significant then invest in data development.

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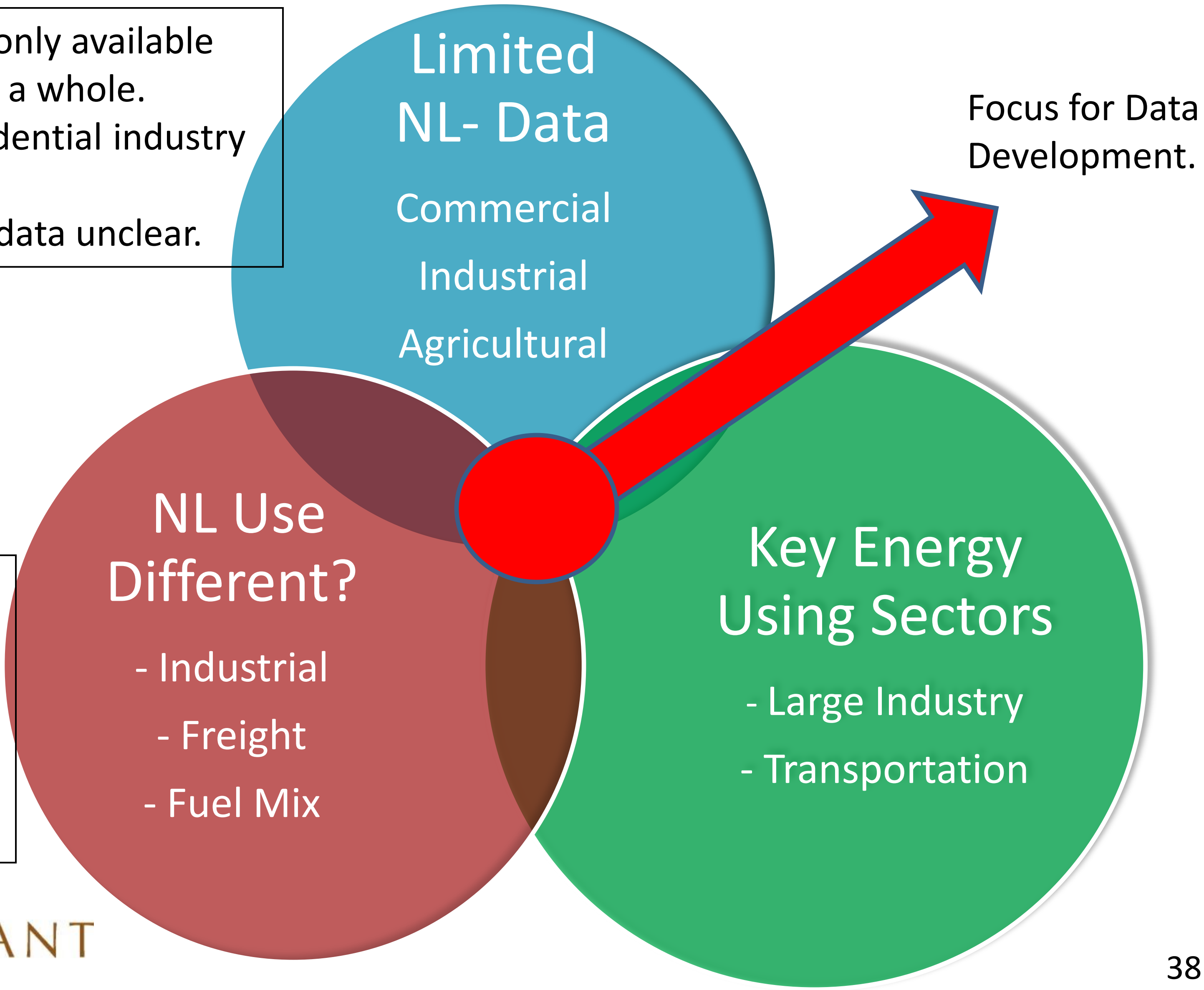
# Data Development

- End use data only available for Region as a whole.
- Limited/confidential industry data.
- RPP/Biomass data unclear.




- Unique mix of industries in NL
- Limited rail, more marine.
- No N. Gas

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# Other Business/Next Steps

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# Next Steps: Data

- Review data
  - ✓ Develop factor analysis of energy use in NL.
  - ✓ How has energy use evolved over past decade and what are key drivers?
- Identify/implement baseline studies (*secondary and primary research as required*):
  - ✓ Large industries,
  - ✓ Freight sector,
  - ✓ Residential, commercial and industrial surveys *(appliance/technology saturations, behaviours/practices, decision criteria, etc.).*

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# Next Steps: Model

- Identify model applications/opportunities.
  - ✓ Projections/scenarios of future energy use.
  - ✓ Policy impact analysis, including energy reductions, reduced out-of-province energy expenditures, increased investments and in-province employment. Illustrative policies include:
    - ❑ Building codes and equipment standards,
    - ❑ Fuel substitution, including on-shore power,
    - ❑ Retrofit, building commissioning, etc.
    - ❑ Reduced truck operation (comfort stations, etc.).
  - ✓ Electricity demand forecasts/scenarios that include estimates of 'naturally occurring' conservation, CDM, etc..
- Develop resulting model requirements
- View (on-line demo's) and select model.
- Use model to refine and focus data development.

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# Thank you.

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