Using backcasting from a low carbon future to inform operations, investment, infrastructure and R&D policy decision making today

Energy Modelling Insights for Iterative Dynamic Decision Making
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Presentation overview

- Who I am
- My research focus -> policy support for deep (-80%+) decarbonization
- Finding our way through the energy modelling “jungle”: The cube -> visioning, optimization, TD/Hybrid/BU simulation & equilibrium, IAM
- Is a common language for communicating with informal and formal policymakers possible?
- The use of “dashboards” and data visualization (a.k.a “policy cartooning”) to backcast from “downward attractors” (e.g. tonnes CO_2/cap) in order to keep short run myopic models and policy consistent with a given long run goal

Me in one slide

- PhD (Simon Fraser University, Vancouver) in energy & climate change policy modelling 2005
- Adjunct Professor at SFU
- 14 years of energy and climate policy forecasting as a consultant using hybrid bottom-up and top-down models. Eventually ran one consultancy and co-founded another
  - Clients: Canadian federal ministries of energy & environment; BC, AB, SK, ON, NFL, & NWT governments; provincial regulators; energy utilities; NGOs; OECD
- Left consulting for research 2 years ago to work on the Deep Decarbonization Pathways Project (DDPP)
- Associate researcher with IDDRI.org in Paris, lead editor of the Climate Policy Special Issue on the DDPP

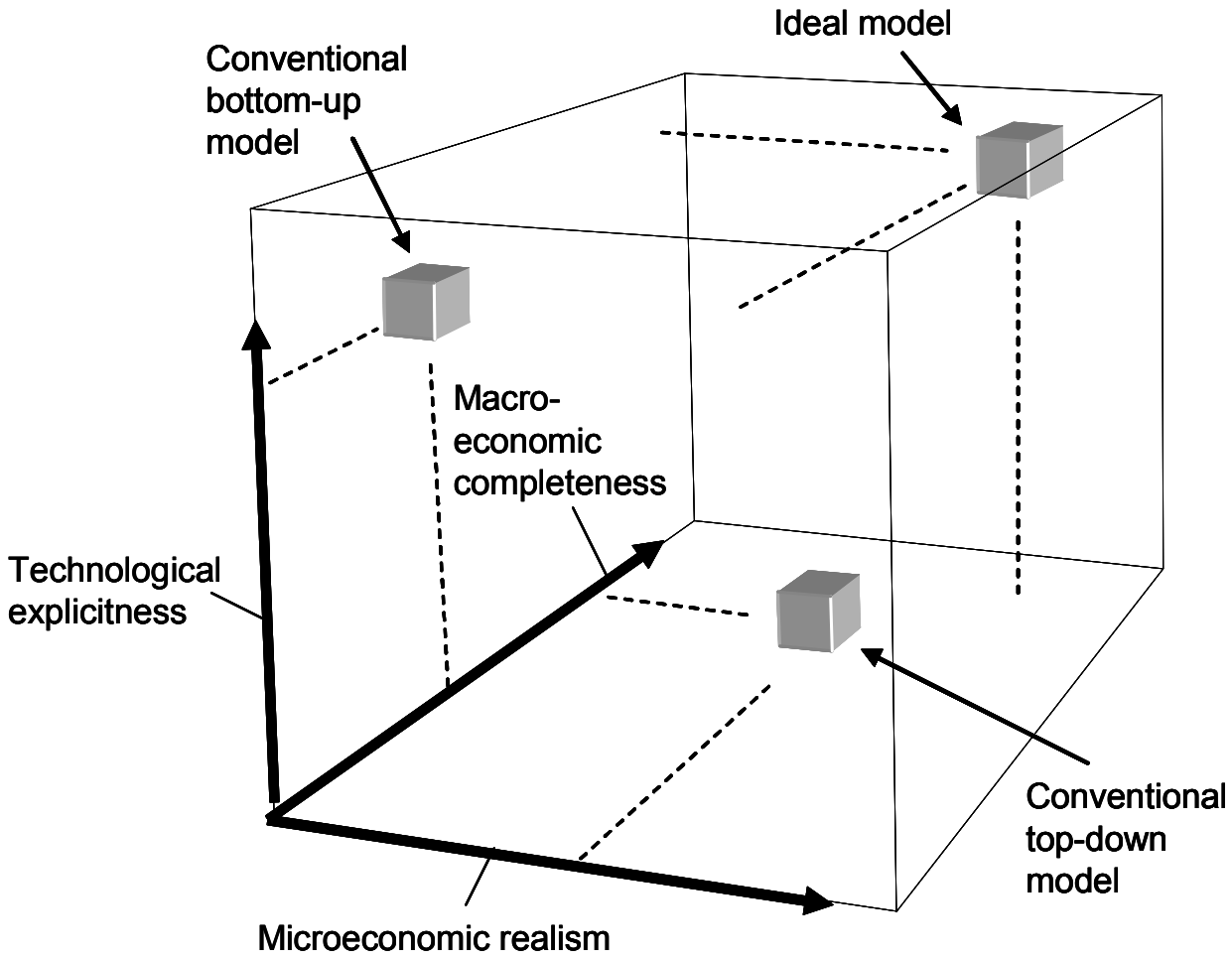
Modelling approaches for which I have earned grey hair

- CIMS firm and household behaviourally realistic technology stock turnover model (hybrid from the bottom-up)
  - Heterogenous decision agents, myopia is standard, technology competitions include a mix of financial and non-financial components, separation of sectoral decision and cash flow discount rates
- RGEEM regionally disaggregated dynamic recursive CGE (hybrid from the top-down)
  - Lots of sectoral and end-use disaggregation, key technologies added, tech parameters set using CIMS
- Linked systems with the above plus land use, urban planning and transport models

My personal research focus

- Policy decision support for deep (-80%+) decarbonization (DD).
- DD includes challenges of: technology, jurisdiction & sovereignty, diffuse benefits & acute pain, uncertainty on many levels, and scale.
- Within each economy we have households, private firms, infrastructure planners and tech entrepreneurs, all with different decision making paradigms. Modelling for operations, investment, infrastructure and R&D is different, operating on different temporal & spatial scales.
- Decision support must speak to the decision maker.
- Is there an easier, clearer, more useful way to inform policy at the appropriate scale?

The modelling “jungle” – the simple version



Source: Hourcade, Jaccard, Bataille & Ghersi 2006

	Accounting	Bottom Up	BU based hybrid	Mixed linked BU+TD	Top Down based hybrid	National IAM
Literature review of national deep decarb studies	PATHWAY (US)*	MARKAL-TIMES (UK) CA-TIMES (Cal) MARKAL Stochastic (UK) MARKAL (UK) ESME (UK) LTMS (SA)	CIMS (CAN-CHIN) MARKAL-ED (UK) MARKAL-MACRO (UK) MARKAL-ED (CHIN) MARKAL-MACRO (CHIN)	Pop, Buildings, Trans, CGE (JP) MARKAL-AIM-Snapshot (IN) IPAC (BU-CGE) (CHI)	IMACLIM-R (FR) MIT-EPPA (US) MRN-NEEM (US) ADAGE (US) THREE-ME (FR) REMIND-D (GER) GEMINI (Swiss)	GCAM-IIM (IN)
DDPP	US* Indonesia South Korea Mexico	UK* Russia	Canada*	Australia Japan Italy China South Africa India	France* Brazil Canada	None

Source: Pye and Bataille 2016

- Other key models: Demographic, land use, water, atmospheric, air quality
- **The upshot** -> they all have something useful to say, but how to pull it all together in something useful to policy makers?

The dashboard as a translation device

- Fairly simple spreadsheet used to quantify stories told by models in a common format
- Use of expanded Kaya identity covering all sectors, expressed as practical building blocks: population, sectoral activity, energy intensity, energy mix, GHG intensity per energy form

$$GHG = Population \sum_{ij} \left(\frac{GDP}{Population}\right)\left(\frac{GDP_i}{GDP}\right)\left(\frac{Energy_i}{GDP_i}\right)\left(\frac{Energy_{ij}}{Energy_i}\right)\left(\frac{GHG_{ij}}{Energy_{ij}}\right)$$

- UNFCCC inventories set the high water mark for what a dashboard should be able to describe
- In an analytical mode: Ideas->Models->Dashboard-> Data visualization->Reiterate
- In a potential dynamic policy mode: Models->Dashboard-> Data visualization->Policy->Outcomes->Reiterate

The dashboard

- Personal transport
- Freight transport
- Residential
- Buildings
- Industry Sum
- - Industry x, y, z
- Electricity supply
- Biofuel …
- RPP …
- NG …
- Coal ….
- Synthetic NG …
- Others …

Combustion

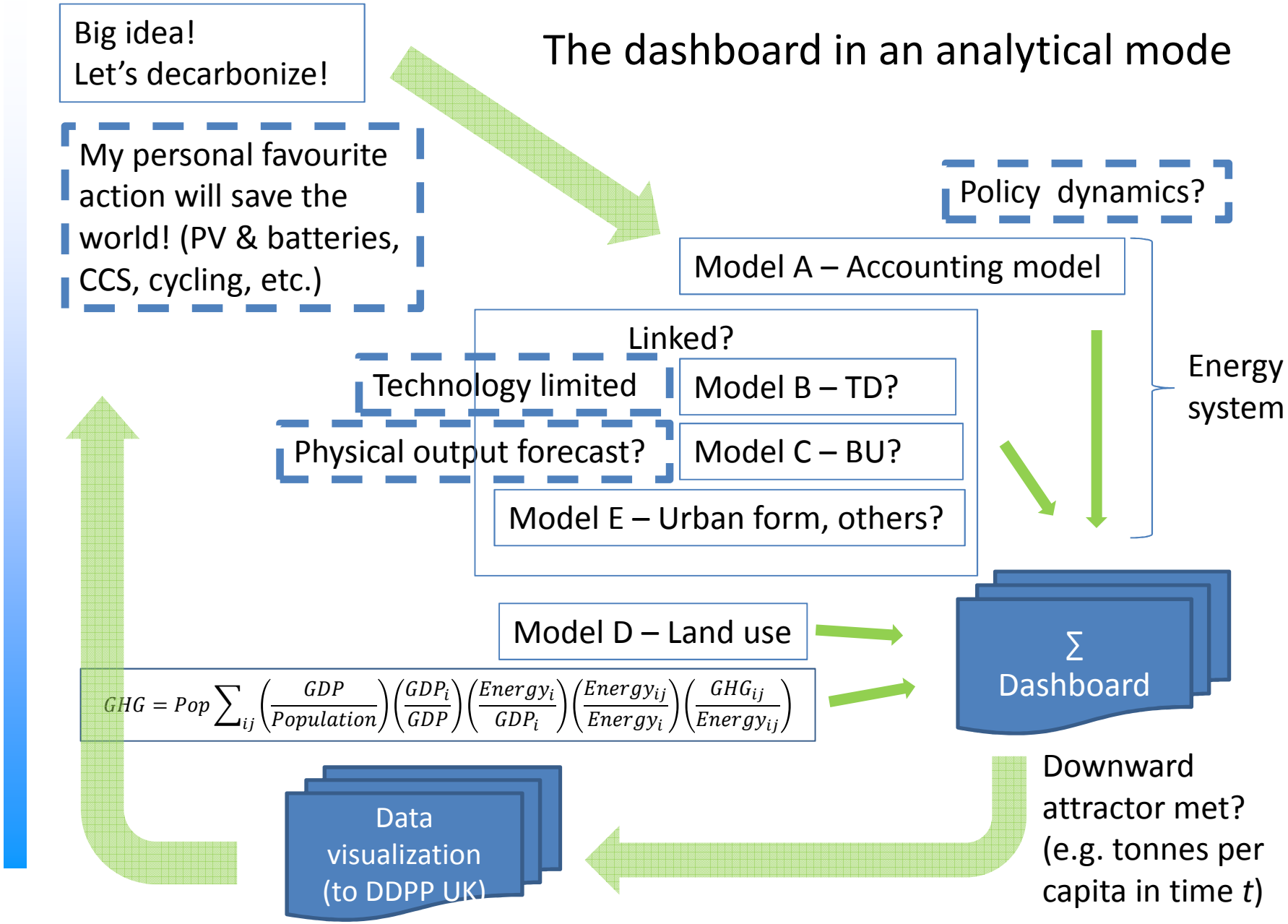
Activity X Energy intensity X Fuel mix X GHG intensity per fuel

Process and fugitive

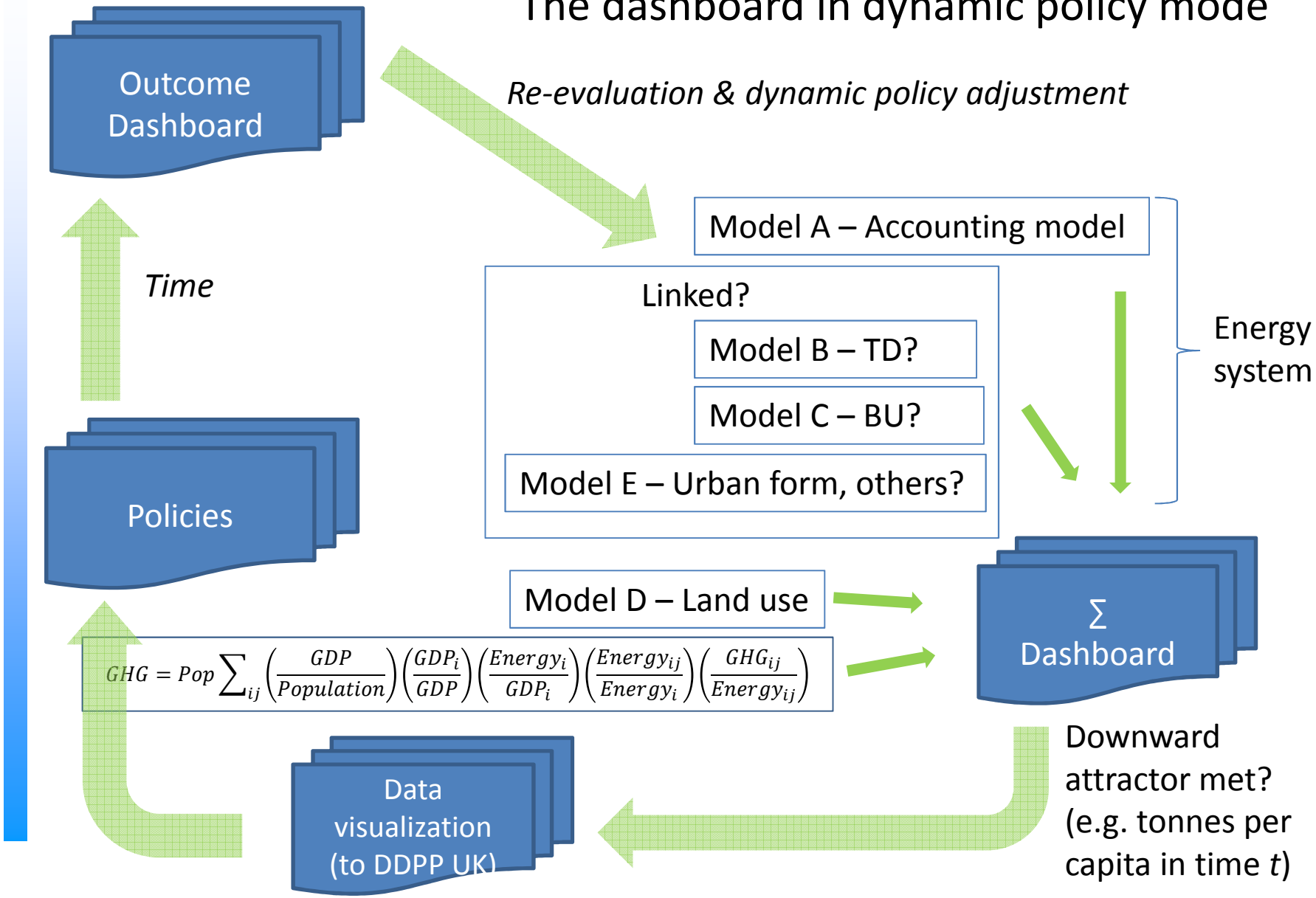
Activity X Intensity per unit activity X GHG intensity per molecule

- Designed with energy consumers and producers in mind
- Each of the above components can be filled from a specialized model or on its own
- Includes adjustments for self gen and consumption
- Adjusted for imports & exports
- Process and fugitive GHGs included, as well as other non- CO_2 GHGs
- The goal is the capacity to match the UNFCCC inventories if sufficient information provided
- Can use LMDI decomposition identity for additive consistency

The dashboard in an analytical mode



The dashboard in dynamic policy mode



Critical commentary

- Dashboards work if model dynamics do not significantly overlap (i.e. influence each other), e.g. land use and energy to a large extent, and not if they are heavily overlapped, e.g. water and hydroelectricity. Model dynamics with overlap should be linked directly, and their results fed collectively into a dashboard
- While the dashboard is meant to be highly democratic and cross comparable, some will have better input analysis than others. Also, some will have policy built in, others will be aspirational. The common format could obscure this, but this a problem with the INDCs as well
- **Is this useful?** Ideas, questions, criticisms?