

Insights from ITC & BC Climate Initiatives

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Overview

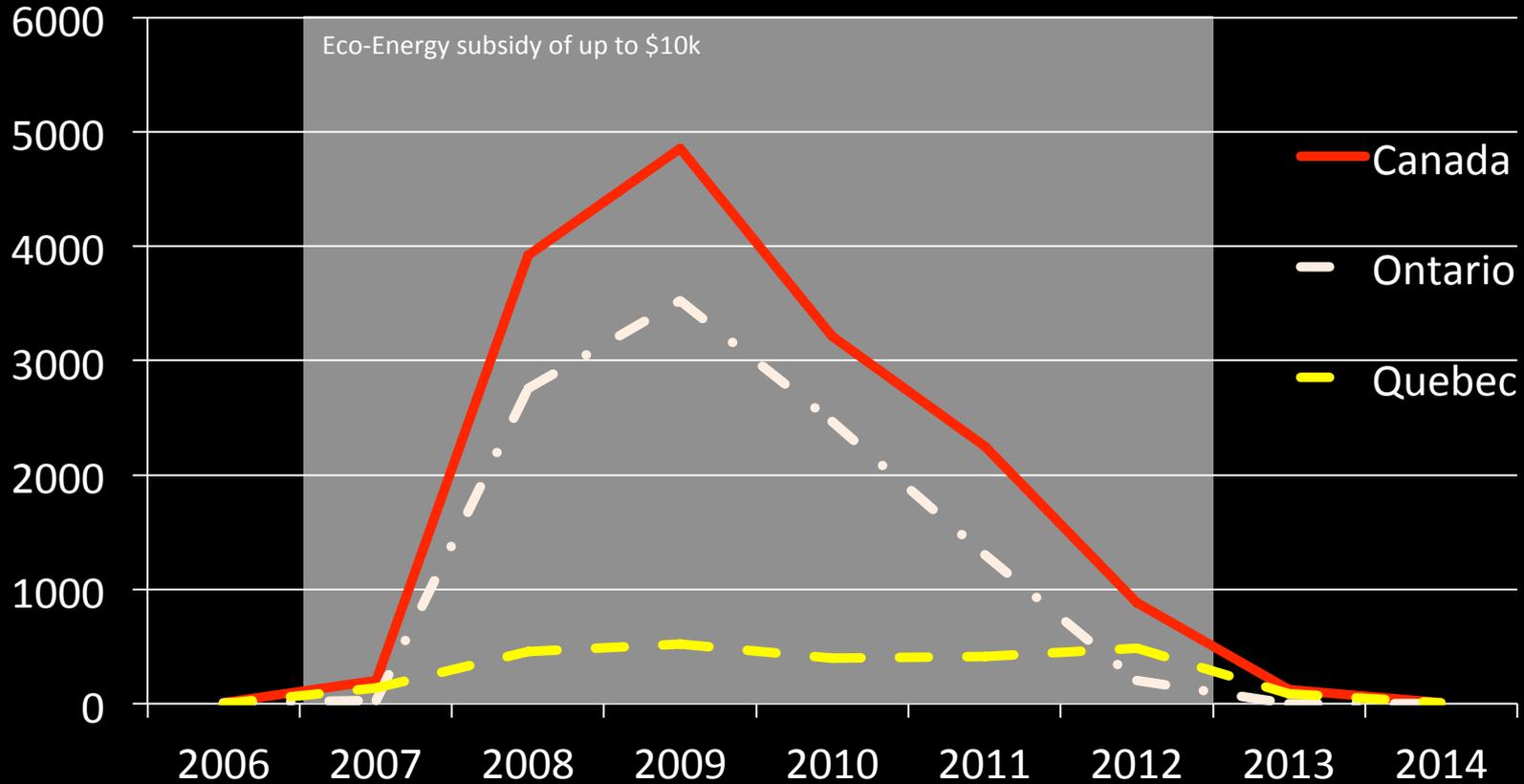
- Why have some technologies flourished while others have languished?
 - Is the “backstop” framing in IAMs adequate?
- Can we capture non-economic drivers of investments?
 - Are the effects too small to include in IAMs?
- How have early policies performed?
 - Can we learn from these in how to model policy options and outcomes in IAMs?

GSHHP: a languishing tech

- 300+% more efficient space & water heating
- Available for >25 years
 - Adoption at residential scale is 2% in US and 4% in Canada
- Strong economies of scale
- Significant opportunities for further savings in neighbourhoods with simultaneous heating & cooling needs
 - Adoption at higher scales > 0.1%



CGC-certified installations





Residential Heating by fuel type

Fuel type	Baseline %	GSHP renovations %
Natural gas	50	6
Electricity	36	43
Heating oil	8.4	47
Wood	4.4	4.4
Other/ Propane	1	9.2

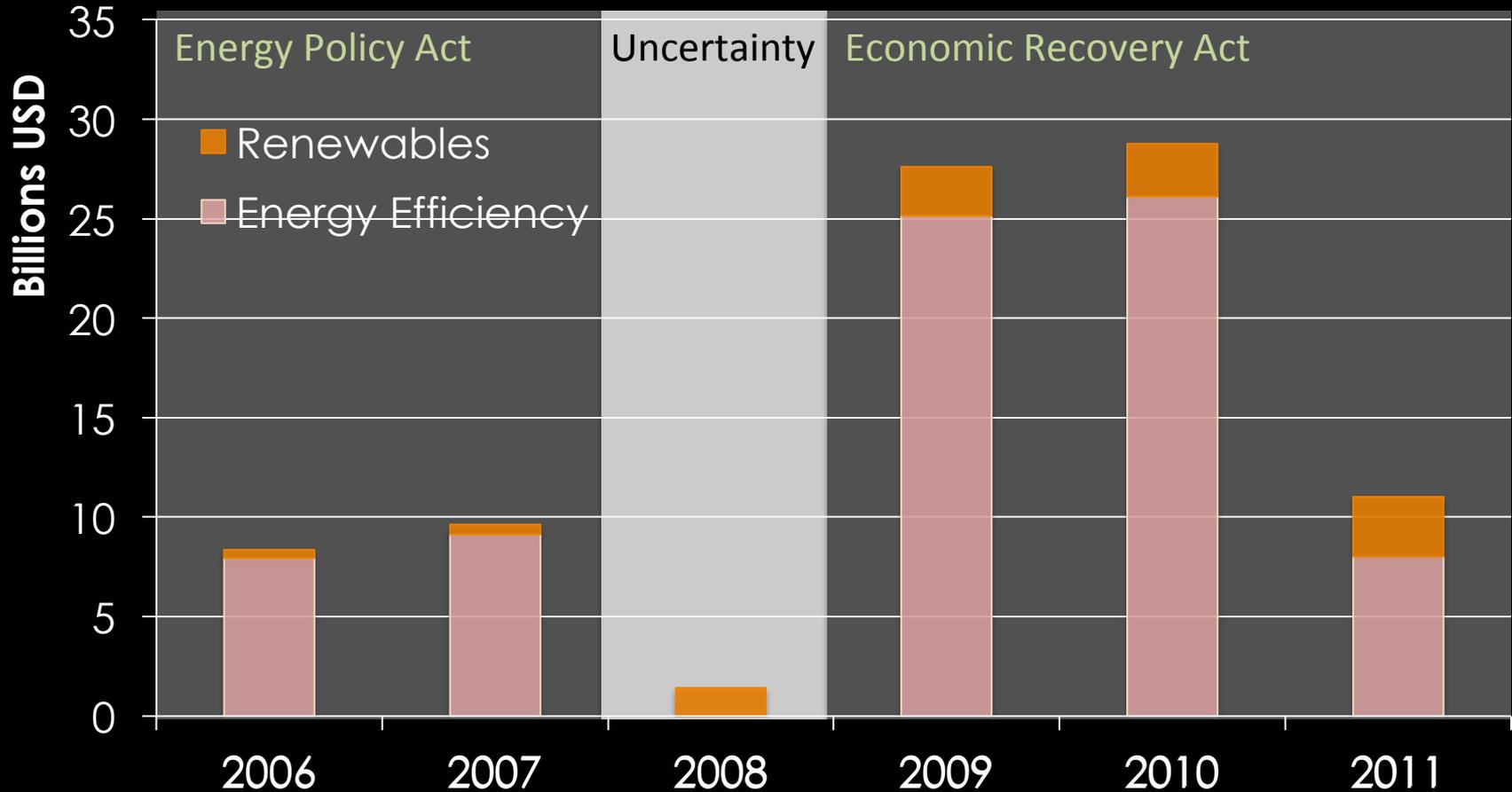


Summary of Canadian Experience

- Free-rides galore, public funds paid for:
 - Switch away from oil.
 - Replacement heat pumps
 - A/C for many who didn't have it
- & by creating a boom, bust cycle, it was detrimental to suppliers



ITC Claims for renewable energy & energy conservation



Our focus

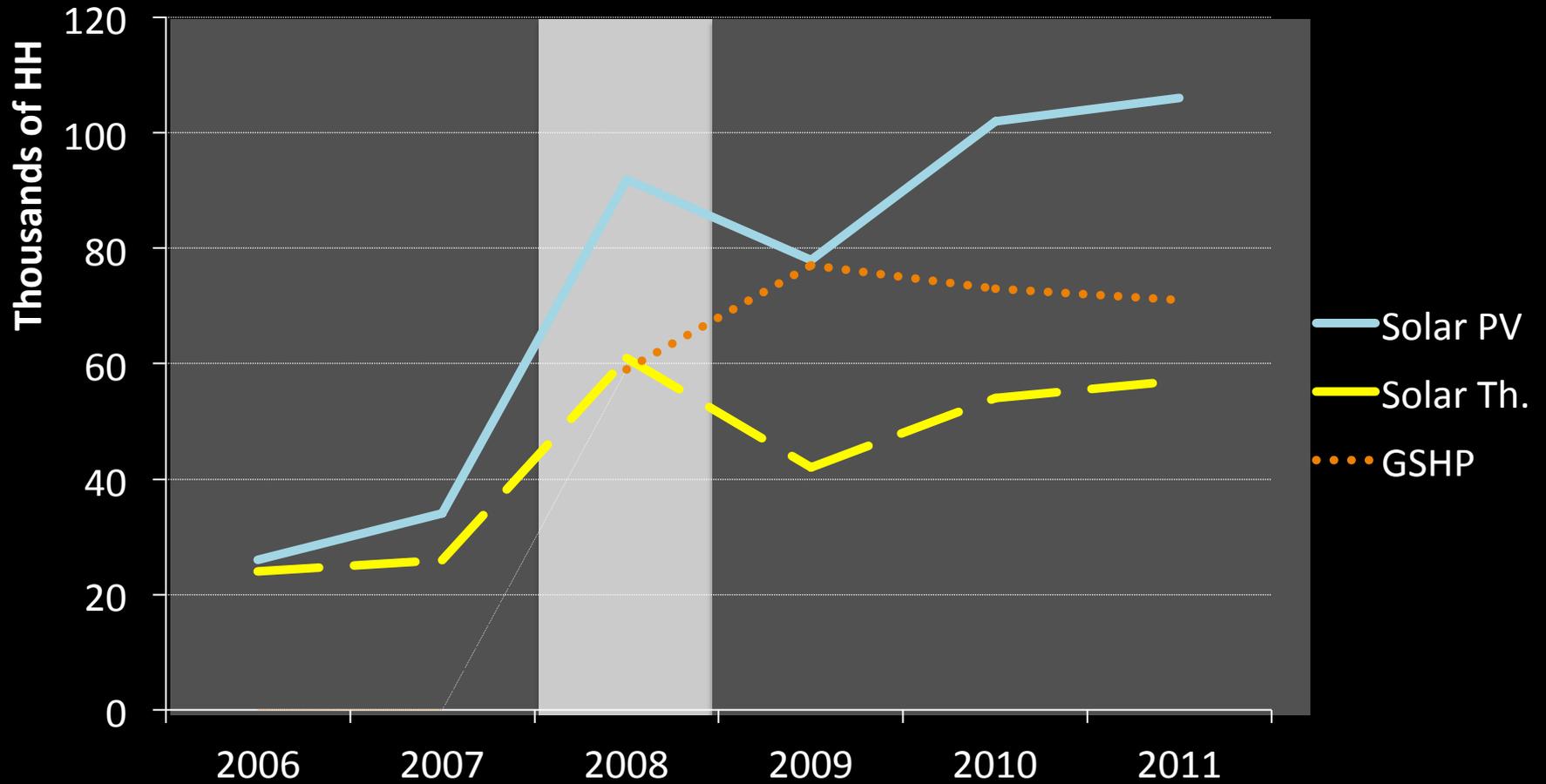
- Renewable investments
 - PV
 - Solar thermal
 - “GSHP”
- They differ in three dimensions:
 - Maturity of technology
 - Modular vs. custom production
 - Scope of investment

Three dimensions of difference

	Maturity	Modularity	Scope
Photo voltaic	No	Yes	Area & capital available
Solar thermal	Yes	Yes	Household demand
GSHP	Yes	No	Household demand

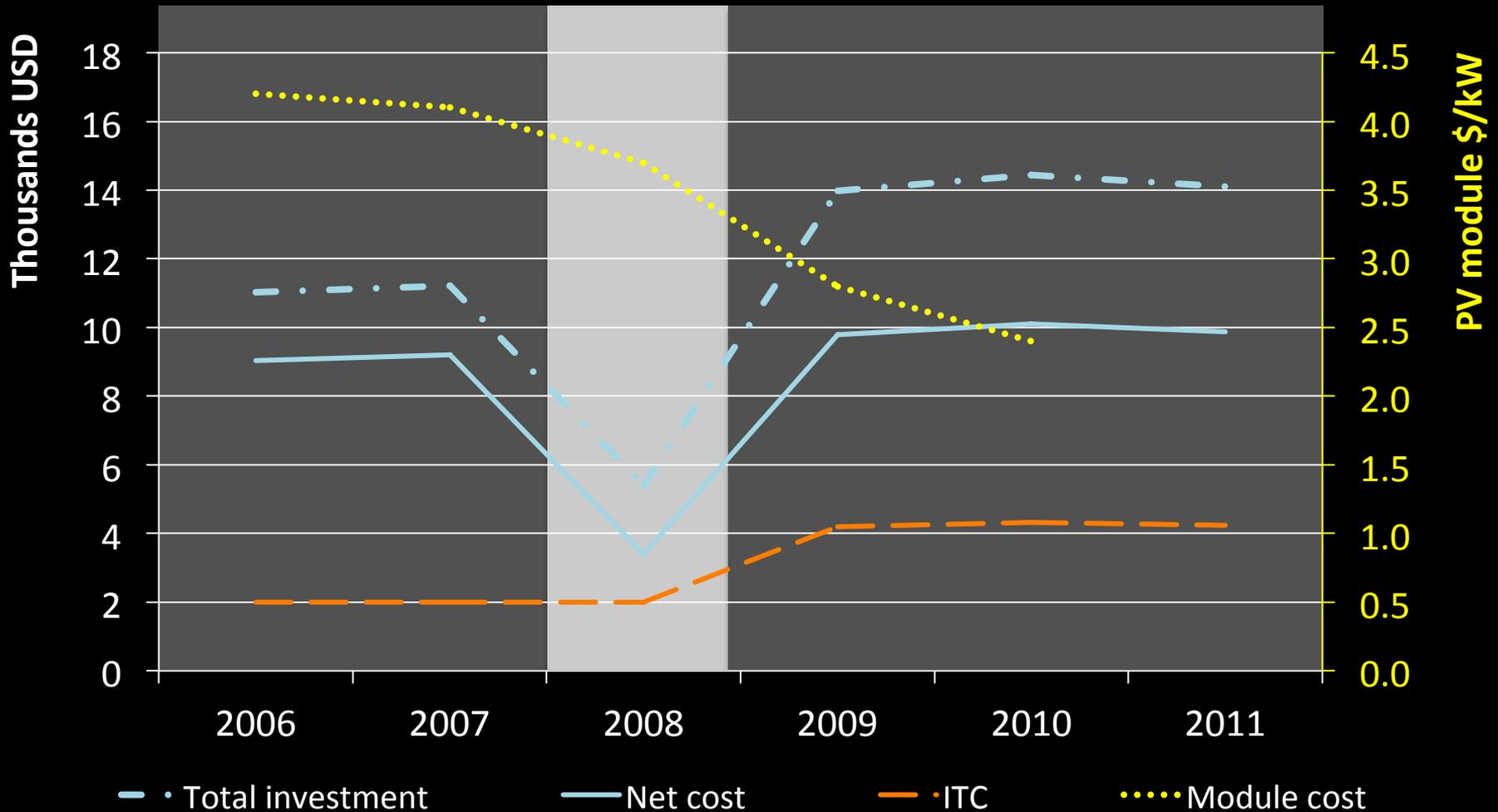


ITC changes & installations



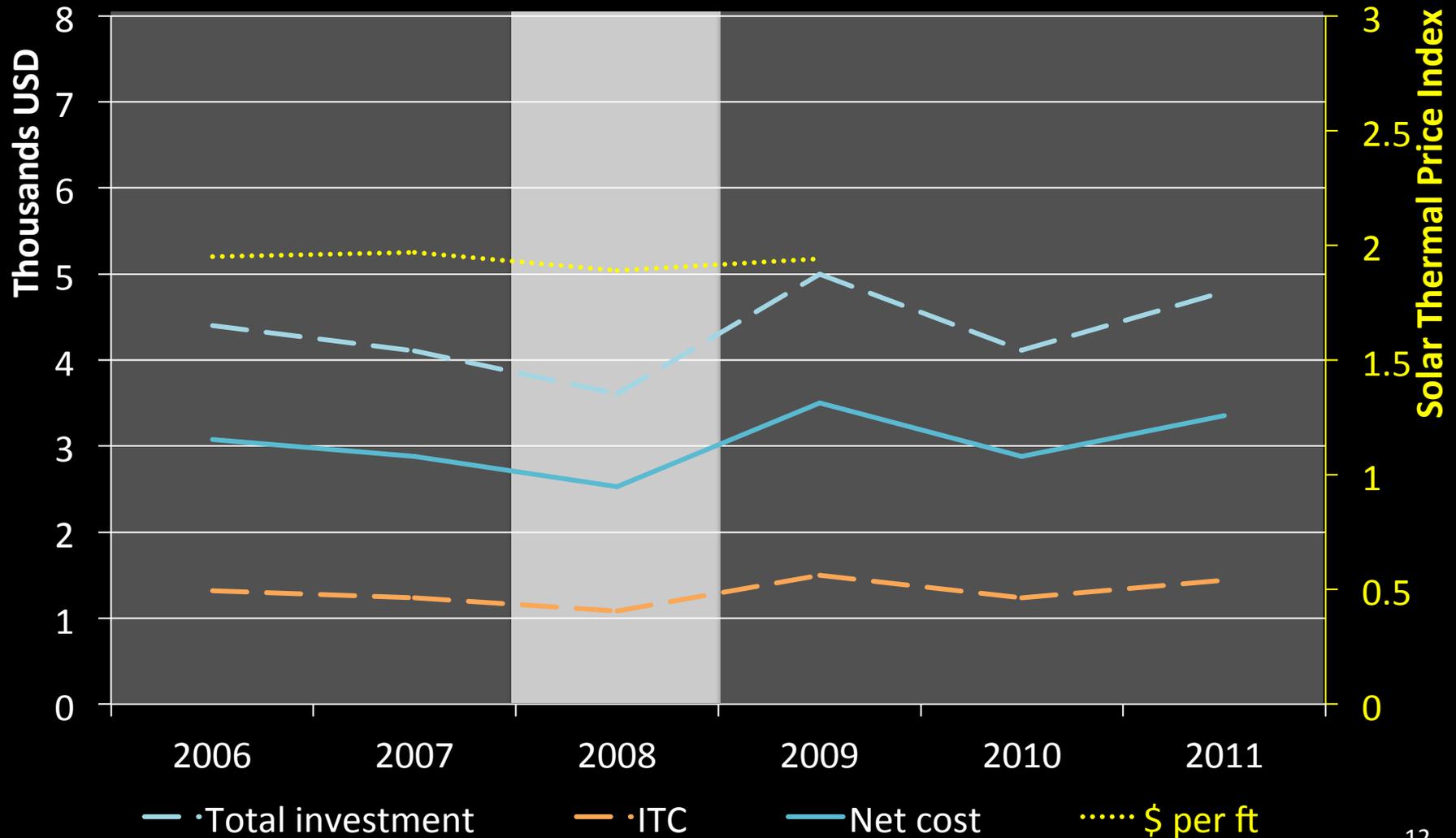


Solar PV: Av. HH investment



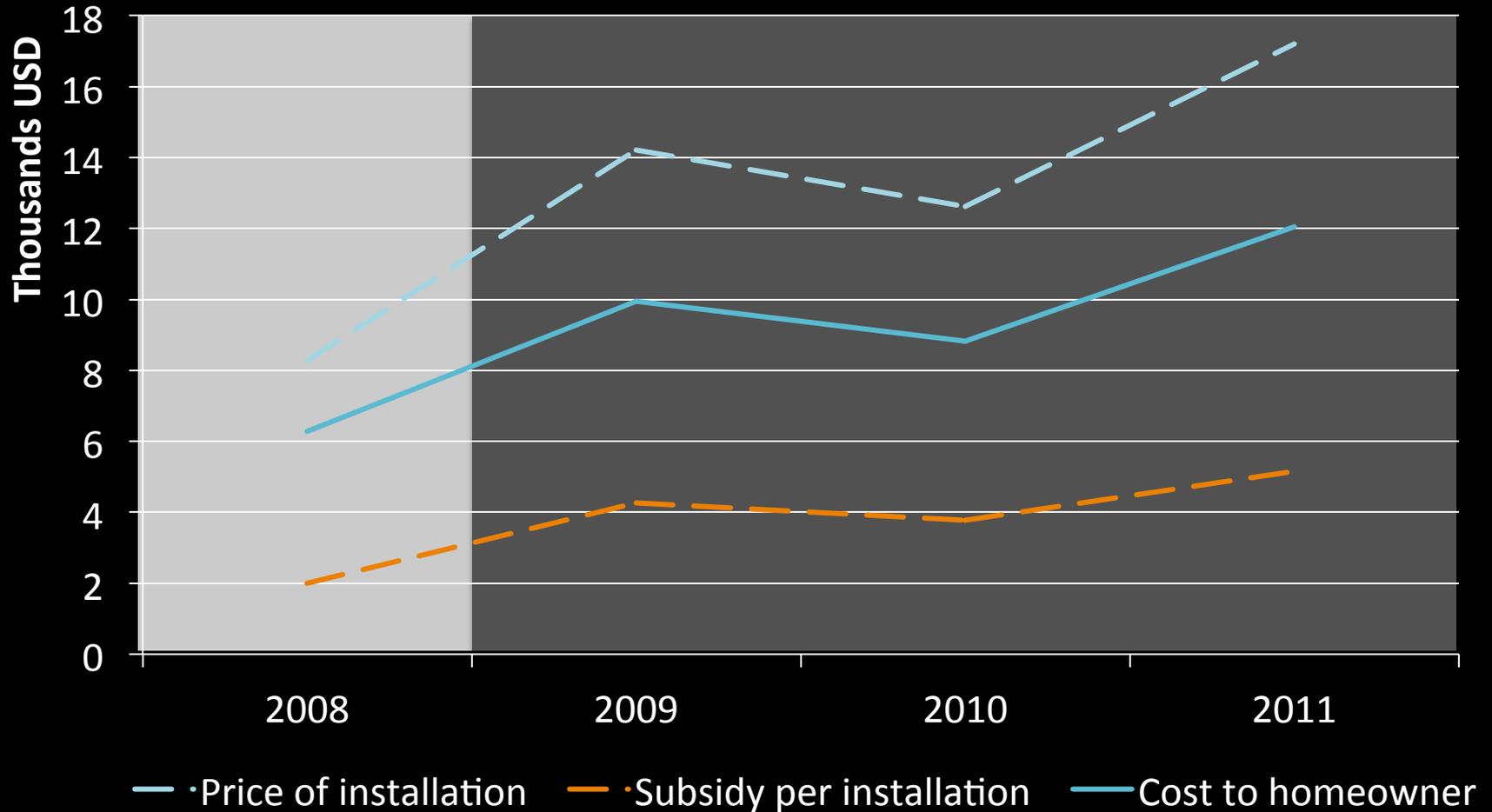


Solar thermal: Av. HH investment





GSHP: Av. HH investment





Summary of US ITC experience

- Households have an investment budget – higher incentives don't change net investments.
 - PV installations grew in size
 - Solar installations grew in number
 - GSHP installations grew more expensive



The adoption of solar

- Why have solar thermal sales stalled?
- Why have PV sales soared despite dubious economics?



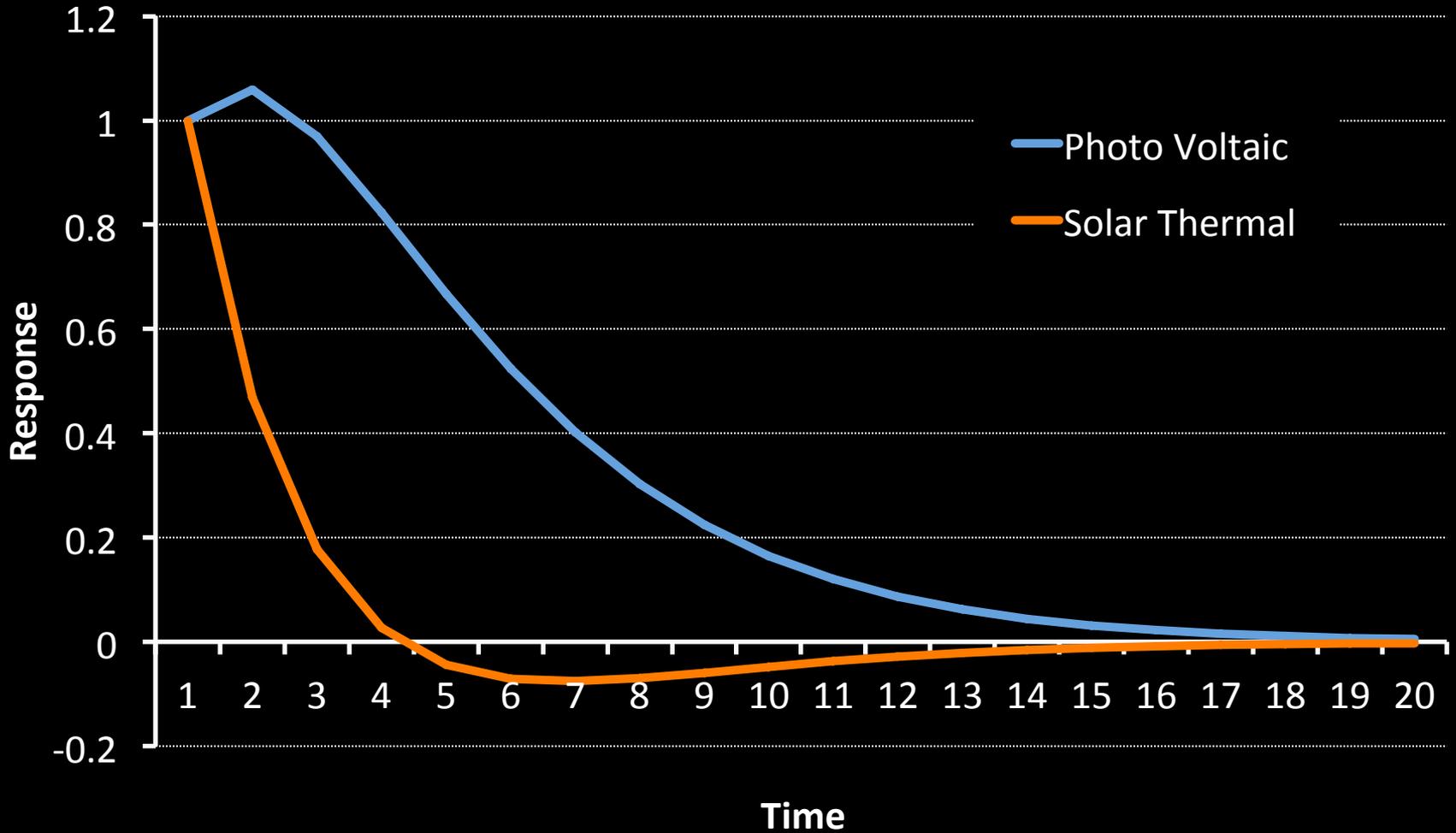
Inspired by Solow



- What is going on?
- Economics is improving:
 - Panel prices are falling
 - The FiTs
 - ITC
- But is there a non-economic residual?



Incentive response curves





Tech adoption residuals

- Solow found that economic growth outpaced labour and capital inputs.
- We used Bayes MC to explore economics of current investments.
- We find a “residual” *momentum* for the incentives that were offered for PVs in contrast to *harvesting* for solar thermal.

Large GSHP projects



BC's Carbon Sticks and Carrots

Sticks:

- \$30/tonne point of use carbon tax on all fuel sales
- Additional \$25/tonne offset price imposed on all public sector emissions (~\$25M/yr)

Carrots:

- Provincial tax credits for investment in hybrid cars, etc.
- Public Sector Grants for carbon lowering investment (~25M/yr)
- Federal tax credits & accelerated depreciation schedules on green investment

Barriers to GSHP at higher scales

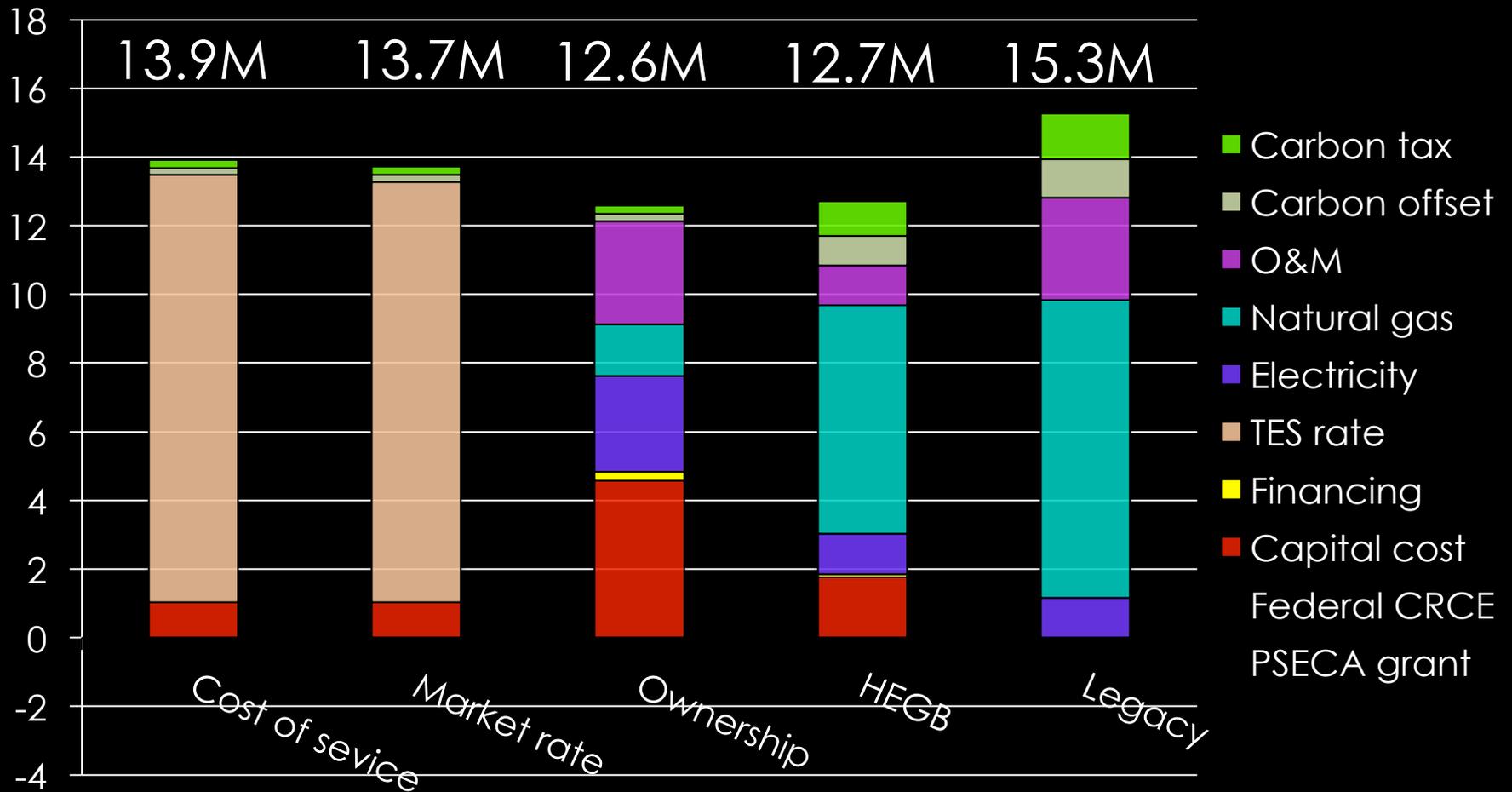
	Survey %	Public sector	Developers
Limited capital budget	36		same
Insufficient ROI	21	Low discount rate	High discount rate
Uncertainty of ROI	16		same
Agency concerns	7	Owner-occupied	Tripe-net lease
Lack technical expertise	6		same
Lack of buy-in	4	Public leadership	
Other factors?	10	Could this dominate?	

Source: Johnson Controls survey of No.1 barriers to energy efficiency measures, 2013

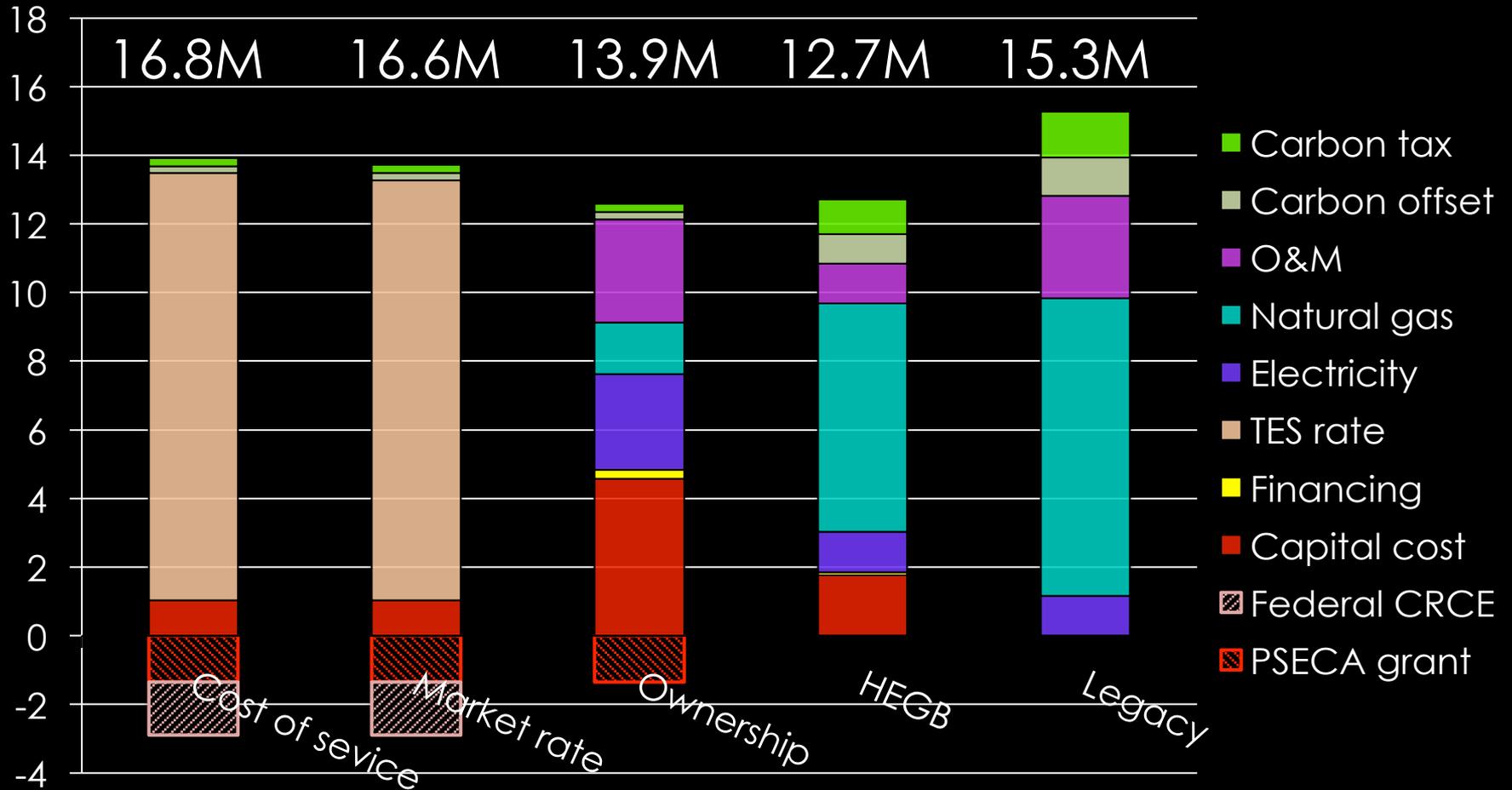
DSB constraints and motivations

- Wanted renovations
 - Was denied funding
- Needed to be green
 - Is subject to BC's zero emissions regulations
- FortisBC – willing to offer TES as a utility

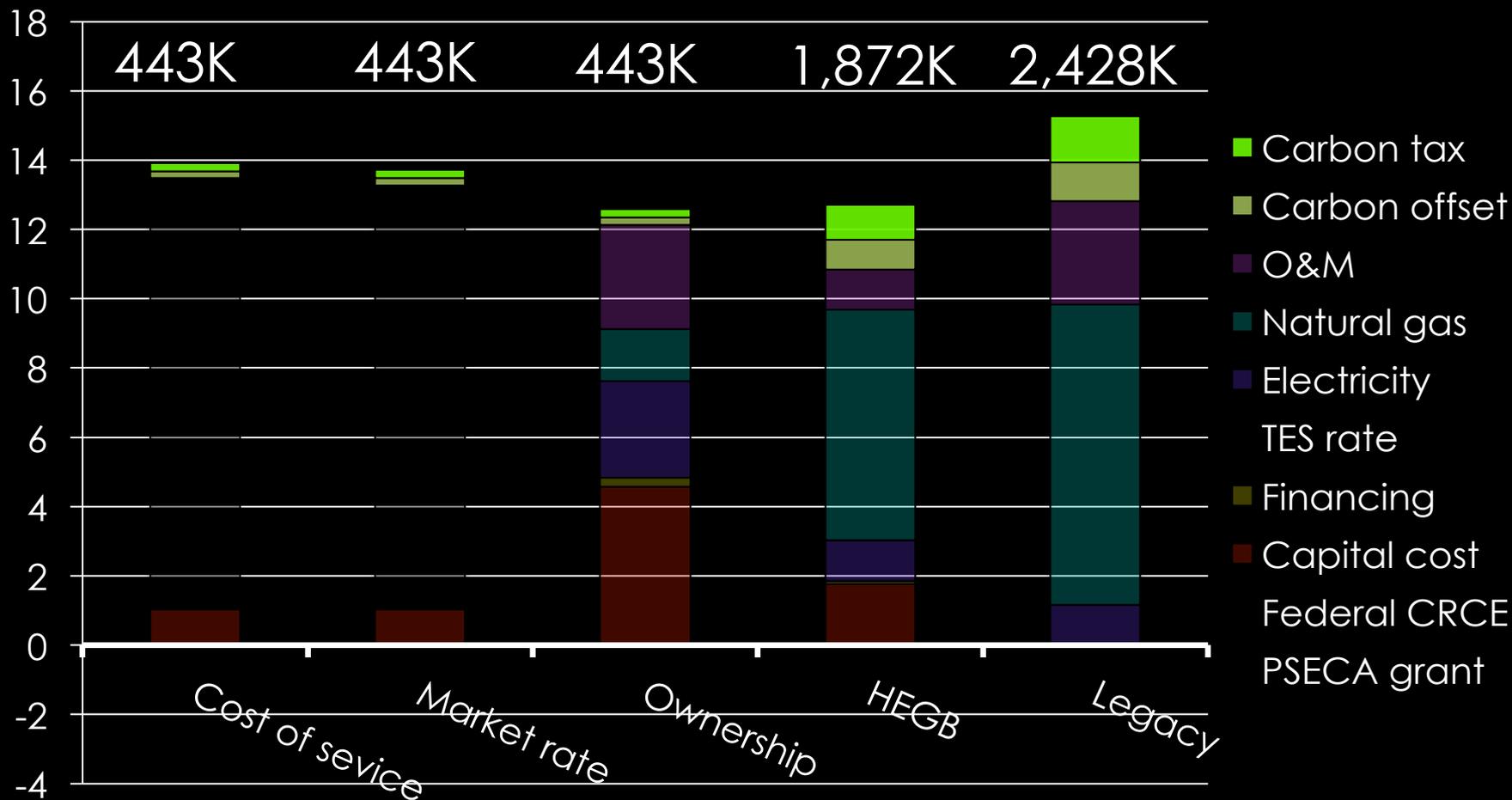
NPV of cash flows for *DSB*



NPV of cash flows for *Canada*

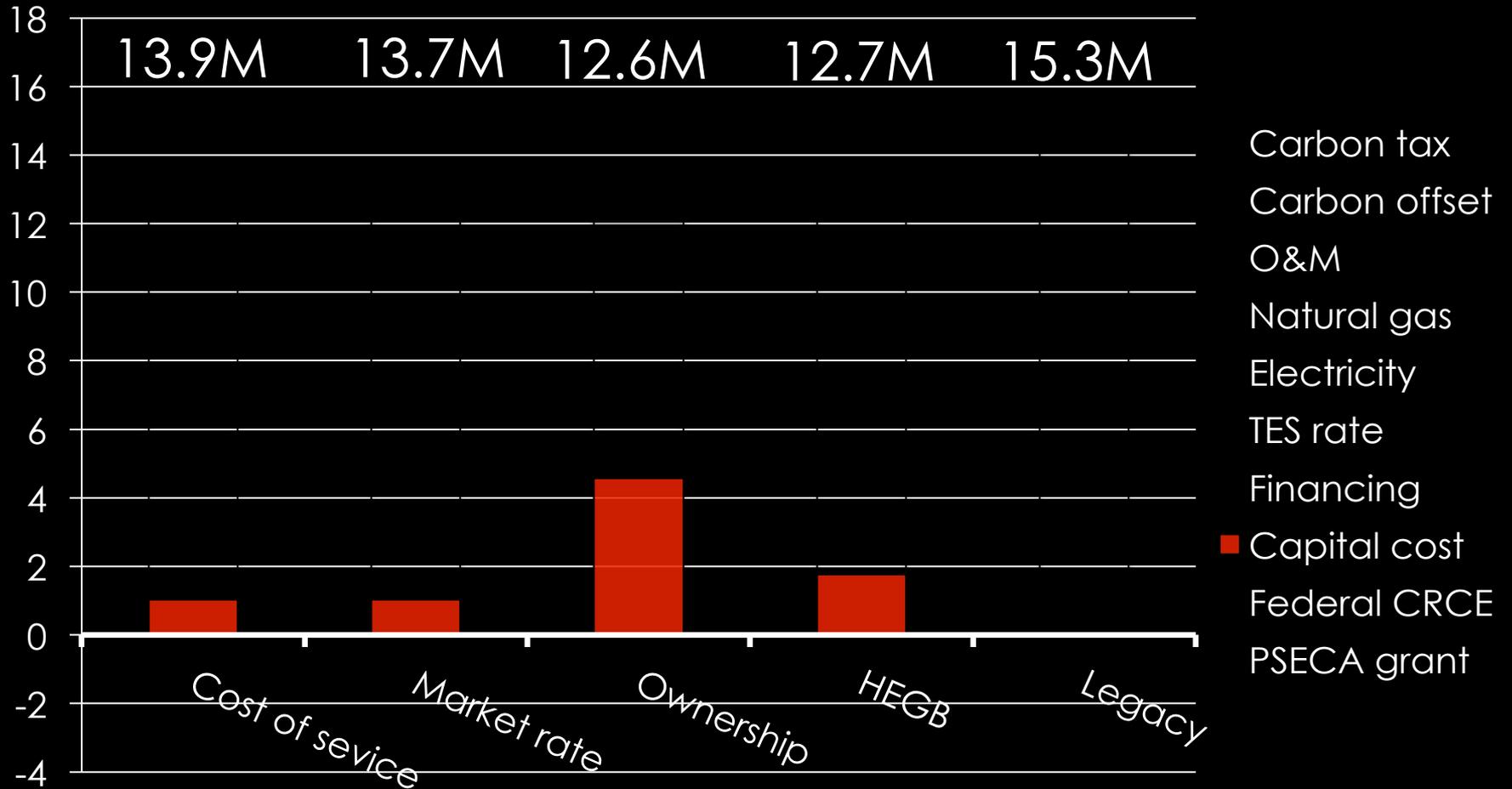


Kermit tax: \$1.2M





Scrooge tax 1.3M



Summary

- The Delta School Board was subject to financial constraints, and desirous of being green.
- They agreed to pay:
 - \$1.3M premium to avoid capital costs
OR \$1.2M premium above carbon neutrality for green tech
 - & they received \$3M in government grants to fulfill their choice.
- As the enabler, FortisBC will earn a regulated rate of return (9.5%) for the next 20 years.

Overall Summary

- The great challenge in IAMs is realistic representation of transition pathways.
 - Sound decision-making is perverted by social & institutional factors – even when intentions may be noble.
 - They involve non-economic barriers and bridges that are probably regional and poorly characterized.
 - Tech change under non-economic factors remains a challenge that is not well represented by a back-stop formulation.

Acknowledgements

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UBC

Our presentations & a few papers can be found at:

<https://www.dropbox.com/sh/9skgog59wdd3m4x/AAQzsPhamXaRmGOIOhyz7Dpa?dl=0>

Examples from transportation

Road Transport is 40% of GHGs in BC

Car ownership is down and temporary access to private transport is up. What impacts can we expect from these trends

- GHG emissions
- Criteria pollutant emissions
- Driving behaviour and collisions
- Demand for other modes of transportation



Background

- In a 2014 survey in Vancouver, ~25% report that they gave up owning a car when they gained access to car-sharing.
- Martin & Shaheen (2011) report that those who use car-sharing reduce their VKT by ~15% (GHGs: ~0.5t/yr).



Cars: *Owned* cf. *Shared*

5 mechanisms impact GHG emissions:

- Higher use of public transit/walk/bike
- Higher chance of trip aggregation
 - Lower VKT
 - Hot engine starts
- Right sized vehicle for the task at hand

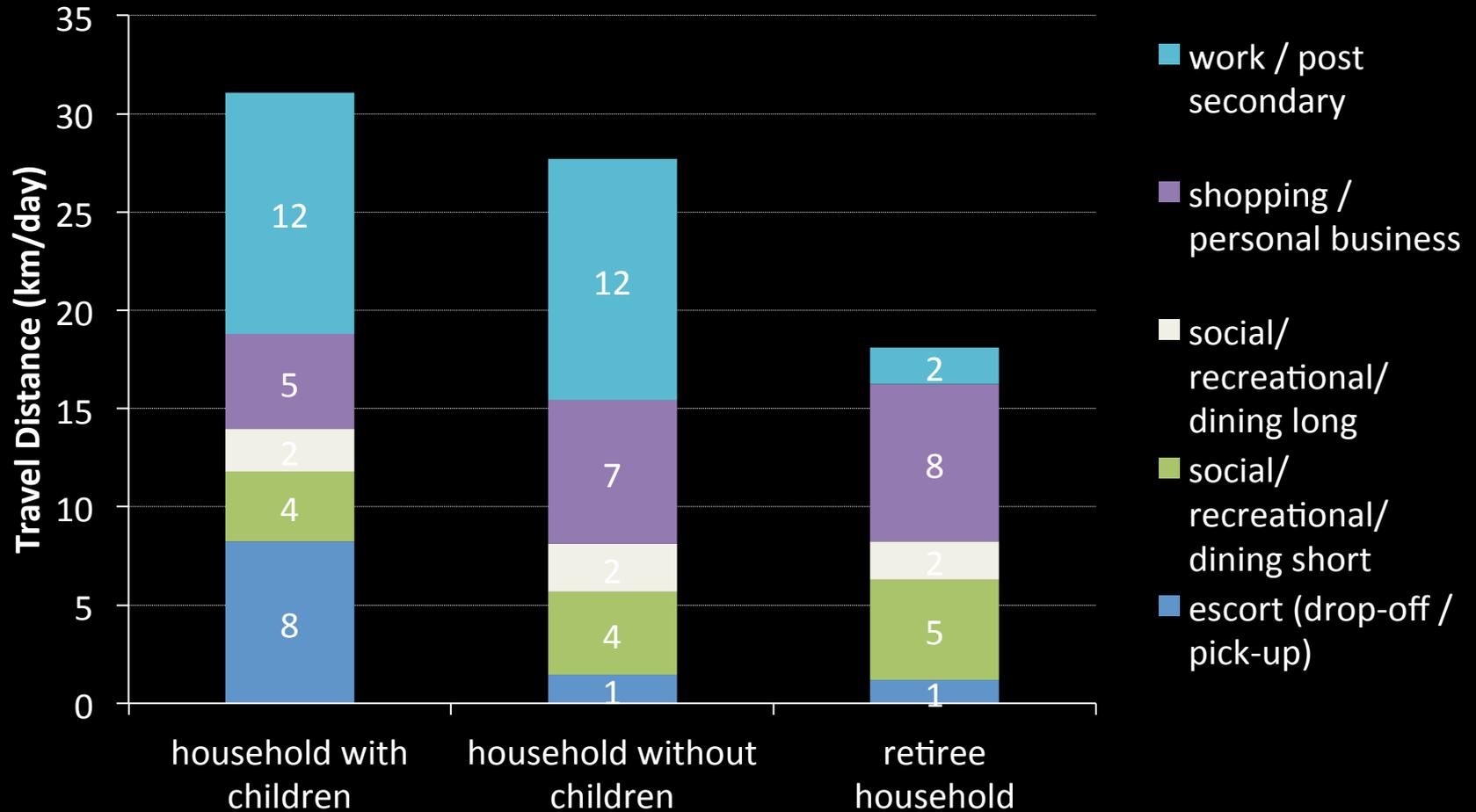


Level of Analysis: *households*

- All else held constant, the capacity to switch away from car ownership varies by hh trip patterns.
- Trip diaries reveal that patterns vary by household type and location.
- We hypothesized three household types in an urban setting:
 - Household with children and one or more employed outside the home.
 - Household without children and one or more employed outside the home.
 - Household of retirees (i.e. no commuting)

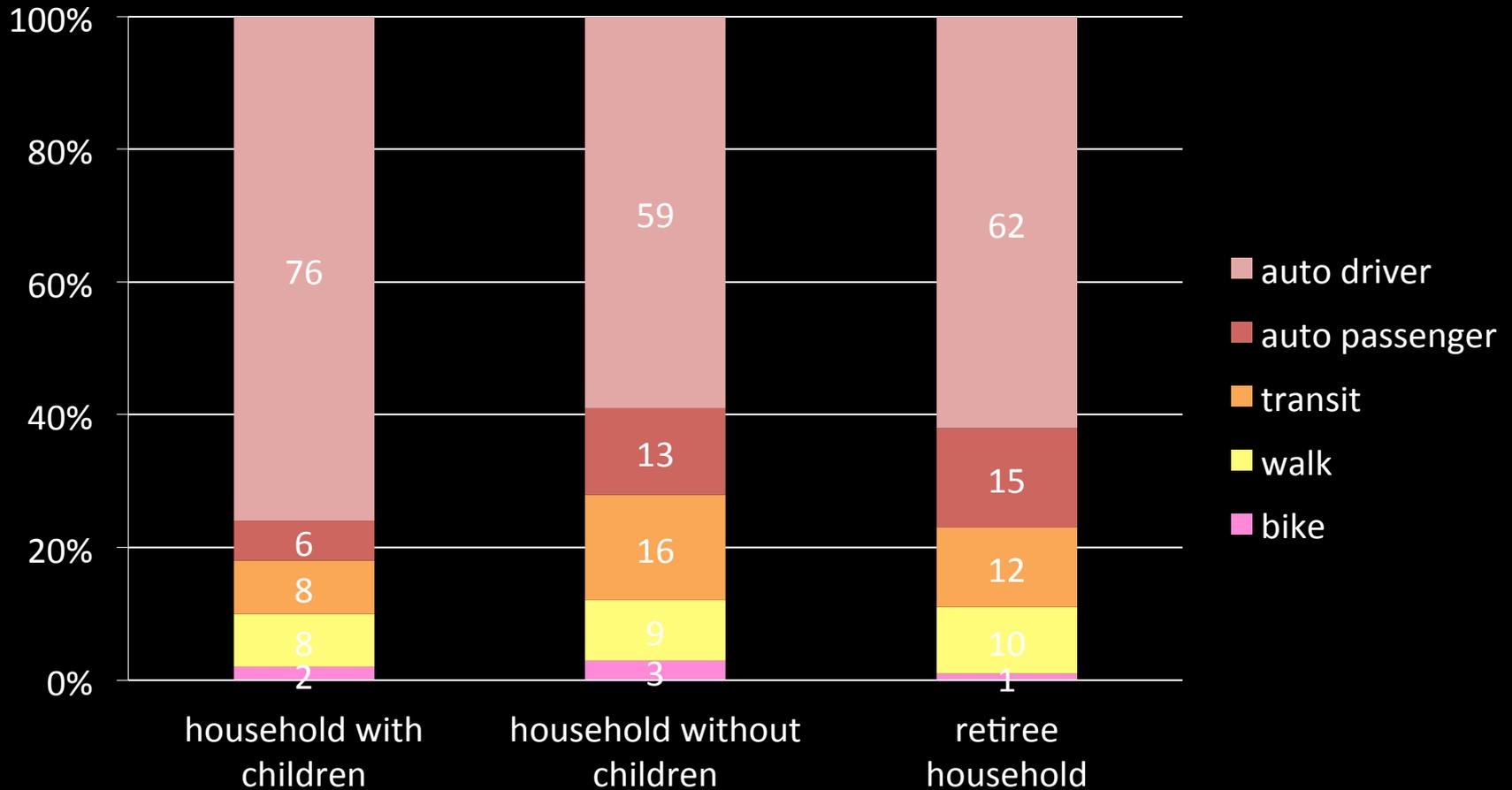


Trips by Household



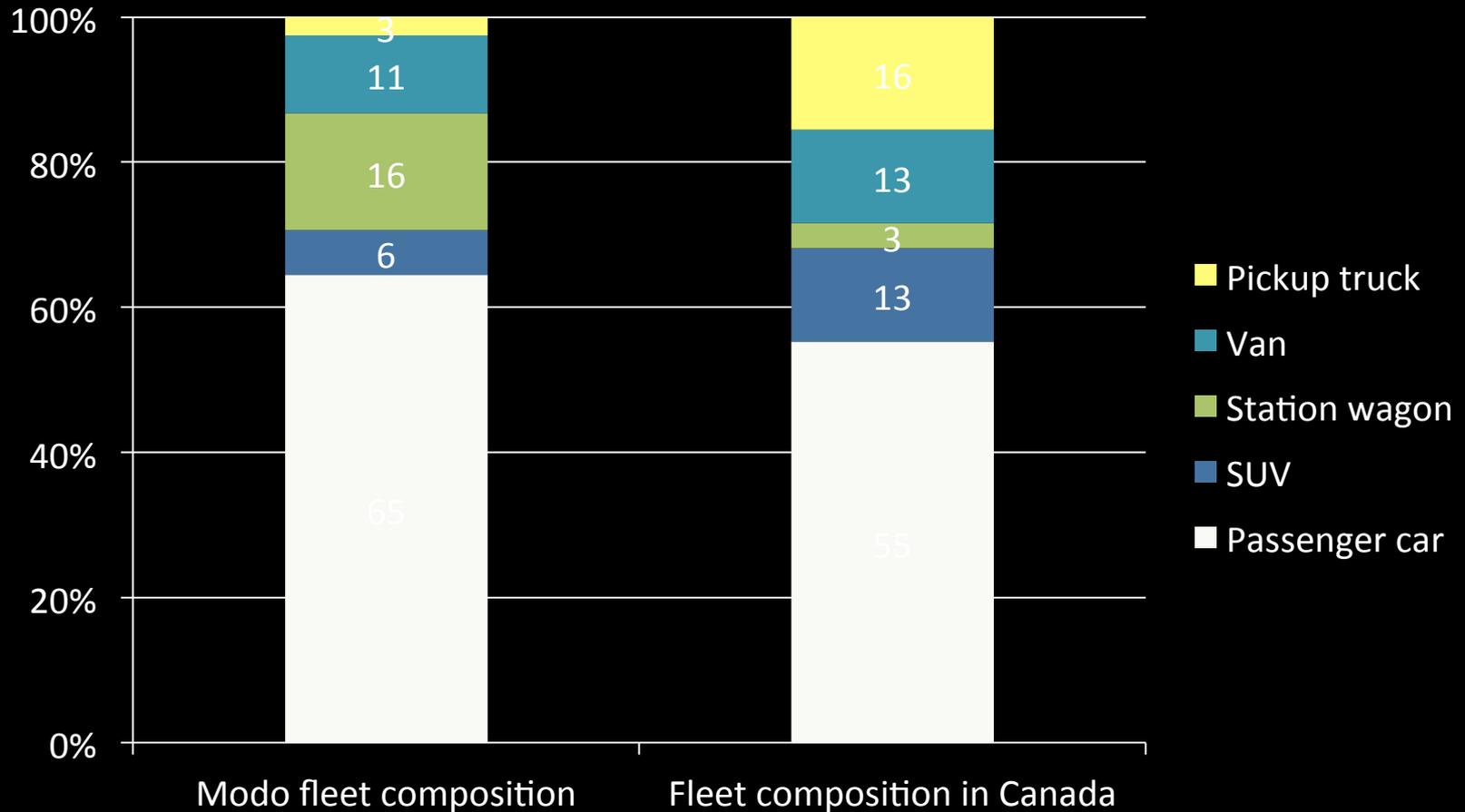


Transport Mode by Household



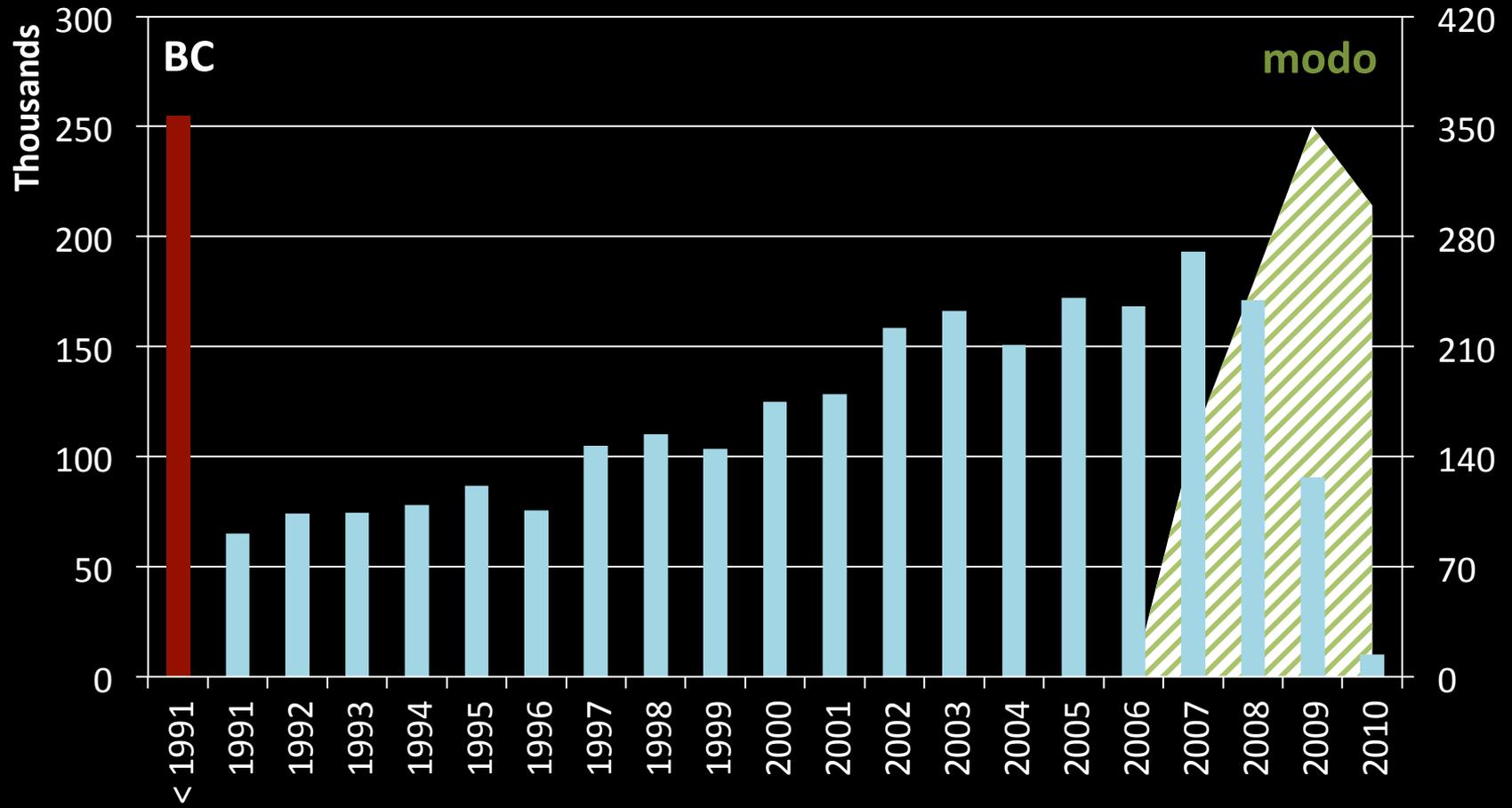


Fleet Composition: modo cf. Canadian Av.

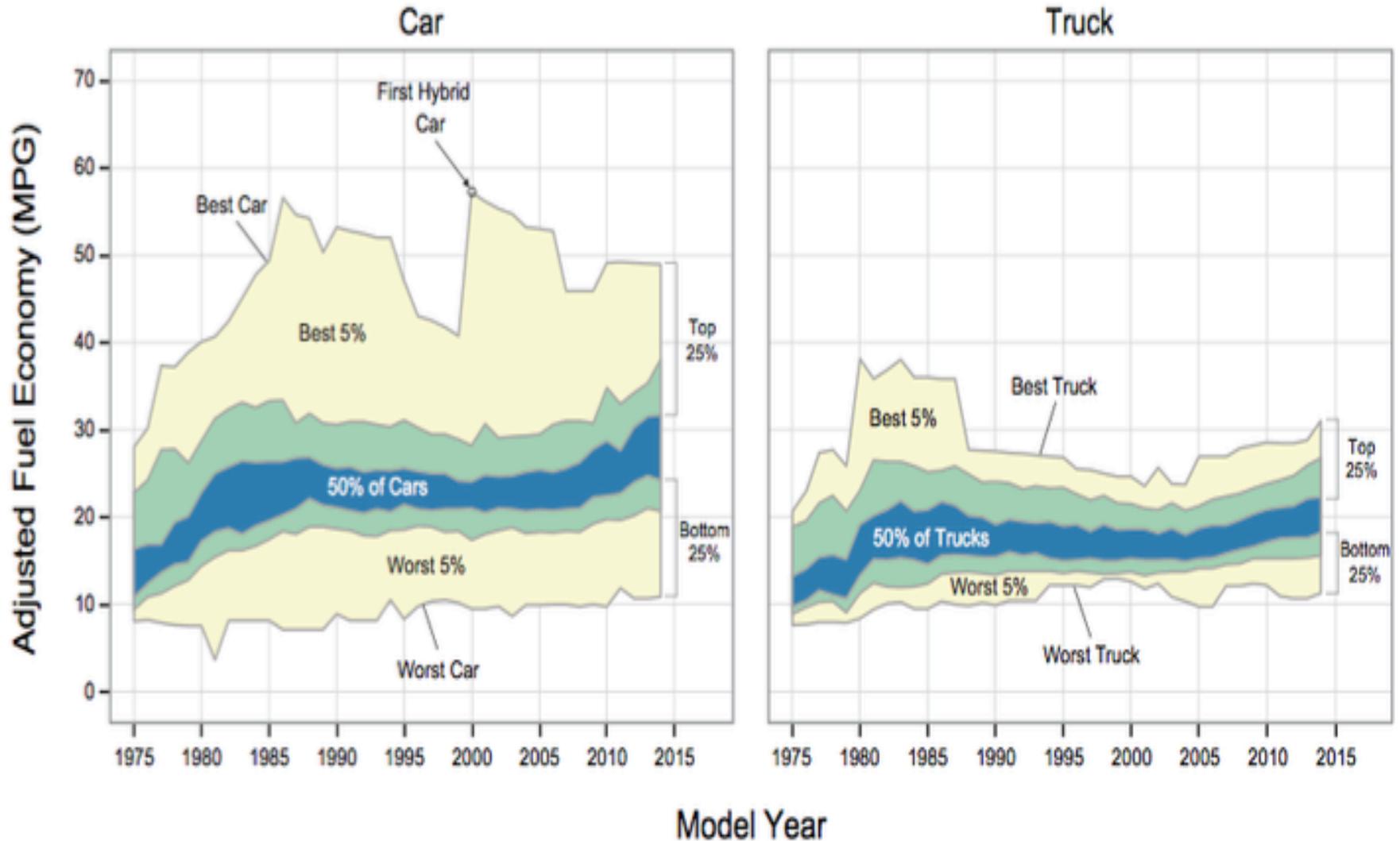




Fleet Age Structure: BC cf. modo



Trends in & Range of Fuel Economy

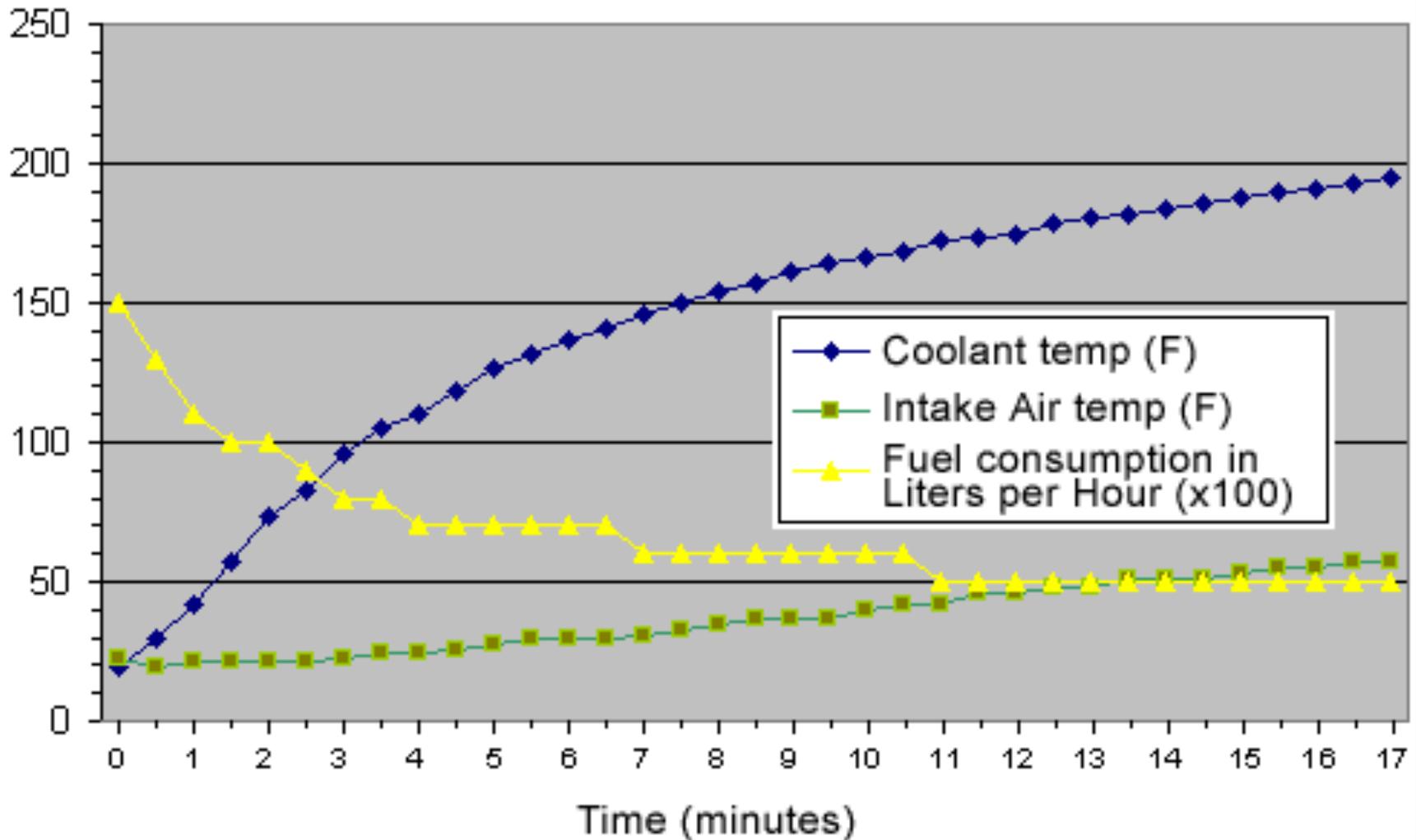


Drive Train Choices: Ford Focus

	<i>Eco*</i>	Base	Sport
Engine Capacity (L)	1	2	2
Cylinders	3	4	4
Horsepower	125	160	252
Urban Cycle (L/100km)	8.1	9.3	10.2
Highway Cycle (L/100km)	5.9	6.7	7.3
Combined (L/100km)	7.1	8.1	8.9



Cold start warm-up: 1998 Pontiac Firefly 1.0 (Geo Metro) (Idling; ambient temp: -7 C / 19 F)



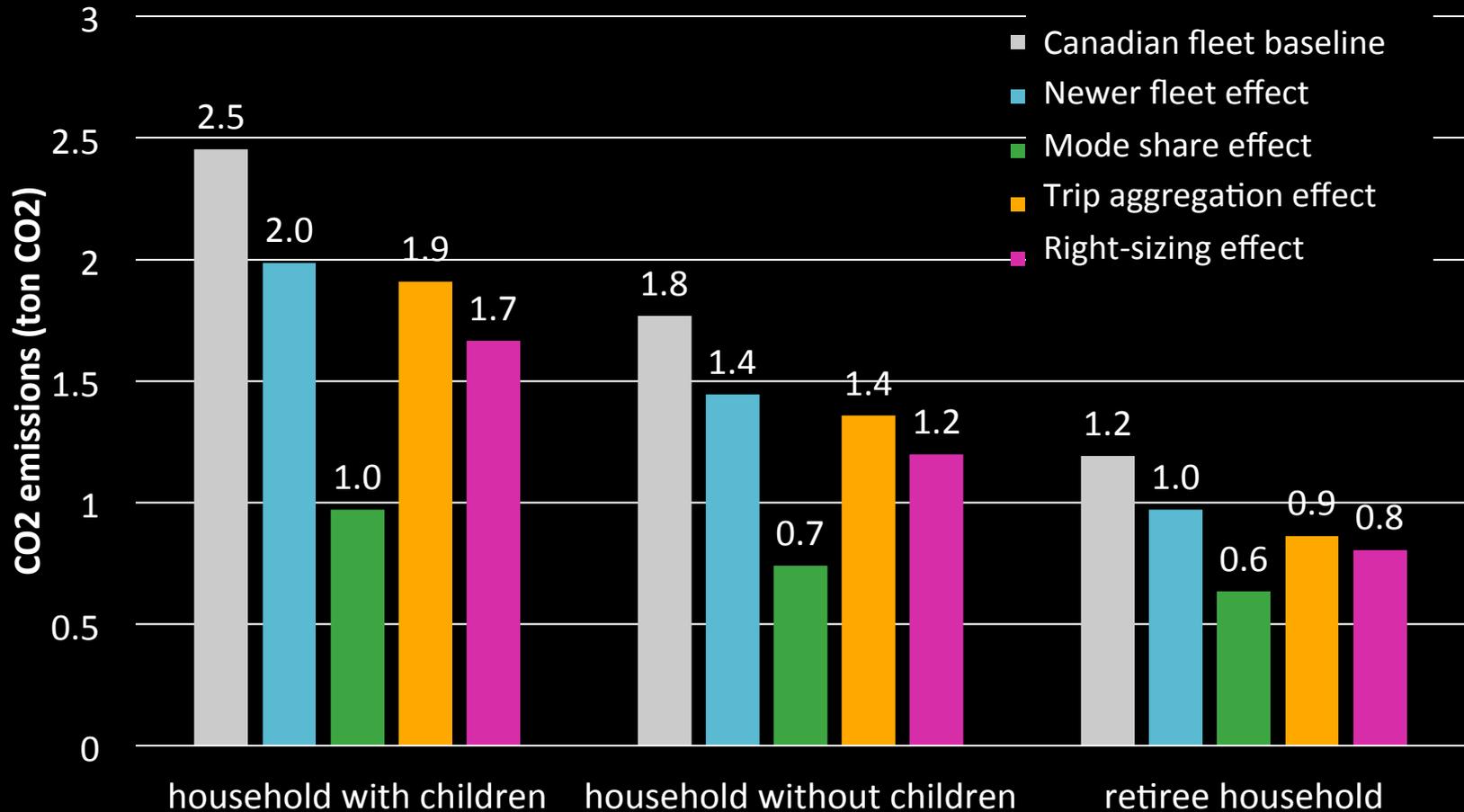


Scenario Assumptions

	Household with Children	Household without Children	Retiree Household
Mode Change	<ul style="list-style-type: none">• Trip share of alternative modes of transport is doubled• Public transportation is used for commuting and escorting		
Trip Aggregation	<ul style="list-style-type: none">• The frequency of shopping/personal business trips is reduced by 25%.		
Vehicle Optimization	<ul style="list-style-type: none">• A station wagon is used for long social trips• A two-seater is used for Working/post secondary trips.• A compact car is used for other trips.	<ul style="list-style-type: none">• A compact car is used for shopping/personal business trips.• An SUV is used for long recreational trips.• A two-seater is used for other trips.	<ul style="list-style-type: none">• A compact car is used for shopping/personal business trips.• A mid-sized car is used for long recreational trips.• A two-seater is used for other trips.



CO₂ Emissions





Conclusions

- Short-term access –in the absence of VKT reductions or mode shift – can reduce GHG emissions by >30%.
 - ~ 20% of savings arises from more stringent efficiency standards, newer fleet and more efficient drivetrains within a model offering.
 - ~ 10-15% of savings arises from right-sizing.

Given challenges in expansion of public transit how can we encourage more car-sharing until *Goosla* the self-driving solar powered car?

Improving on-road fuel efficiency

- ~10% of GHG emissions from road transport is due to *avoidable* road roughness.
- Road maintenance is subject to many conspiracy theories & significant financial constraints.
- If road resurfacing could be less expensive, we could lower GHG emissions.
- In-situ road recycling:
 - <50% of conventional
 - ~20% of GHG emissions in resurfacing

Why not?

- Contracts are:
 - negotiated in the Fall for the following year,
 - since the oil crisis, they are “cost plus” for material!
- BC finance:
 - carbon taxes (6.7 ¢/L)
 - gasoline taxes (14-25 ¢/L)