IMACLIM-R France:
Focus on Heating Demand

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Outline

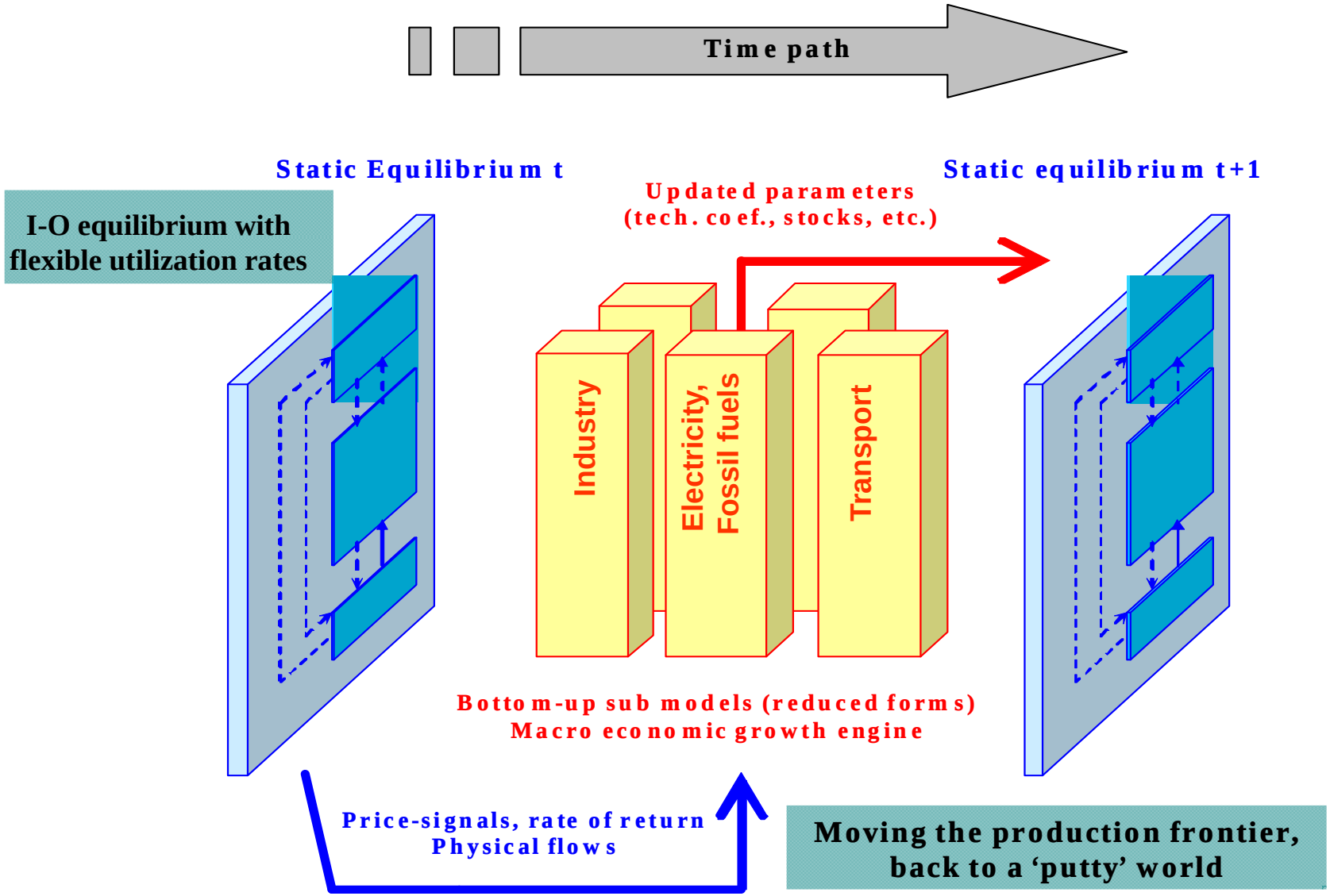
I. **Model**

II. **Results**

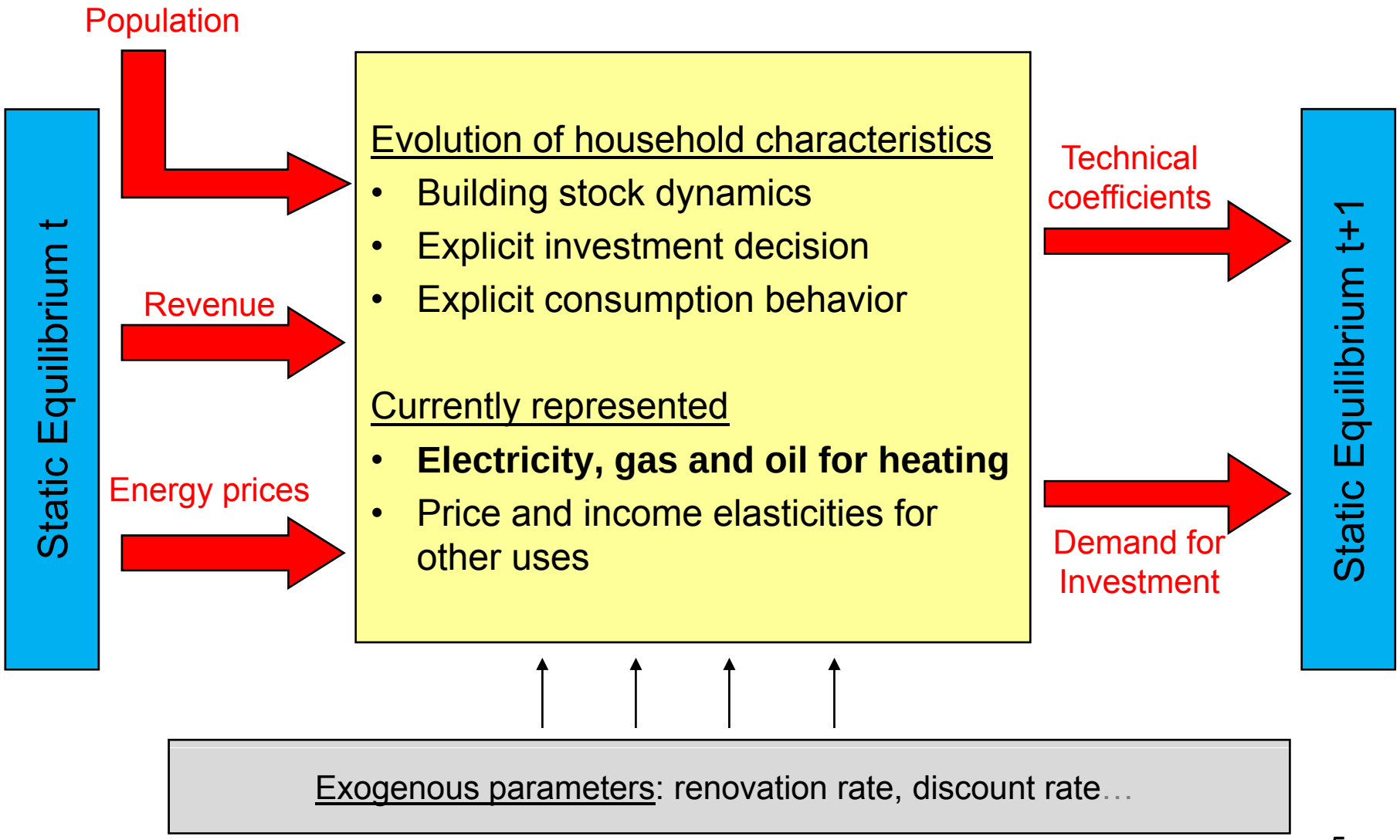
III. Perspectives

I. Model

IMACLIM-R Hybrid Structure

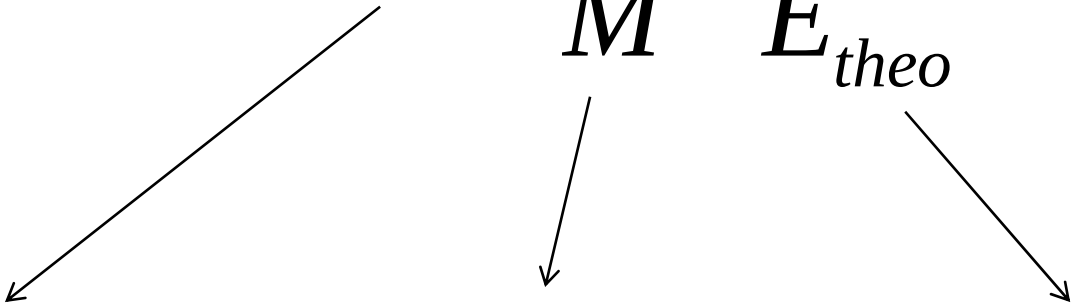


The Residential Sub Model



Demand for Heating Energy

$$E_{real} = M \frac{E_{theo}}{M} \frac{E_{real}}{E_{theo}}$$



Term 1:
Volume variable

Term 2:
Theoretical unitary consumption

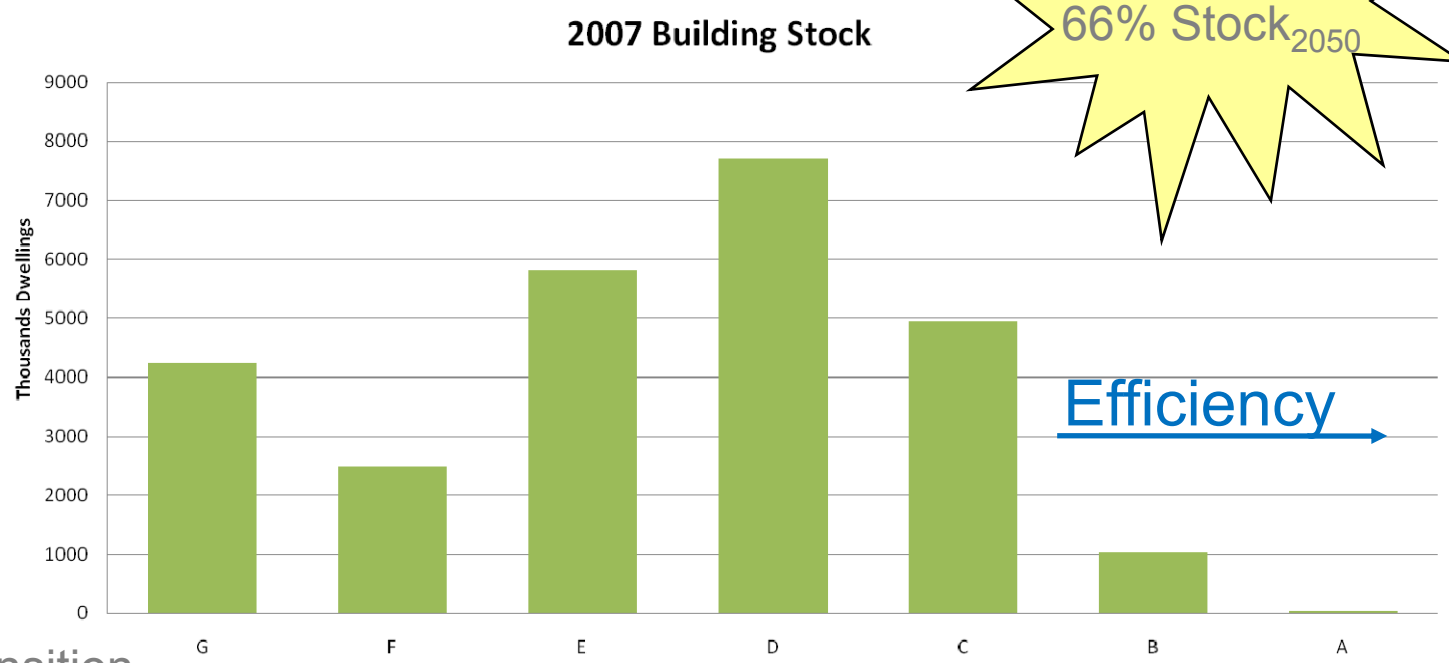
Term 3:
Service factor

$$[kWh] \equiv [m^2][kWh / m^2][\ \ ]$$

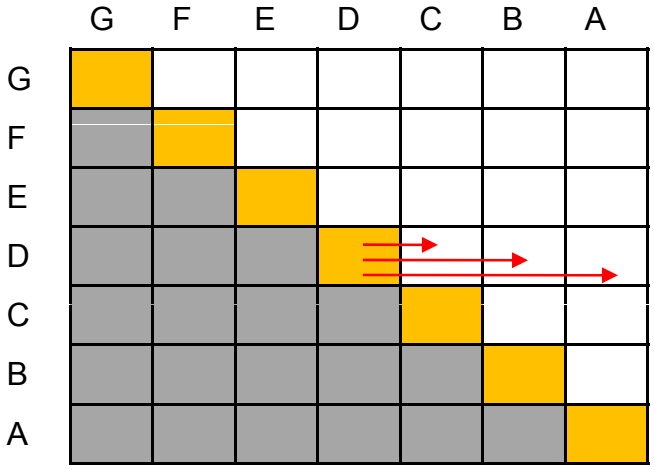
Renovation Dynamics

$Stock_{2007}$ = 66% $Stock_{2050}$

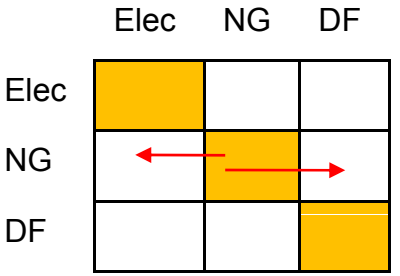
Renovation rate



Energy class transition



Fuel switch



Term2: Investment Decision

- Market Share Function (*à la* CIMS)

$$MS_i = \frac{LCC_i^{-\nu}}{\sum_j LCC_j^{-\nu}}$$

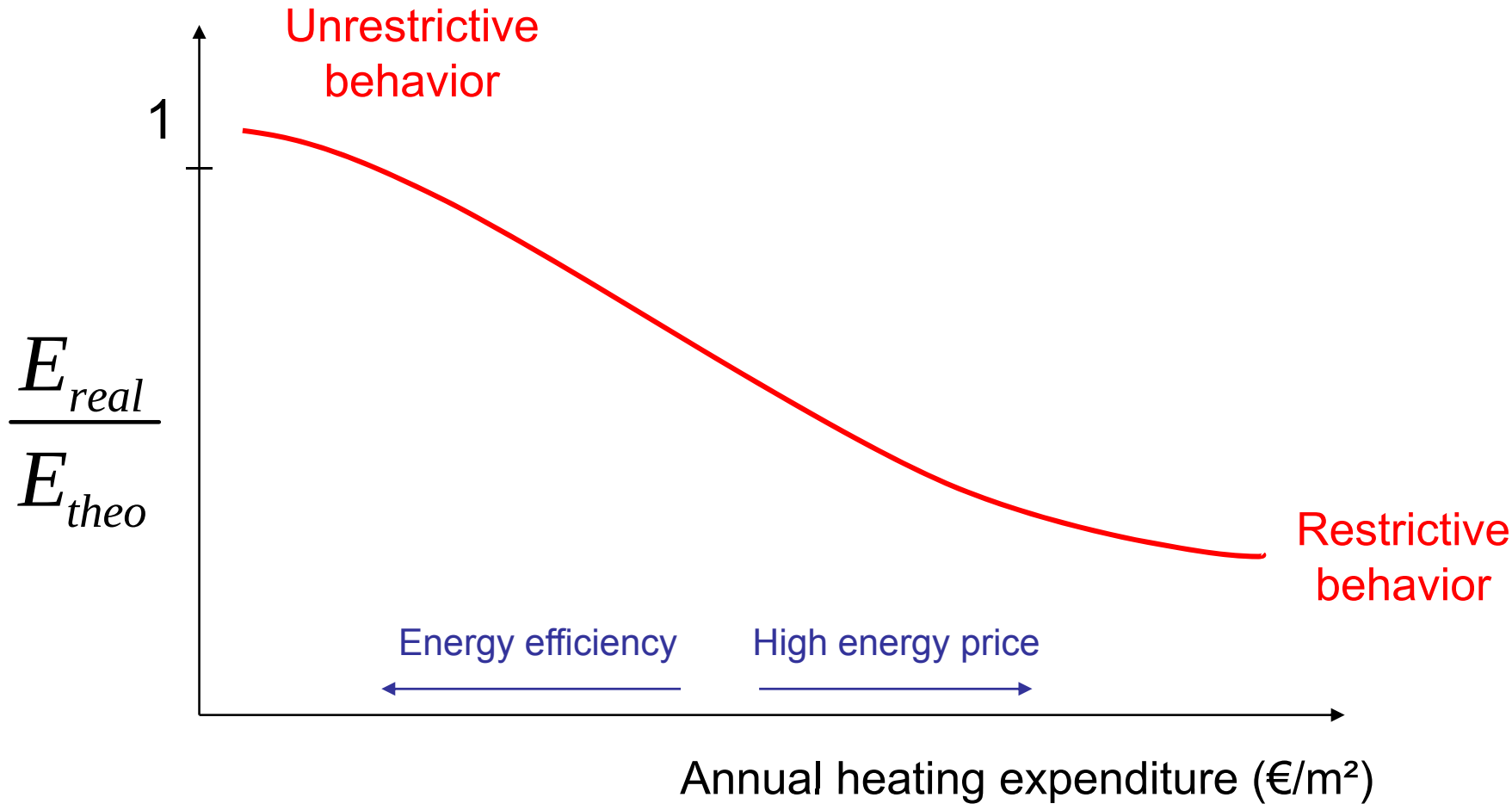
- Life cycle cost with myopic expectation

$$LCC_i = CINV_i + CENER_i(Pener_t, disc)$$

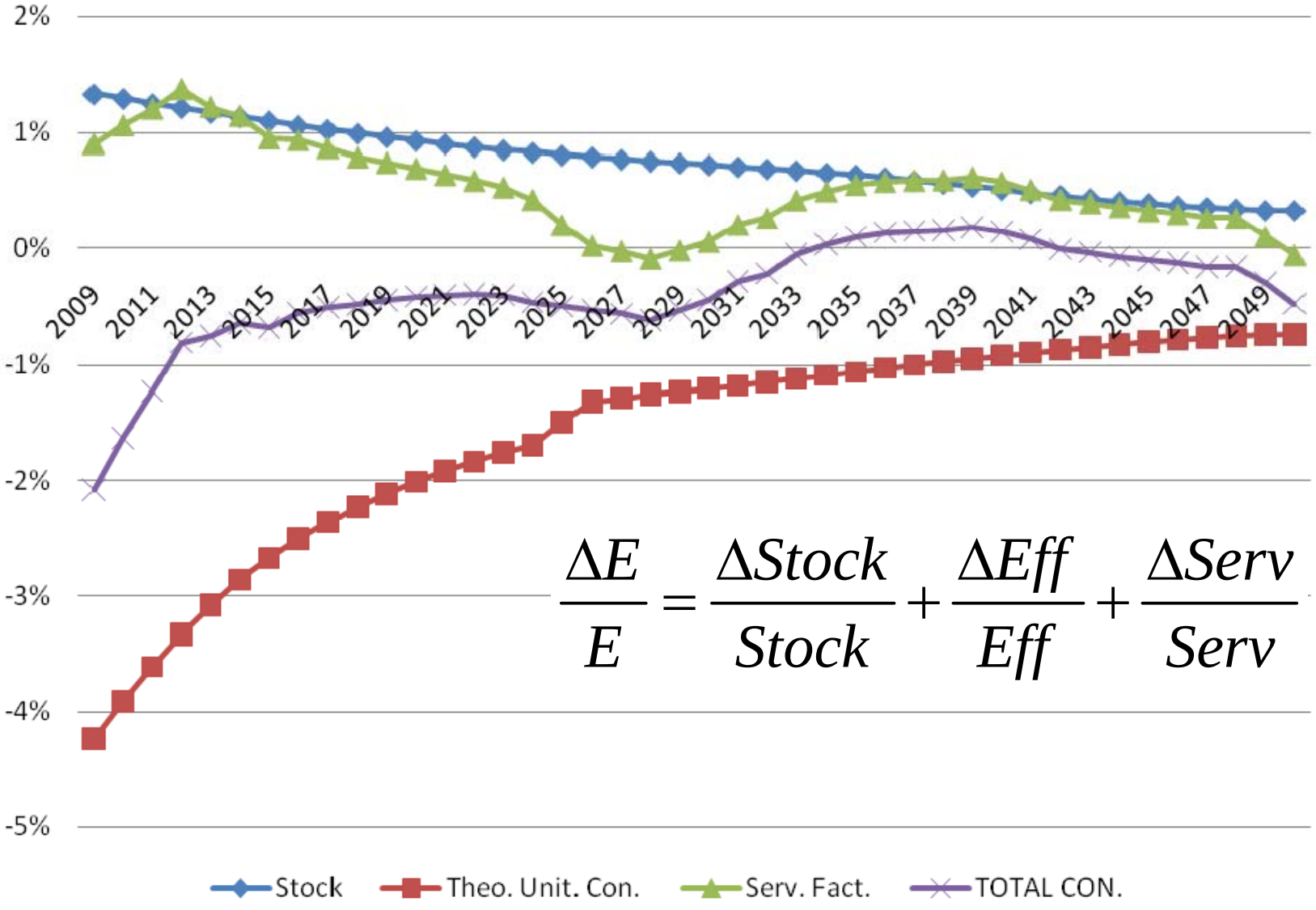
- Heterogeneous discount rates

	Individual dwelling	Collective dwelling
Landlord	4%	6%
Tenant	8%	10%

Term3: Consumption Behavior

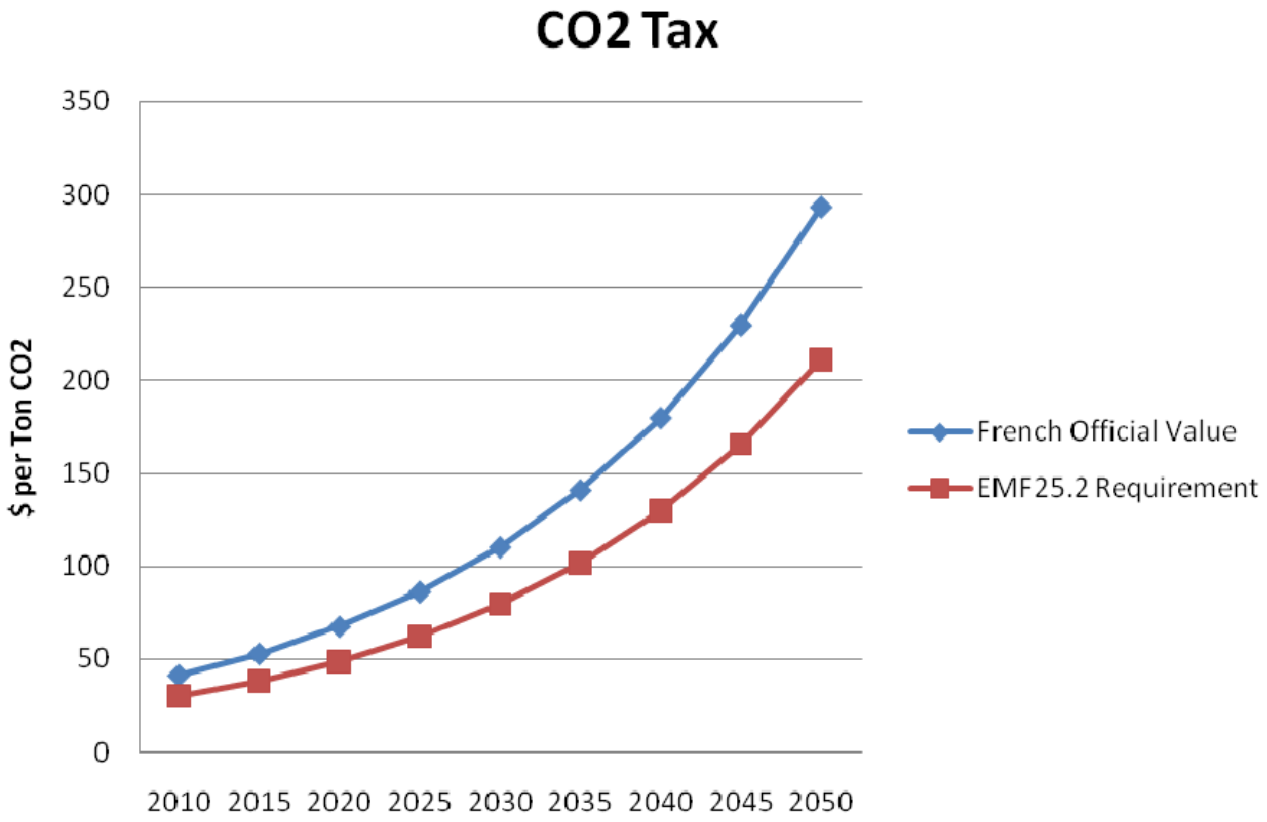


Demand drivers in REF scenario



II. Results

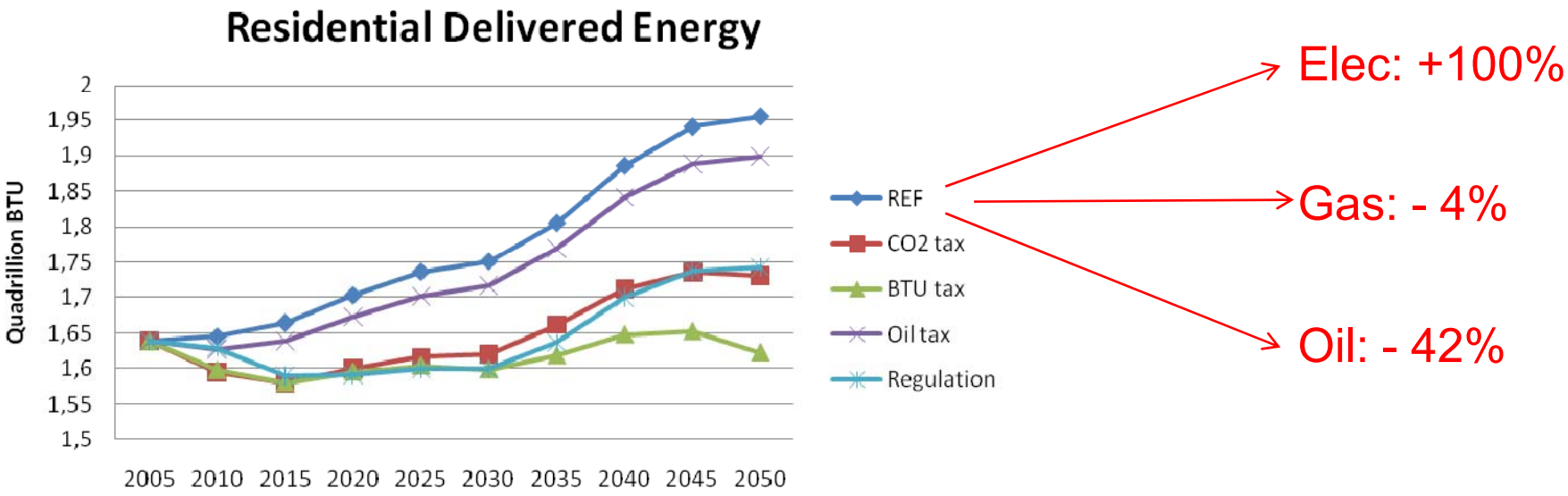
EMF Scenarios Adaptations

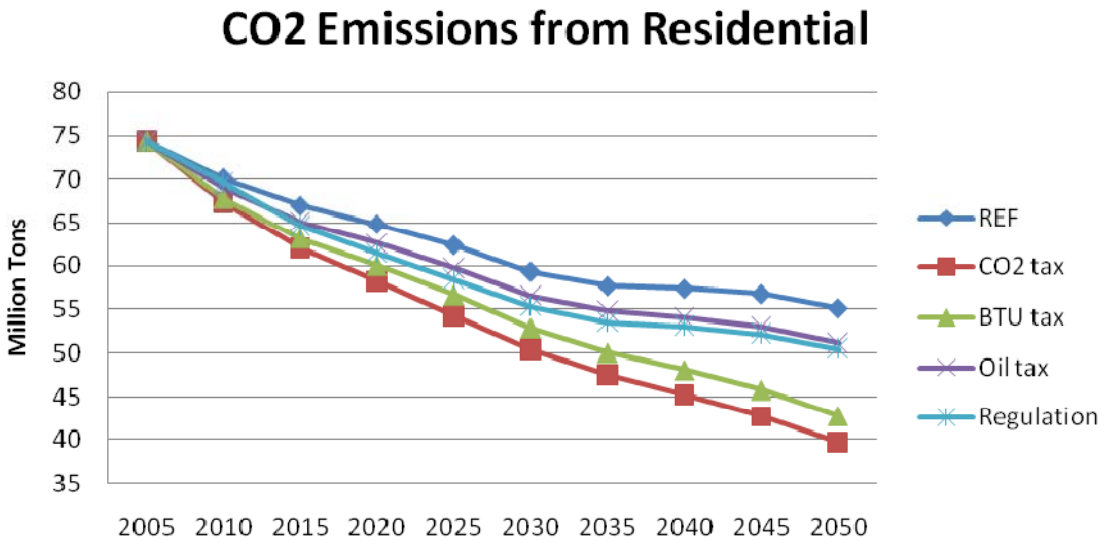


Regulation case

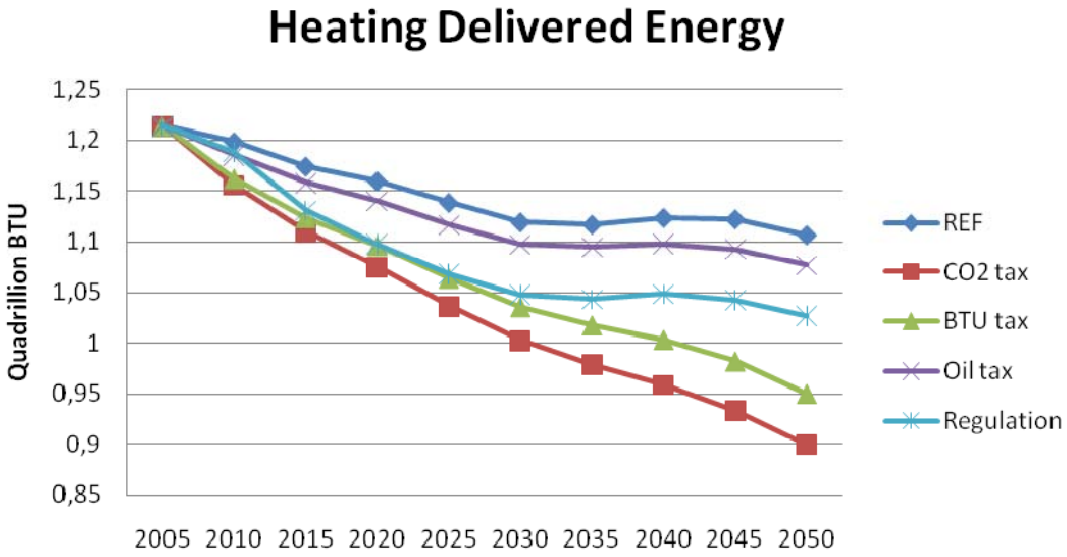
- Every renovation reaches class C
- Every new construction at « low consumption » level

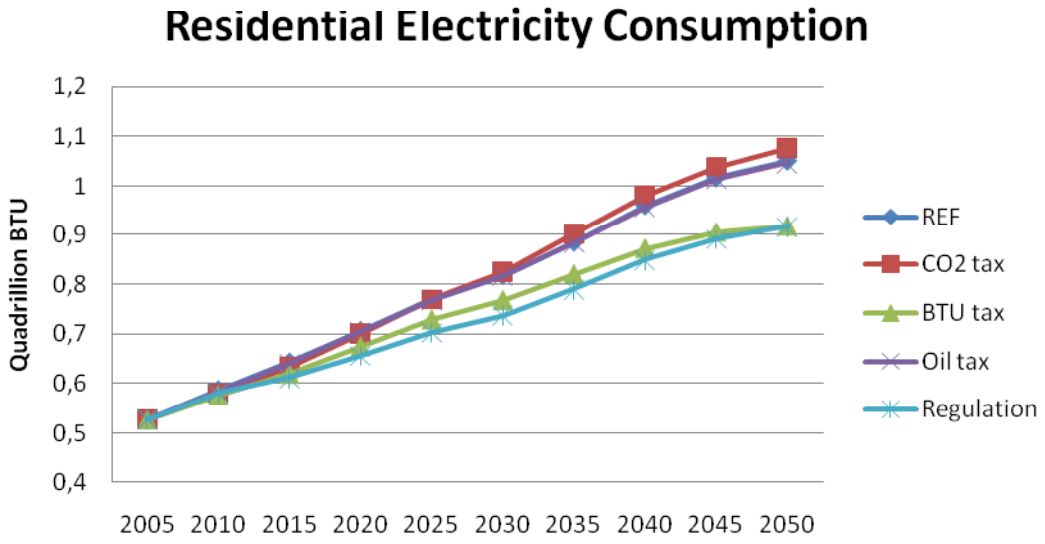
More energy with less emissions



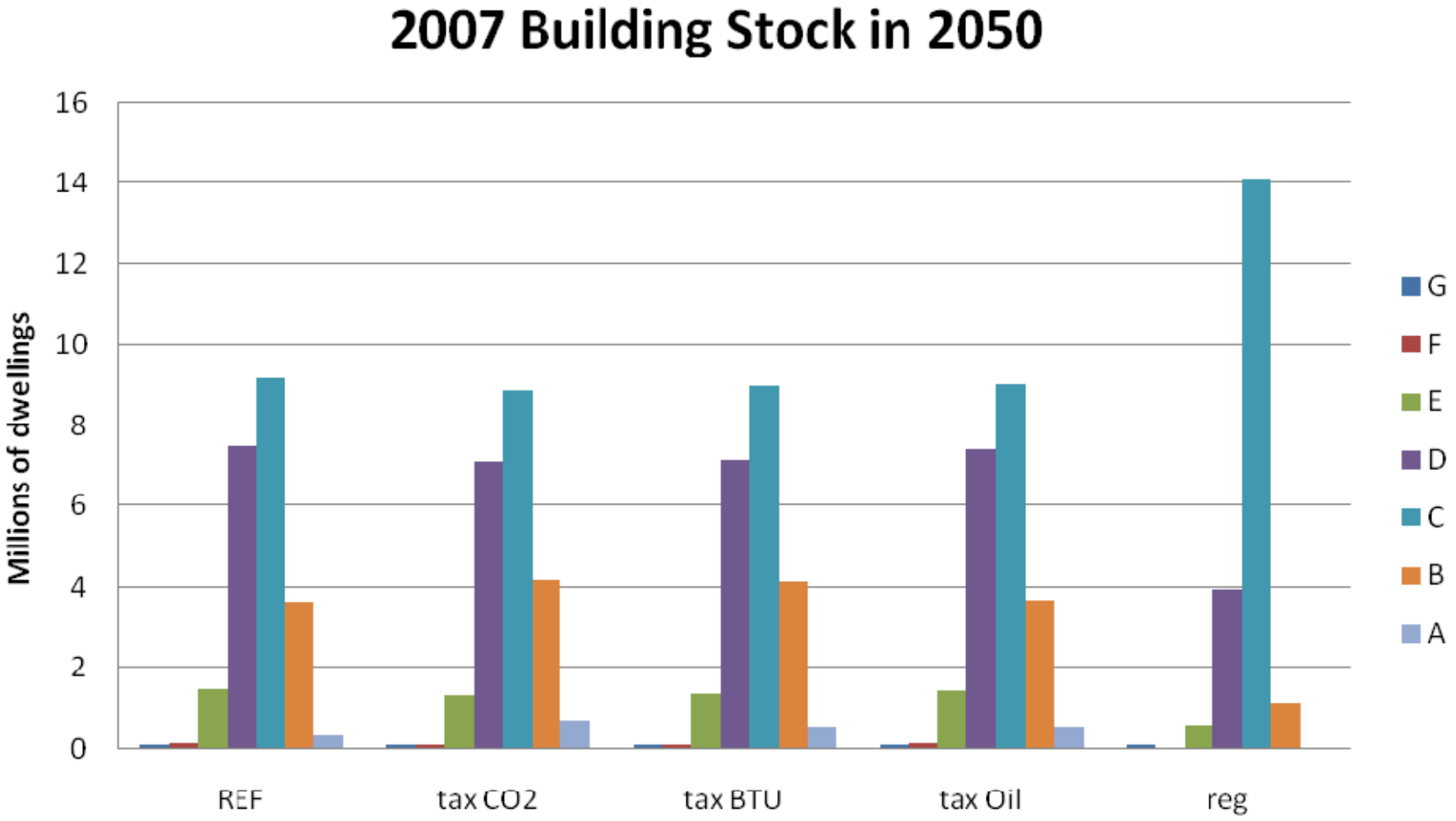


Less heating but more electrical uses

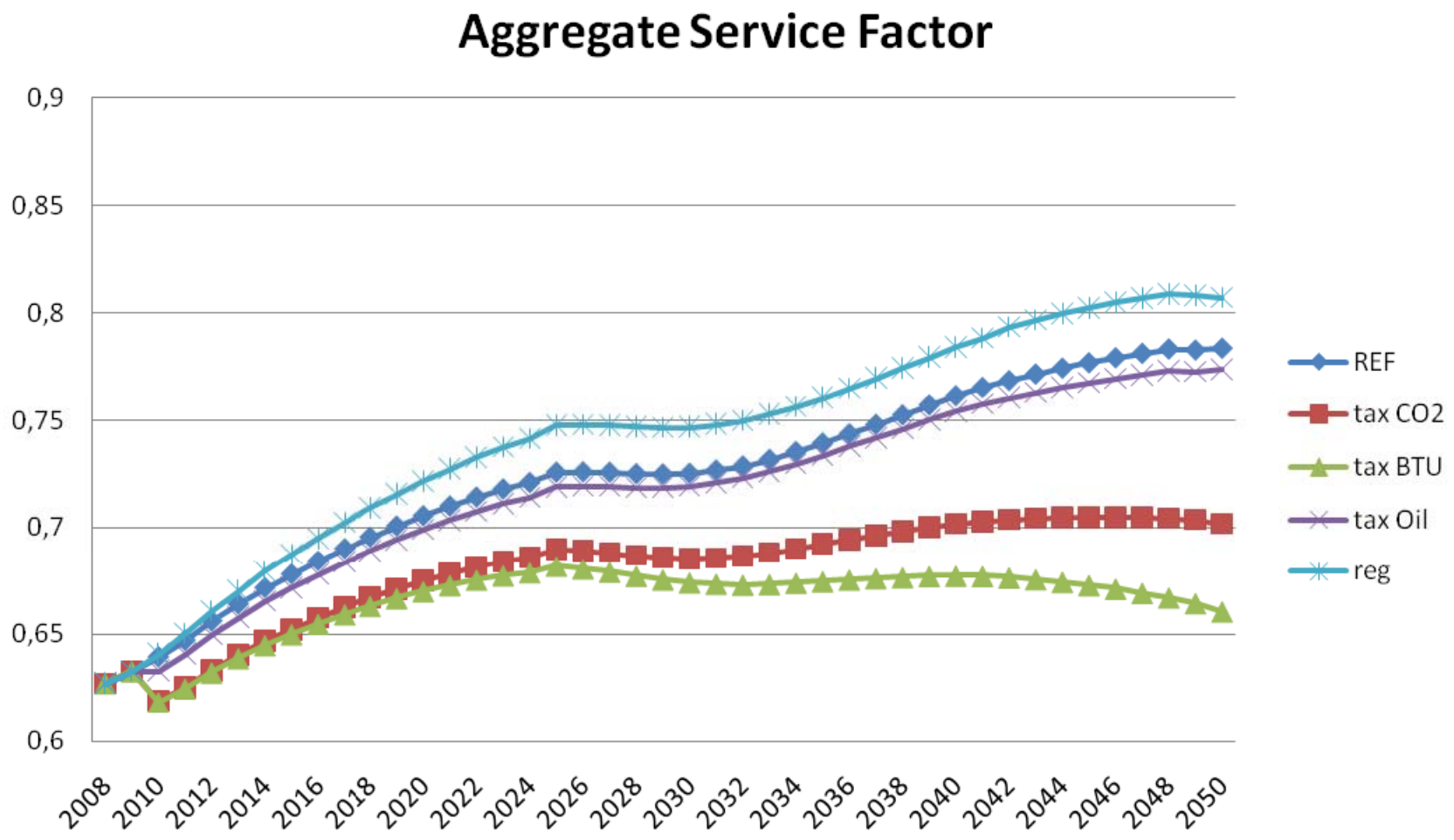




Policy Effect on Capital Structure and Efficiency



Policy Effect on « Sufficiency »



Rebound effect of Regulation compared to REF: 10%

Main Findings

- Methodology
  - Innovative representation by energy class
  - Model quite pessimistic→renovation rate
  - Electricity penetration

- Policy making
  - Potentials in renovation of « thermal wrecks »
  - Separate policy effects on efficiency/sufficiency
  - Regulation generates a rebound effect

III. Perspectives

Thermal use improvement

- Modeling options
  - Endogenous refurbishment rate
  - Induced technical change
  - Intangible costs calibrated with consistent data
- Data improvement: currently working with
  EDF, ANAH, ADEME, Ministry, CSTB
- Sensitivity analysis

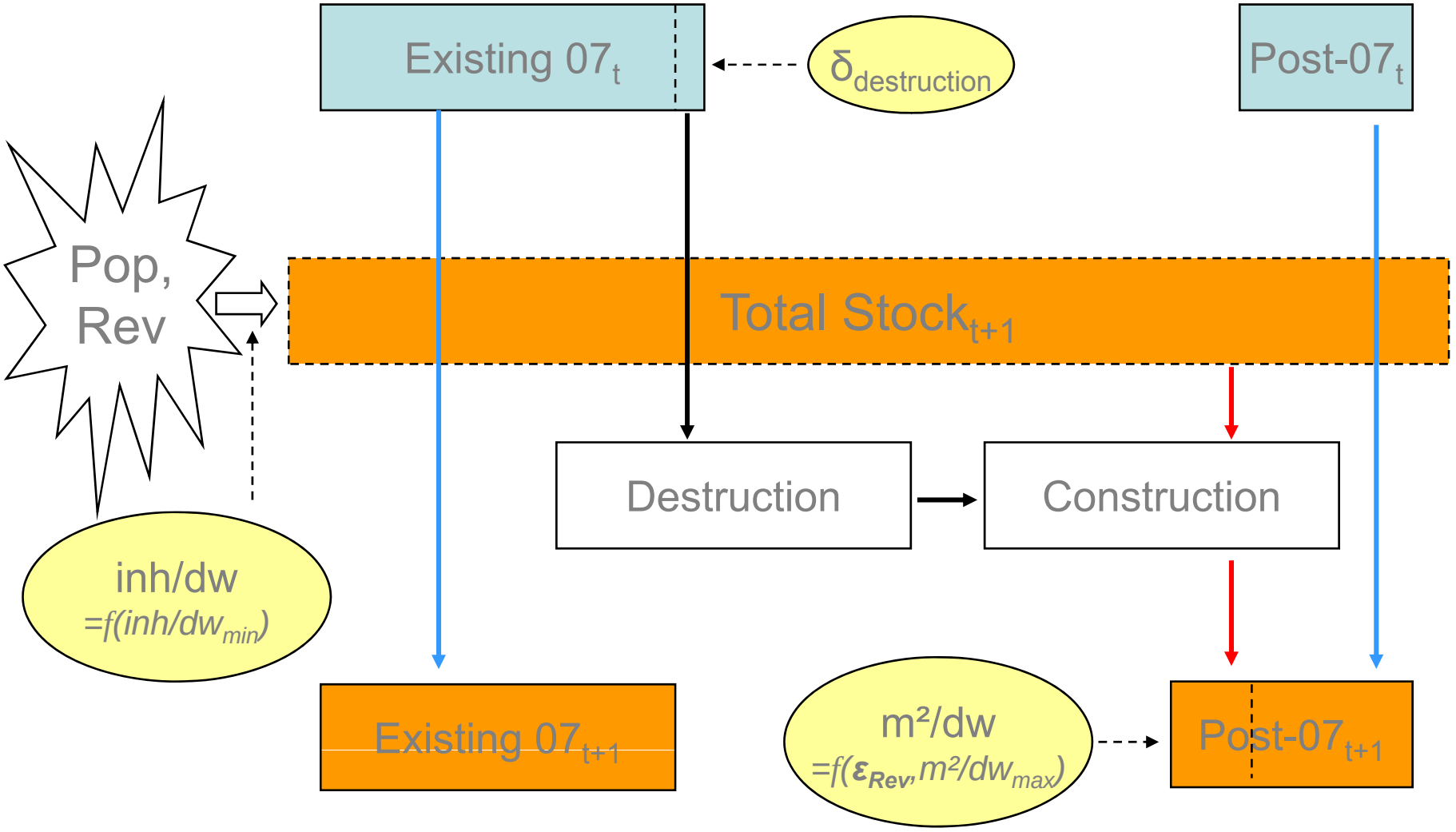
Further steps

- Whole residential uses modeling
  - Hot water → conditionnal link to heating
  - Specific electrical uses
  - Other policies: white certificates

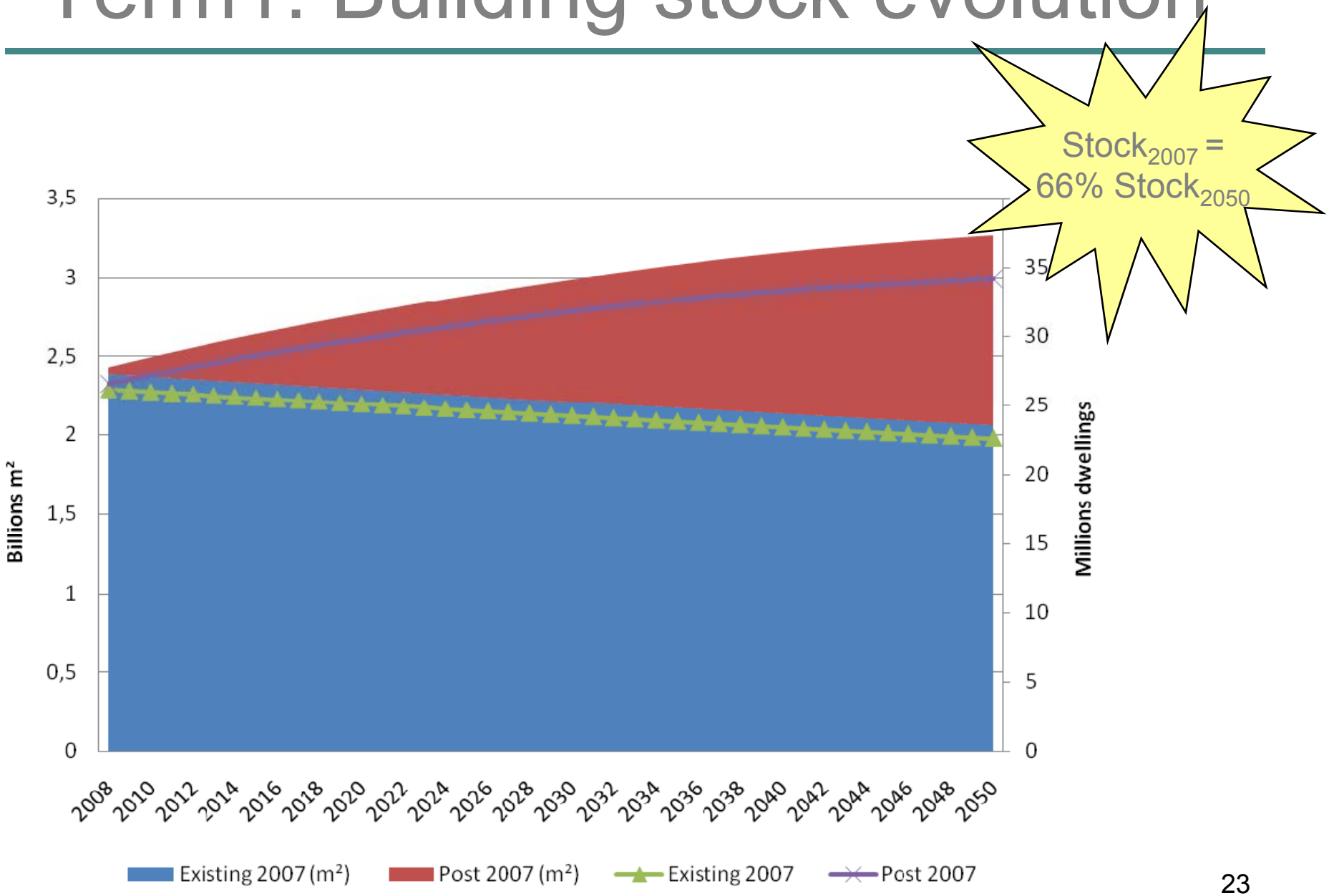
- Hard-link to the CGE model
  - Link with other sectors: rent market, building market
  - Budget constraint
  - Utility?

Appendix

Term1: Building Stock



Term1: Building stock evolution

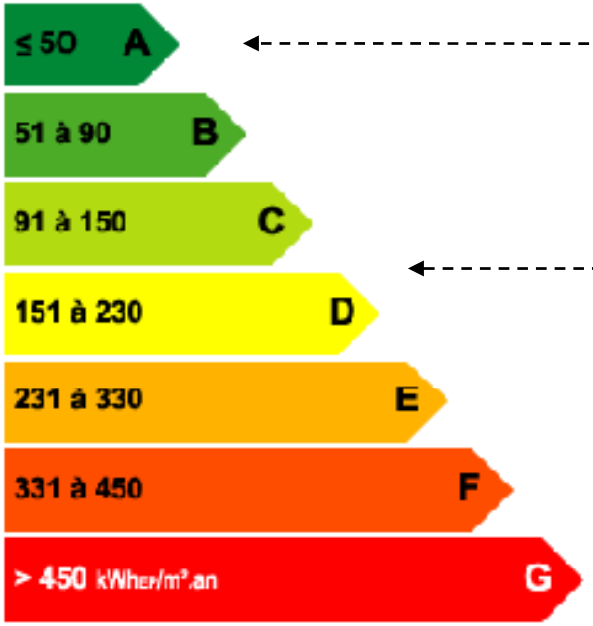


Technologies for Thermal Use

Thermal performance

- Envelope
- Energy carrier

+++ *aggregated representation*
- - - *cost dispersion*



Existing buildings

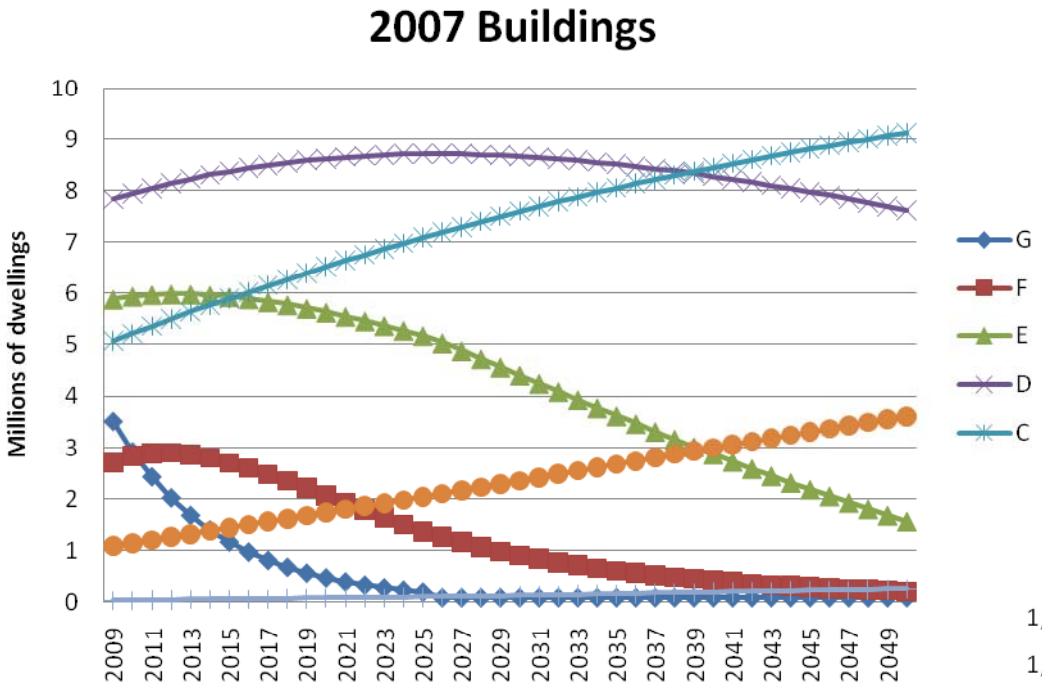
MAISON CERTIFIÉE BBC

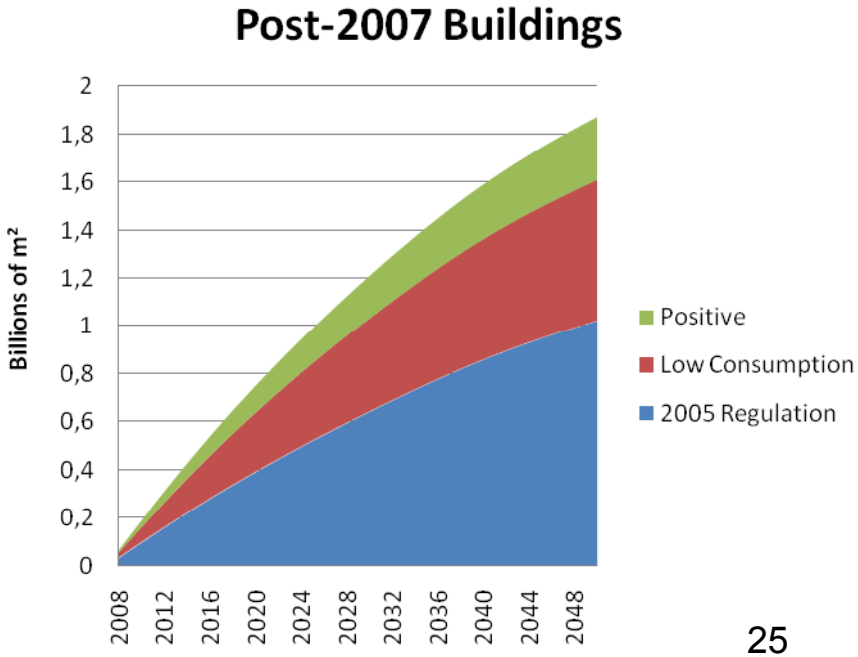
effinergie
Qualité de vie et économie d'énergie

REGLEMENTATION THERMIQUE 2005

New buildings

Energy Class Transitions (REF)





Demand for mobility

Utility Maximization $$\boldsymbol{U} = \prod \left(\mathrm{C_i} - bn_i\right)^{\xi_i} \left(S_\mathrm{j} - bn_j\right)^{\xi_j}$$

with $$S_{Mobility} = CES\left(PKT_{air}, PKT_{public}, PKT_{cars}, PKT_{non\ motorized}\right)$$

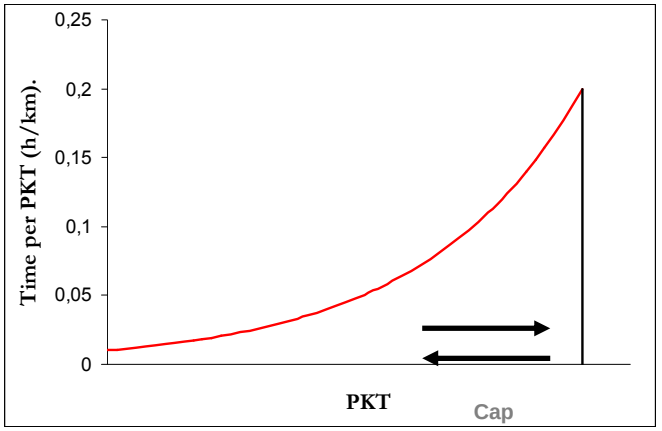
4 Modes

With Revenue and Time Constraint

$$Income = \sum_i p_i \cdot C_i + p_{public} \cdot PKT_{public} + p_{air} \cdot PKT_{air} + \sum_{\text{Energies } Ei} p_{Ei} \cdot \left(PKT_{cars} \cdot \alpha_{Ei}^{cars}\right)$$

$$Tdisp = \sum_{\text{Modes } \mathrm{T_j}} \int_0^{PKT_{T_j}} \tau_j(u)\, du$$

Transportation time
=
f(infrastructure, equipement)



Findings on Transportation

- Optimistic model for electric car costs and penetration rate
- Car choice very sensitive to oil price
- The energy efficiency indicator does not take into account fuel for the electric car