The residential refurbishment market far away from economic rationality: application of marginal abatement cost to the French white certificate

ECEEE 2015

Jean-René Brunetière (CEC)
Xiaofen Xu (ENSTA)
Marie-Hélène Laurent et Dominique Osso (EDF R&D)

White certificates in France

- Since 2006 in France (law “POPE”)
- Energy suppliers (the "obligated")
  - Must generate energy savings with their consumers
  - Attested by "energy saving certificates" (ESC)
  - Up to a total amount of “kWh cumac” each year
  - kWh “cumac”:
    - cumulated over the lifetime
    - and discounted at 4% per year
- Penalty: 2 c€ per kWh cumac missing

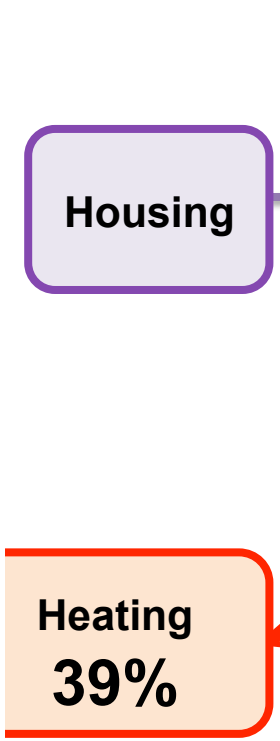
The overall annual targets of energy saving

- 1st period, 200-2009: **18** TWh cumac/year
- 2d period, 2011 to 2014: **115** TWh cumac/year
- 3rd period, 2015 to 2017: **230** TWh cumac/year
- Divided between "obligated“ parties:
  - 75 % on turnover
  - 25 % on quantity of energy sold

How to get WC ?

- 75 % of the WC come from “standardized operations” (SO) in the residential sector
  - The list of SO is fixed by the government
  - 304 sheets of standard operations (up to 2014)
  - the 10 largest cover 67% of energy savings
- We are interested here only to these “SO" in the residential sector

The main standardized operations (SO)



Sector	action	description	% kWh cumac
Housing	BAR-TH-06	Individual condensing boiler	16.02%
	BAR-EN-01	Roof insulation	9.40%
	BAR-TH-07	Collective condensing boiler	7.24%
	BAR-TH-12	wood stove	6.40%
	BAR-EN-02	Wall insulation	6.36%
	BAR-TH-08	Individual low-temperature boiler	5.39%
	BAR-EN-04	Double glazing windows	5.10%
	BAR-TH-04	air / water heat pump	3.89%
	BAR-TH-07-S2	Collective condensing boiler with energy performance contract	3.77%
Industry	IND-UT-02	Electronic speed variation system on an asynchronous motor	3.71%
Total of the top 10			67.28%

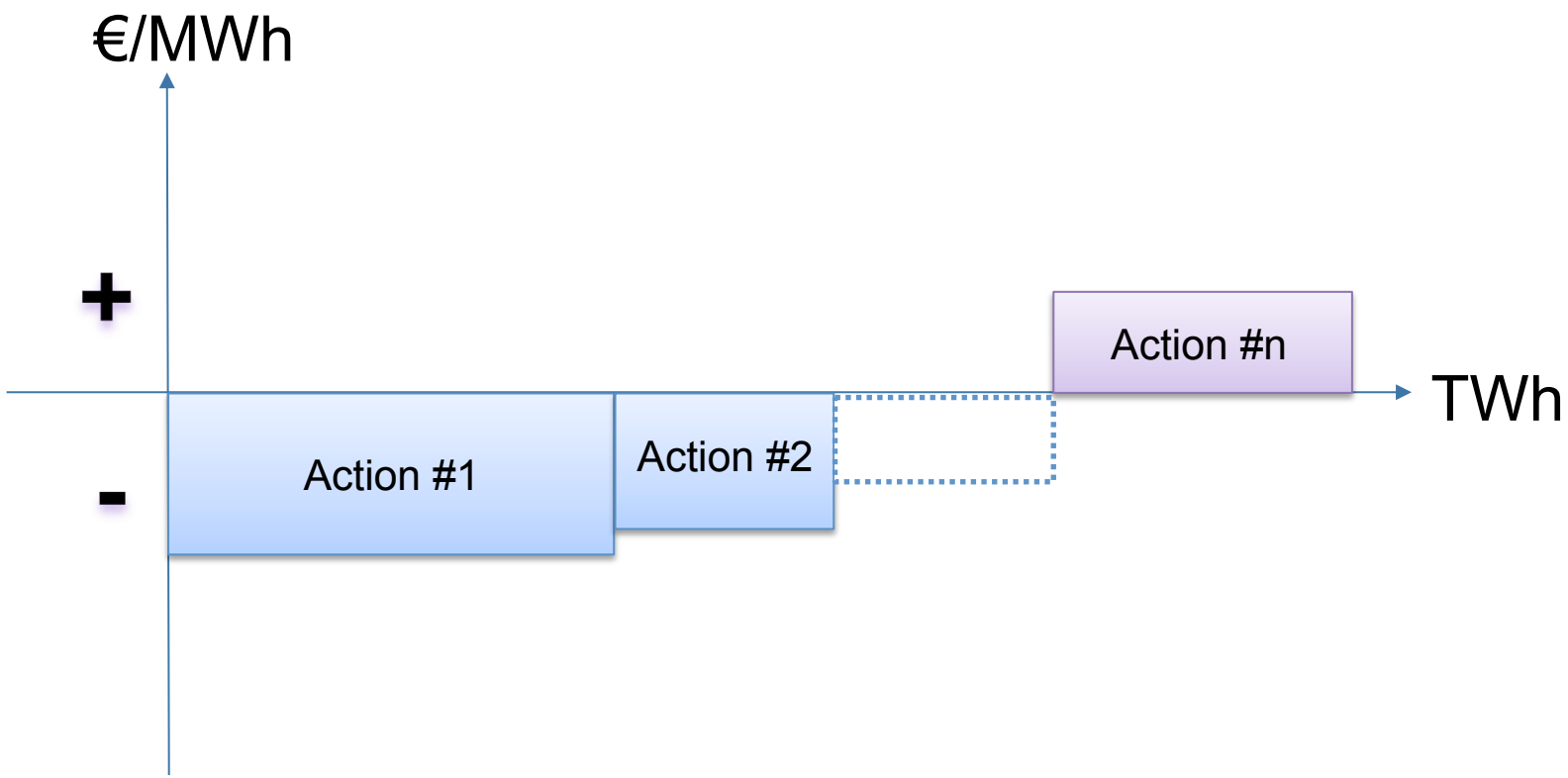
Chaire Economie du Climat
Université Paris-Dauphine
CDC Climat

EDF

MONOTONIC CURVE OF ABATEMENT COSTS

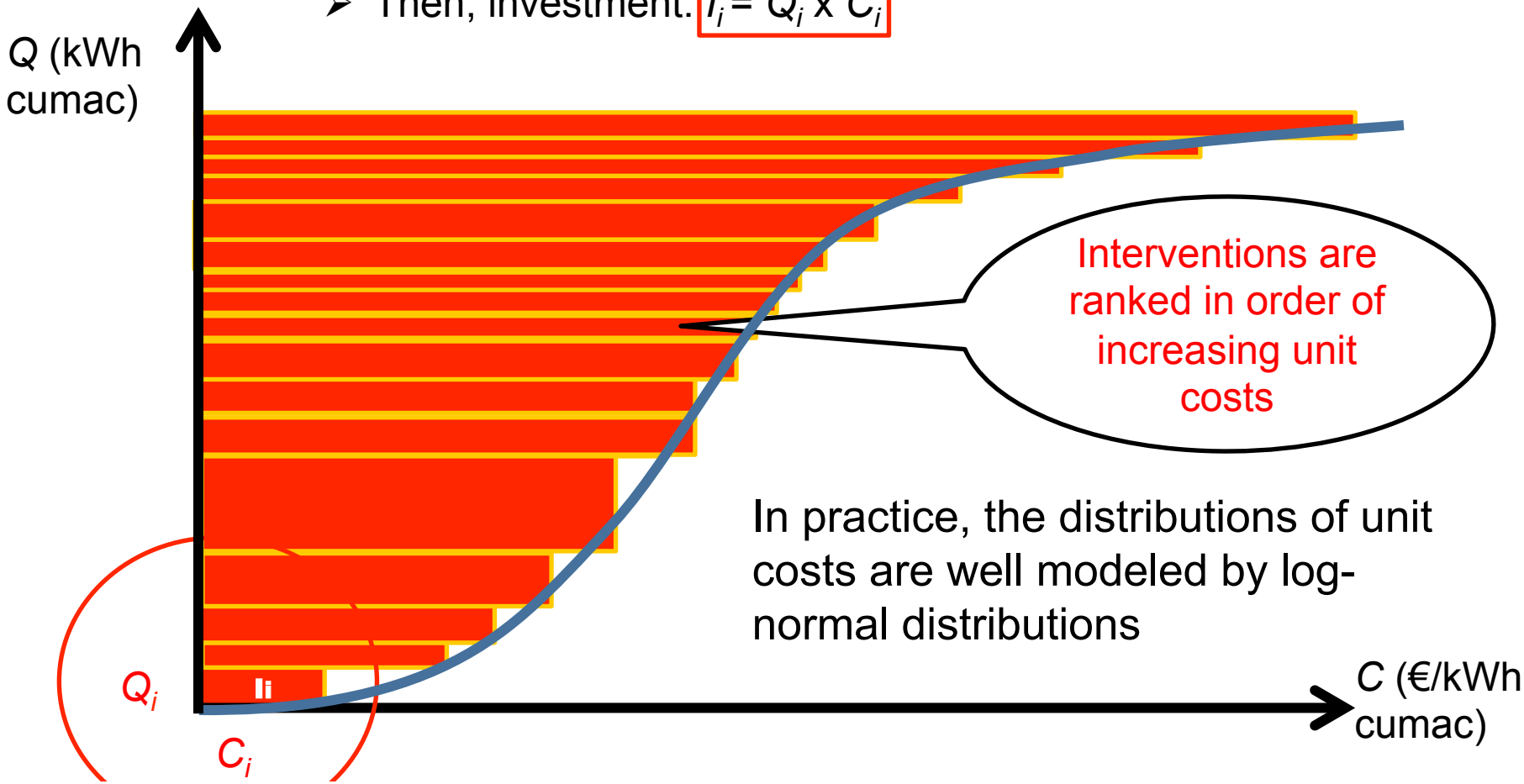
monotonic curve of abatement costs

Is the world square?

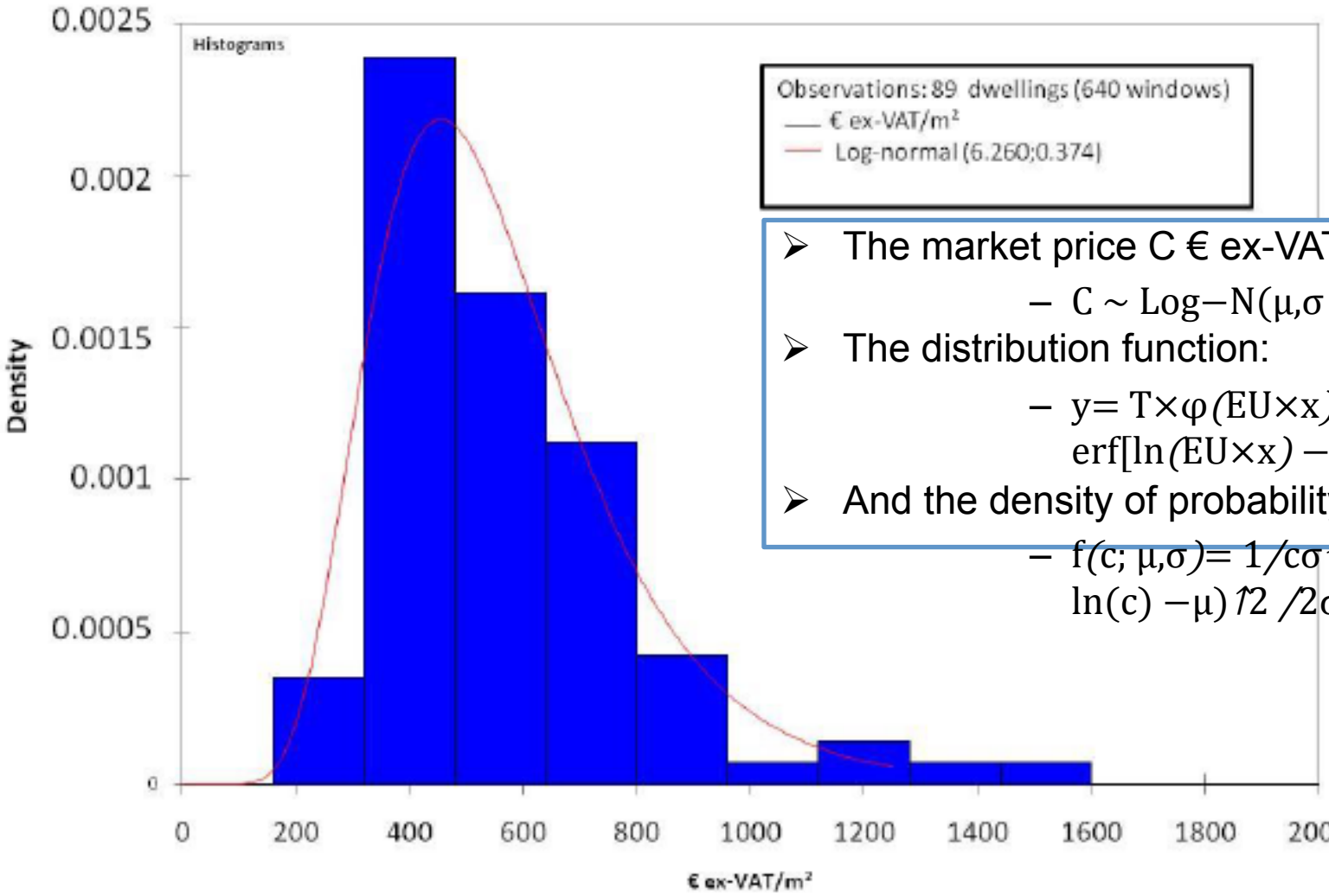


Monotonic curve of unit costs

- If *I* is an intervention of a household in a given SO:
  - Quantity Q_i (kWh cumac) of deemed savings
  - Unit cost of investment C_i (€ / kWh cumac)
  - Then, investment: $I_i = Q_i \times C_i$



The « log-normal » model



- The market price C € ex-VAT/ unit of work:
  - $C \sim \mathrm{Log}-\mathrm{N}(\mu,\sigma^2)$
- The distribution function:
  - $y = T \times \varphi(EU \times x) = T/2 + T/2\ \mathrm{erf}[\ln(EU \times x) - \mu/\sigma\sqrt{2}\ ]$
- And the density of probability:
  - $f(c;\mu,\sigma) = 1/c\sigma\sqrt{2\pi}\ \exp(-(\ln(c) - \mu)^2/2\sigma^2)$

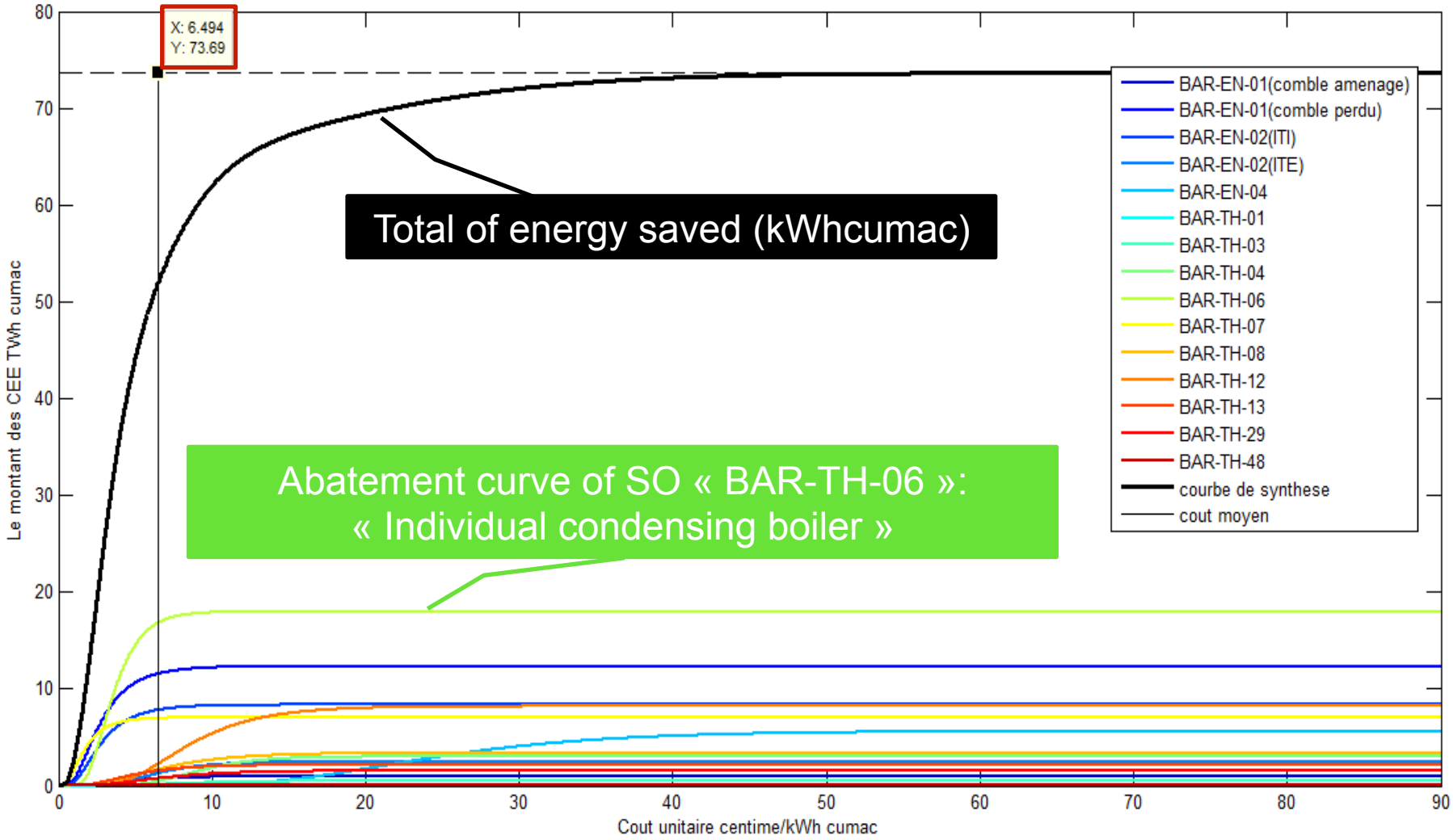
Building useful abatement curves

- Three steps:
  - 1) Building a monotonous abatement costs curve of the retrofits awarded in 2012
  - 2) Establish a monotonous abatement costs curve of the retrofits achieved in 2012 (awarded or not)
  - 3) update it to reflect changes to the scheme in the WC 2015 rules
    - by withdrawing the curves of SO "overtaken" by market standard
    - and modifying the curves according to the reward in the new worksheets of SO

Chaire Economie du Climat
Université Paris-Dauphine
CDC Climat

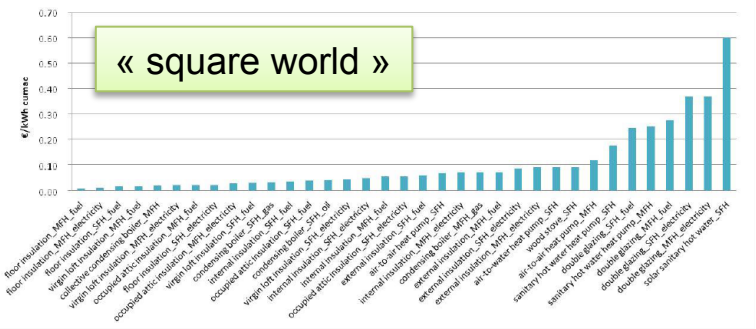
Distributions of unit costs for each SO (abatement curves of the retrofit awarded in 2012)

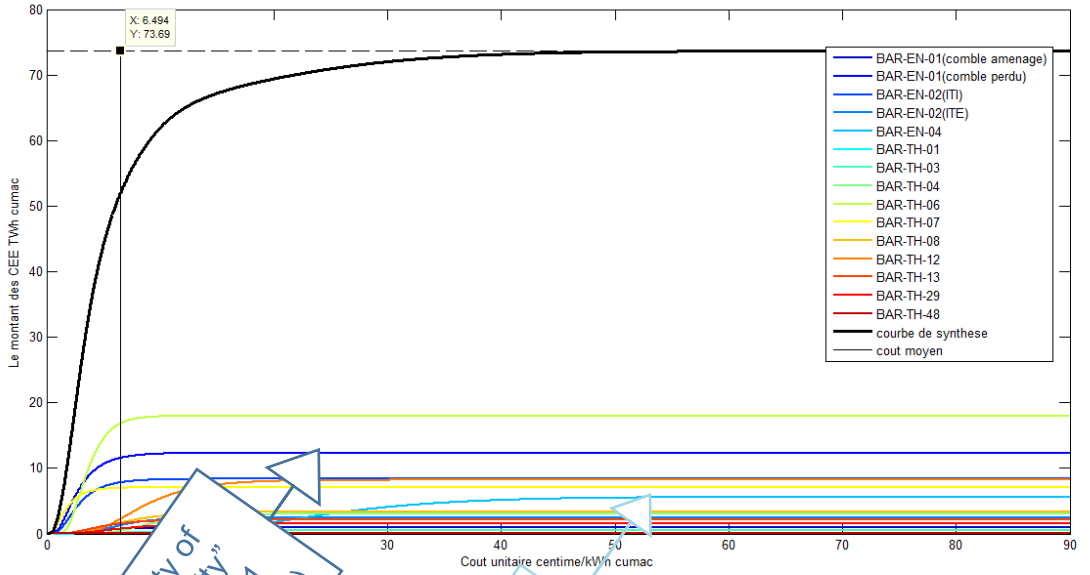
EDF



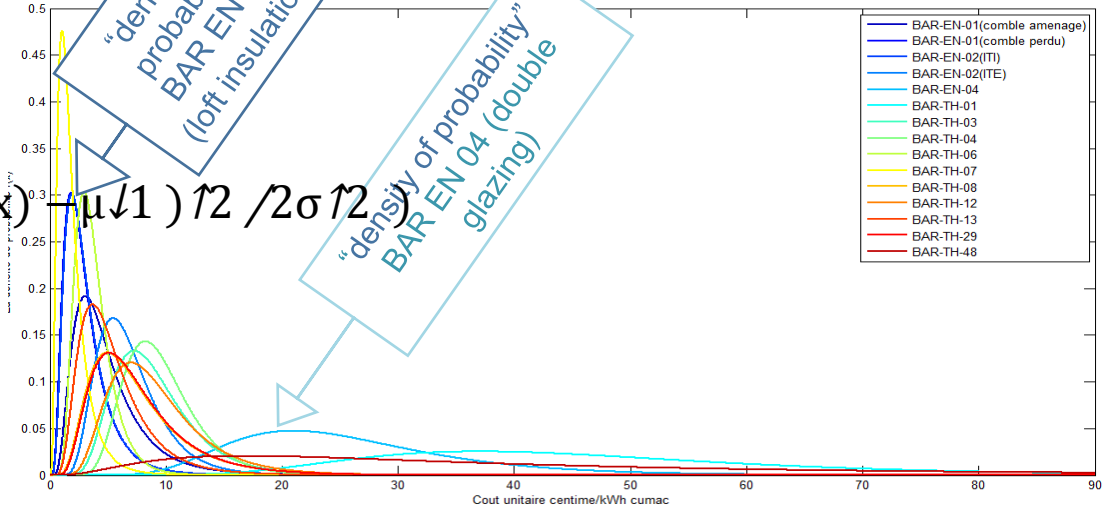
(1) Distribution and density of probability

$$y = T \times \varphi(EU \times x) = \frac{T}{2} + \frac{T}{2}\,\mathrm{erf}\left[\frac{\ln(EU \times x) - \mu}{\sigma\sqrt{2}}\right]$$





$$f(x;\mu_1,\sigma) = 1/x\sigma\sqrt{2\pi}\ \exp(-(\ln(x)-\mu_1)^2/2\sigma^2)$$



"density of probability" BAR EN 01 (loft insulation)

"density of probability" BAR EN 04 (double glazing)

(2) abatement costs curves of the EE market during the second period

- **Hypothesis: In every OS, distribution of unit costs of the “EE market" is the same as the distribution of awarded retrofits**
- Now we can determine the “EE market" of the year by OS, using the "coverage" of retrofits by the WC
    - If:

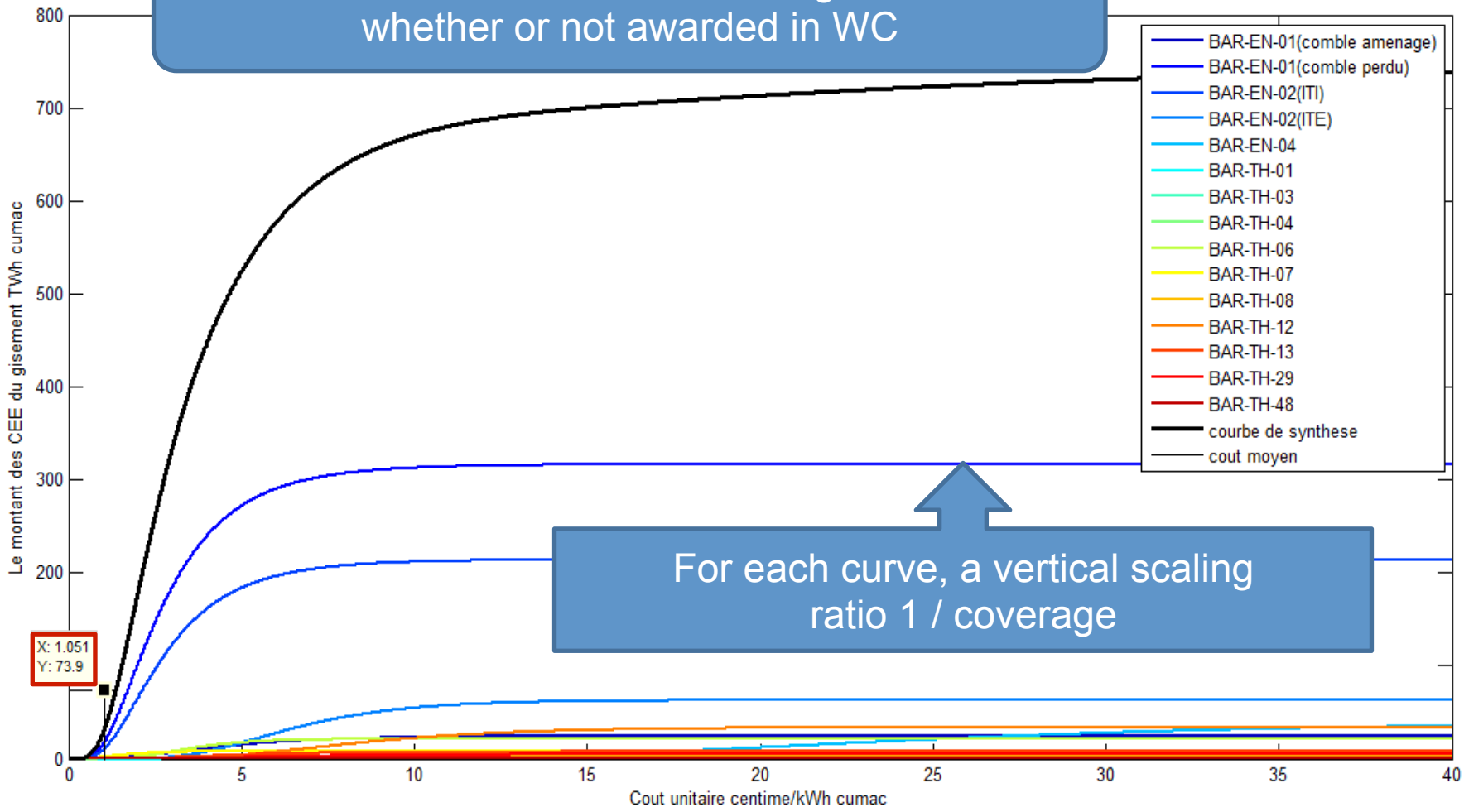
$$Coverage\ rate\ (\%) = amount\ of\ energy\ savings\ registered\ in\ WC\ (kWh\ cumac) / overall\ market\ amount\ of\ energy\ savings\ (called\ “EE\ market”)\ (kWh\ cumac)$$

Examples of contrasting coverage level

- **BAR-EN-01, roof insulation: 3.9 %**
- **BAR-TH-06, individual condensing boiler: 93.4 %**
- **Average: ~ 10 %**

Abatement cost curves of the “EE market" in the second period

“EE market" means all the savings of 2012, whether or not awarded in WC



For each curve, a vertical scaling ratio 1 / coverage

To achieve the 2012 target

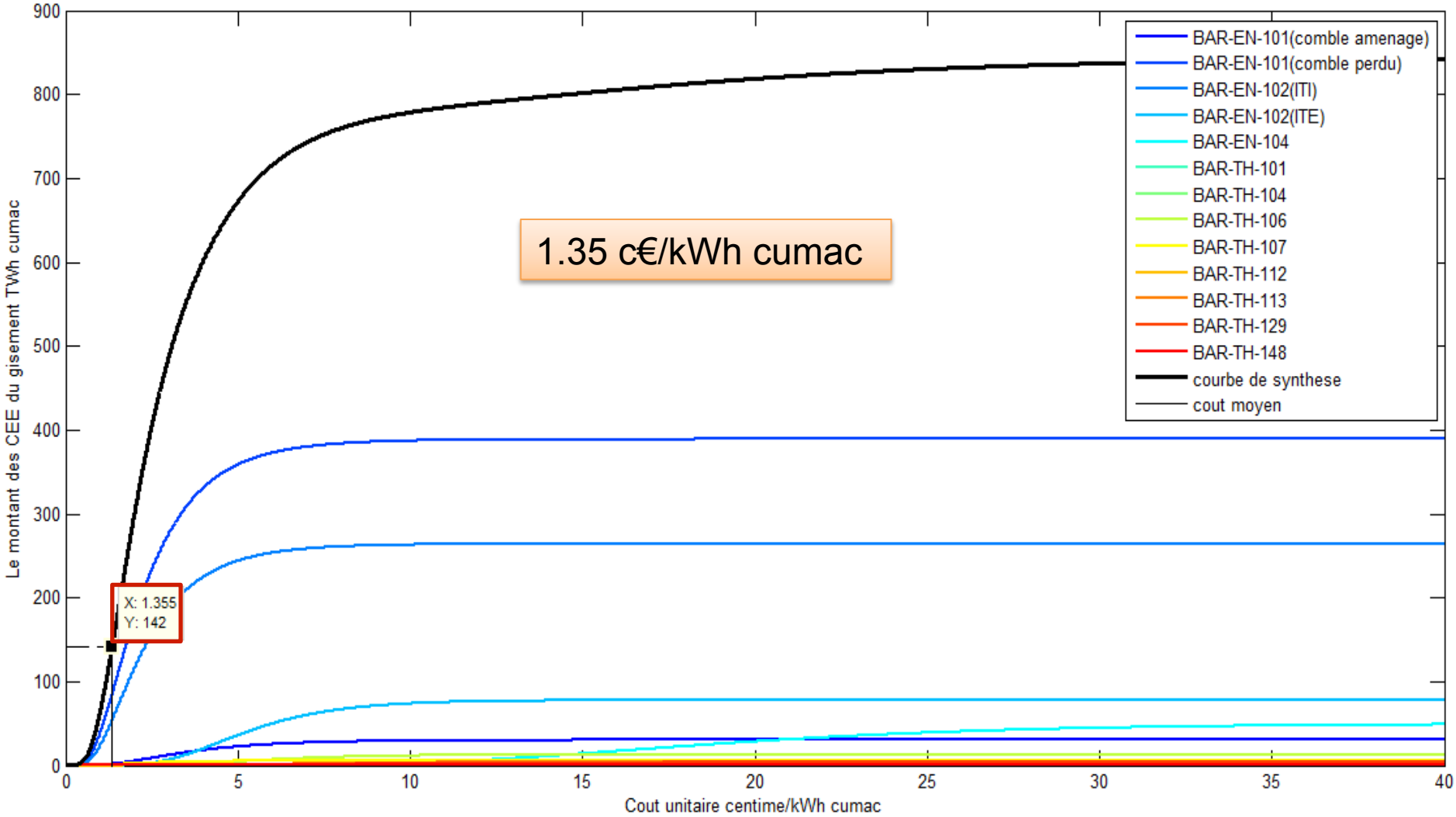
- If proceeding according to the “merit order":
  - average cost of 1.05 c€ exVAT / kWh cumac
- In reality:
  - average cost of 6.5 c€ exVAT / kWh cumac
  - 6 times more
  - A total investment of 4,785 M€

But not taking into account barriers or drivers (fall into disrepair, non energy benefits…)

3) Modeling the third period (2015-2017)

- Objective two times higher than for the previous period:
  - Reference to a “market“ baseline instead of a reference to the “stock" for equipment
  - Awarding by certificates only if the equipment more efficient than the basic equipment on the market
  - Operations “phase out" of the WC scheme or with reduced valuation
  - The energy saving efficiency change (due to technical progress)
- Assumptions:
  - Price distributions unchanged (despite technical progress)
  - “EE market" unchanged by OS

3) Abatement cost curves of the EE market of the third period



Conclusions and future work

- Conclusions
  - Obviously, no merit order related to the cost of saved energy prevails in the household decisions
    - Inside the same refurbishment action, the cost distribution varies greatly, typically a factor 1 to 3 between extreme decile (1 to 8 for the most varied)
  - we could establish abatement functions providing for a given period the volume of WCs awardable under a certain unit cost
  - It means very likely to reduce the support of the less cost-effective operations for the benefit of the most profitable
- Trail for more as this is only preliminary results:
  - Consolidating the findings of this study, by varying the assumptions
  - according to the method proposed, to build abatement curves on the long term “EE market" (2050)
  - Embed assumptions about technical developments
  - Consolidate market coverage assessment
  - Model the WC market developments
  - Analyze cost curve with marginal or total up-front cost
  - Embed also the energy savings distribution, etc.

Chaire Economie du Climat
Université Paris-Dauphine
CDC Climat

EDF

THANK YOU FOR YOUR ATTENTION