A Model for Forecasting Data Centre Infrastructure Costs

CHEP 2015 @ Okinawa

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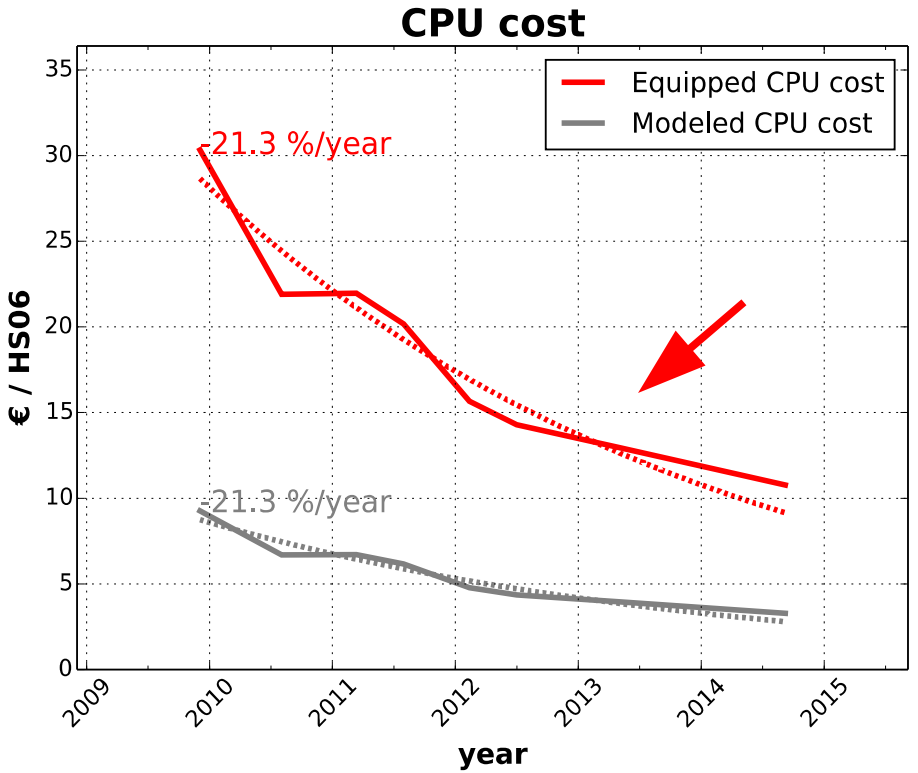
- Context
  - Large computing resource requests to come
    - LHC, Astroparticles...
  - Tight funding situation
- Need of rationalization
    - What of data centre infrastructure ?
- Recurrent kind of questions (as a site)
    - how much **does and will** an experiment computing cost me ?

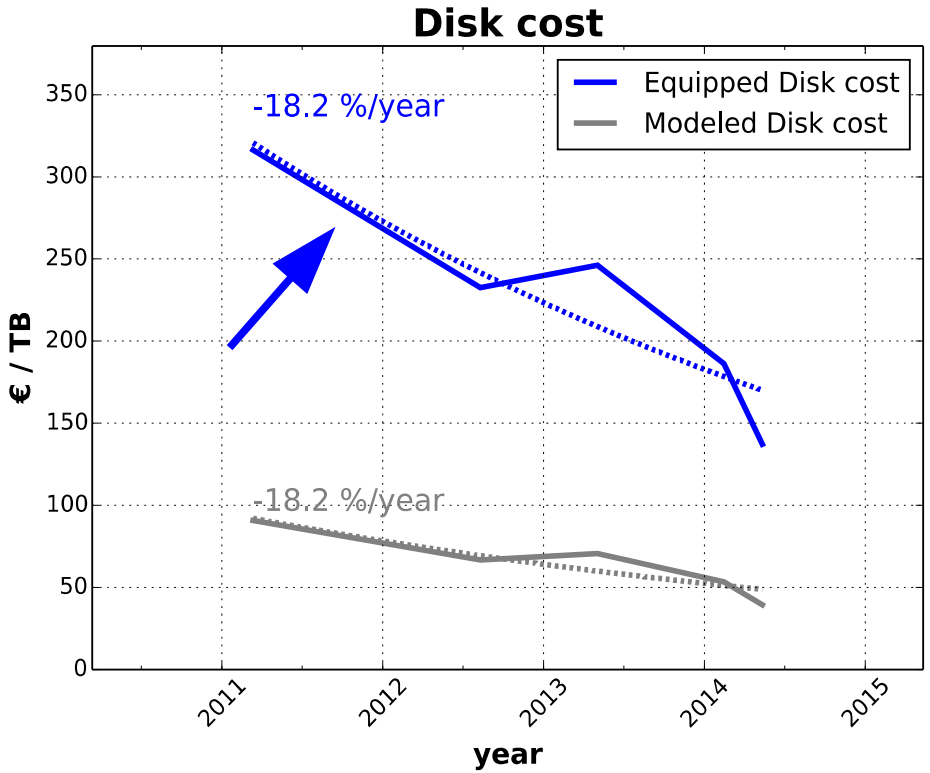
Aim of this talk

- How to estimate hosting cost in terms of infrastructure ?
  - Hardware + Power
- The trends
  - Resource cost
  - Power consumption
- → Model yearly resource investment
- → Quantify and give estimates for the future
  - Assuming todays technos trends
  - No major (r)evolution in the next years
- Results for CC-IN2P3

Hardware

- Evolution of unitary cost with time
  - including rack, switch
  - €/HS06 or €/TB





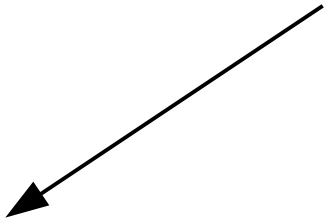
= Data

= Fit

- One thing to consider
  - Hardware has a life time, you need to renew it
  - Makes things complicated, let's try to make it simple

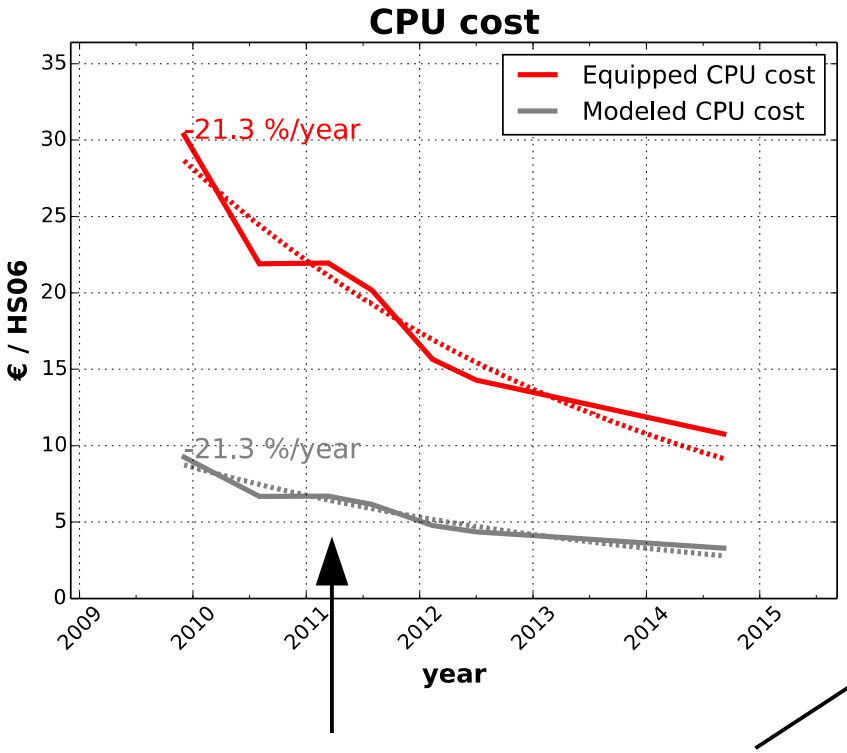
Investment (t) = Capacity (t) * Modeled Cost (t)

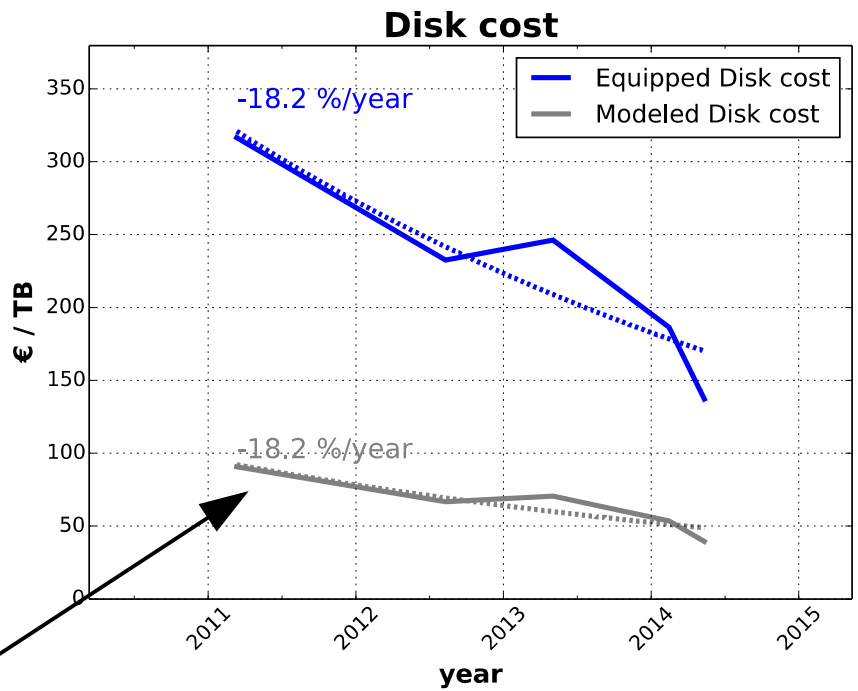
€ HS06, TB € / HS06, TB



- Hardware Cost
  - Related to procurement cost, but
  - **yearly** basis
  - **includes renewal**

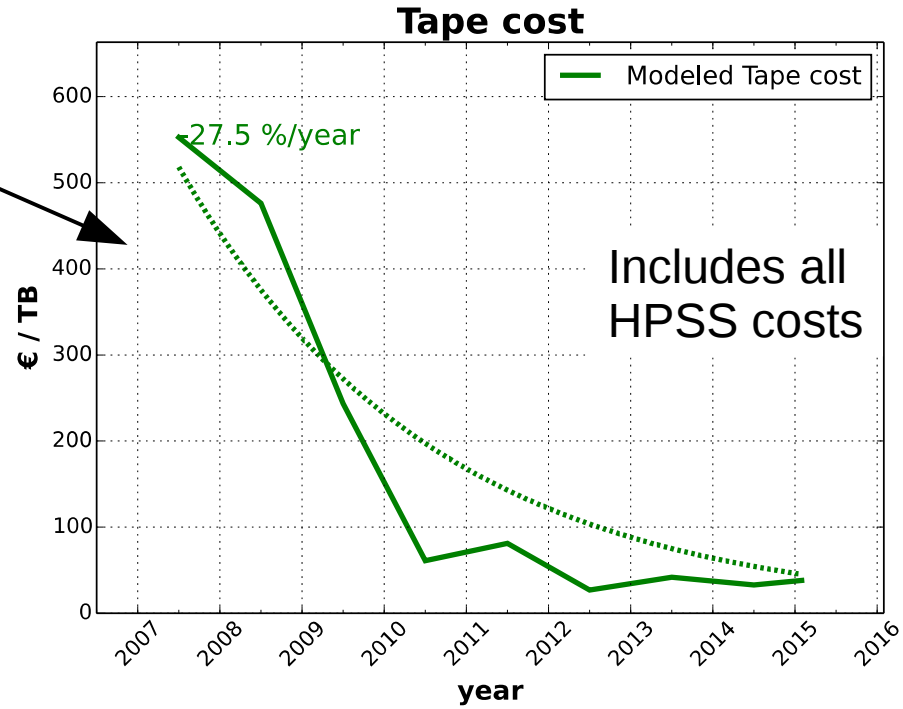
Modeled cost





This is the modeled cost

See backup for model formula

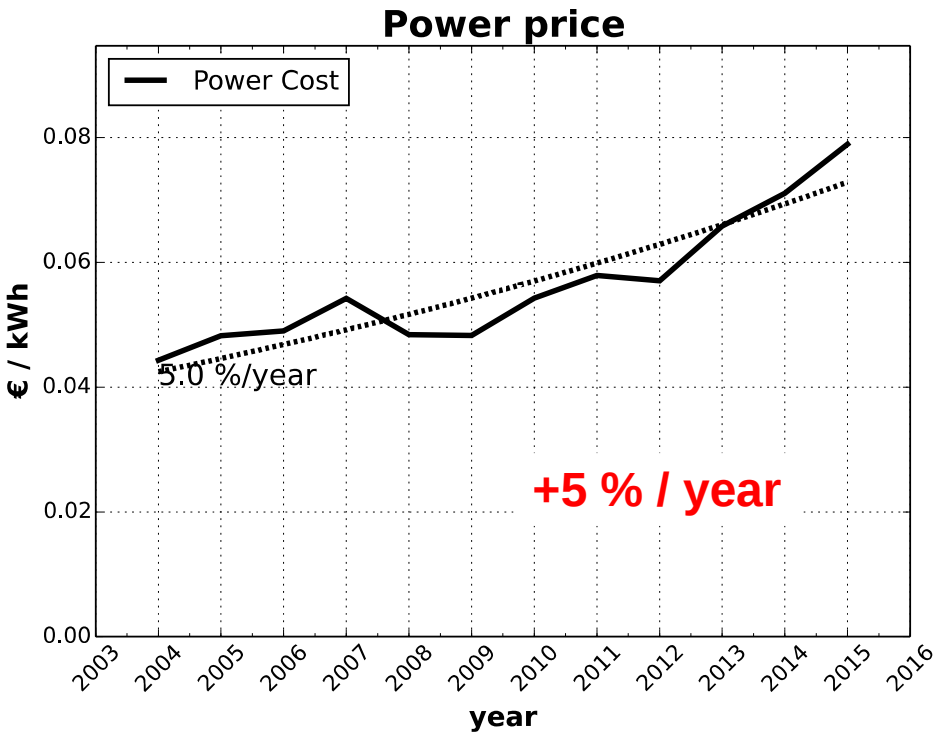


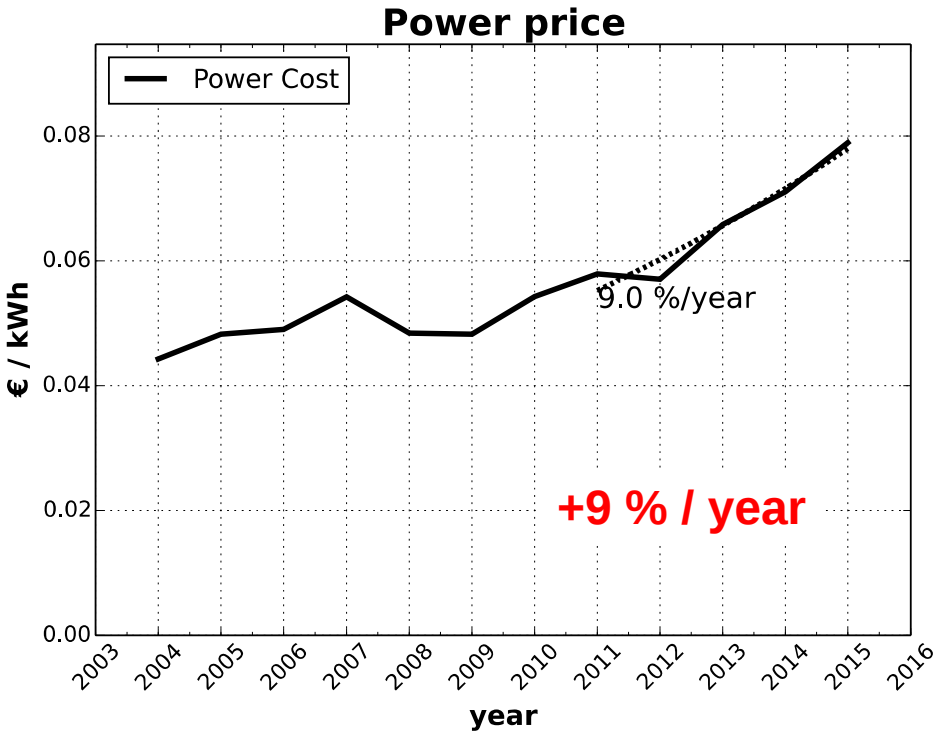
NB :
- tape cost not cheaper (HPSS)
- but price drops faster than disk

Power

Price & consumption

- Evolution since 2004 (France)



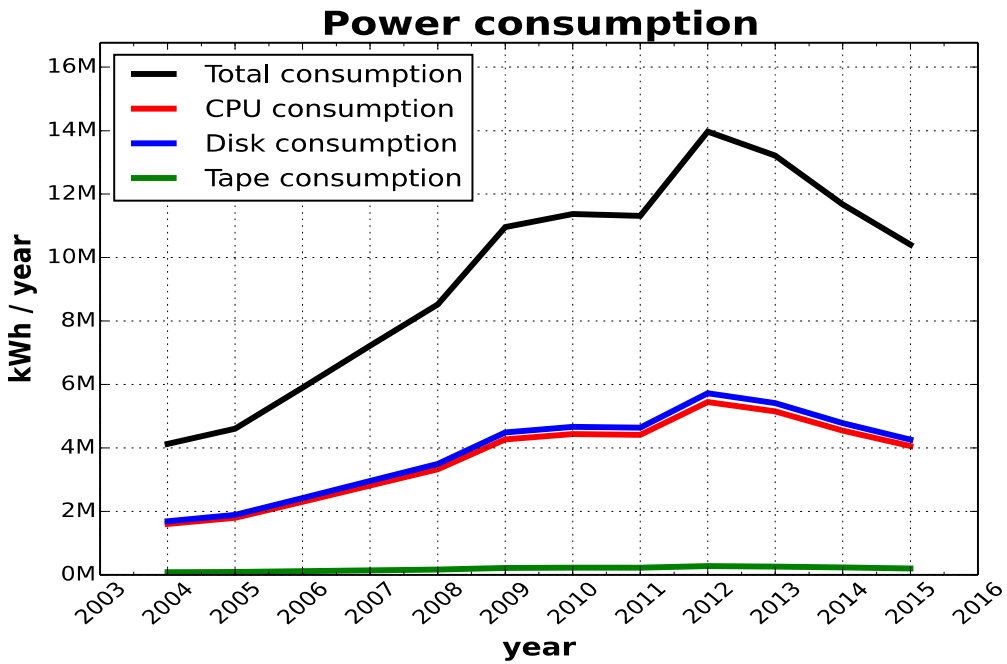


- Power price evolution hard to foresee

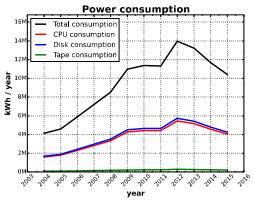
- Should increase by 5-10 % / year

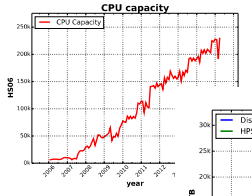
Power consumption per service

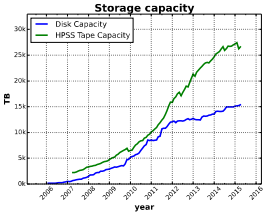
- Measurements on PDUs
- Grouping by service
- Estimate of power consumption evolution with time
  - Per service (CPU, Disk, Tape, Other)
  - Including PUE
    - ⇔ hardware consumption + cooling



Unitary Power Consumption

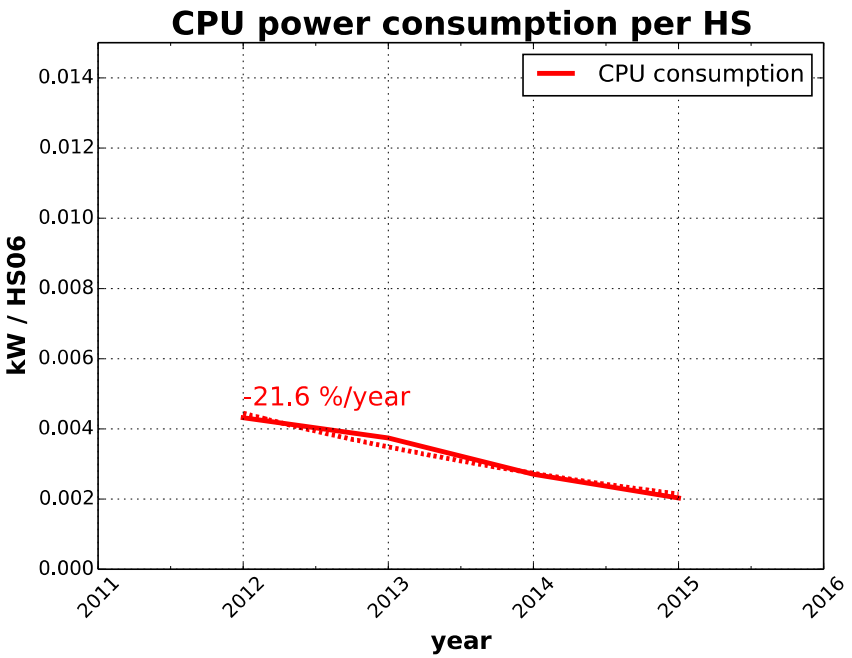


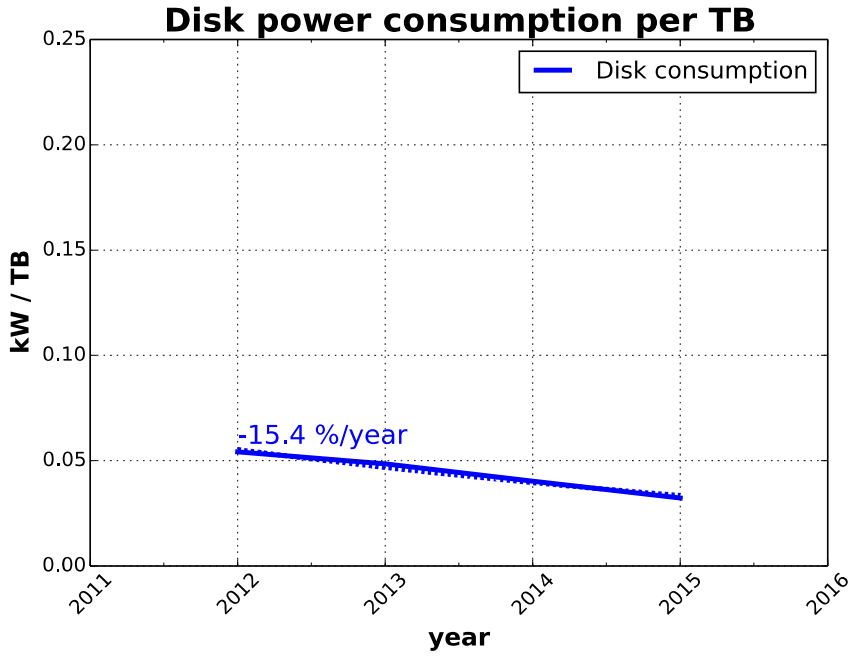




Unitary consumption = Resource consumption ÷ Capacity

[kW / HS|TB] *[kW]* *[HS|TB]*

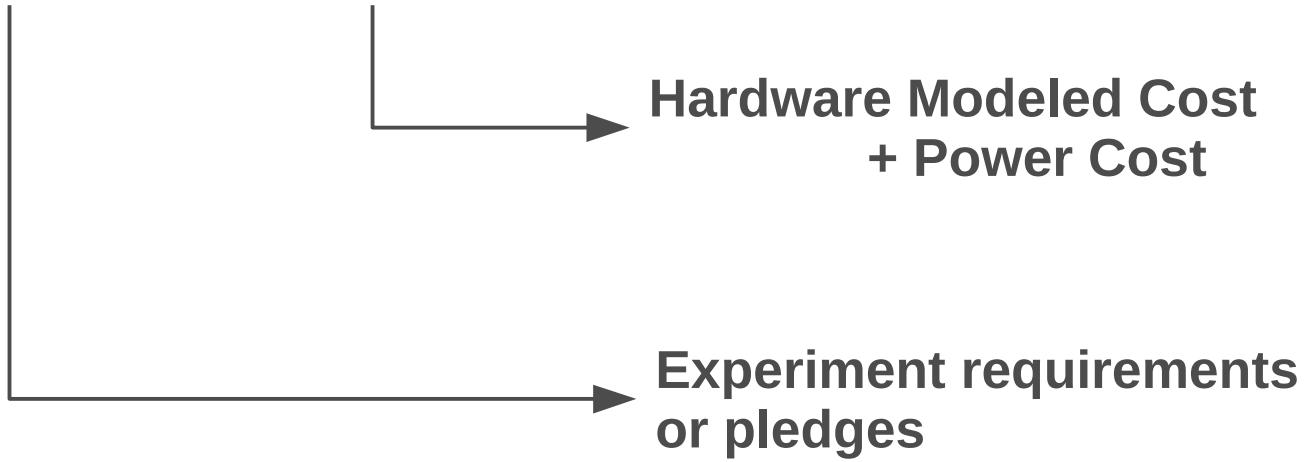




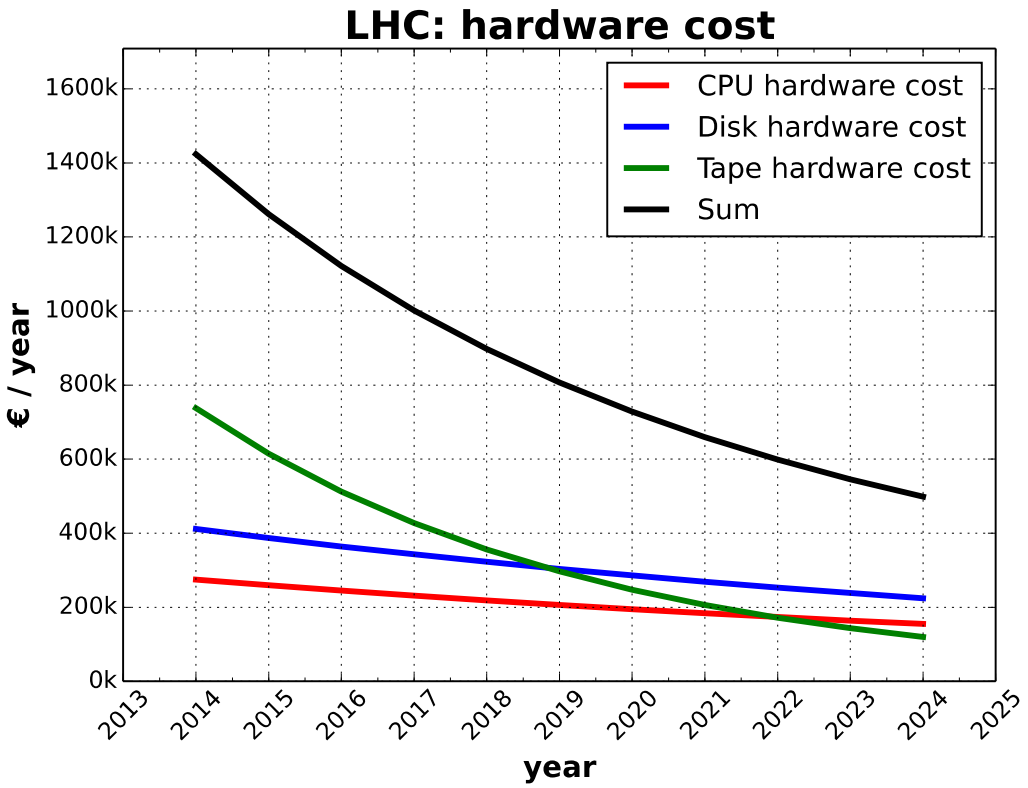
And... finally... the cost ?

- So now the ingredients to answer the question :

Investment (t) = Capacity (t) * Cost (t)

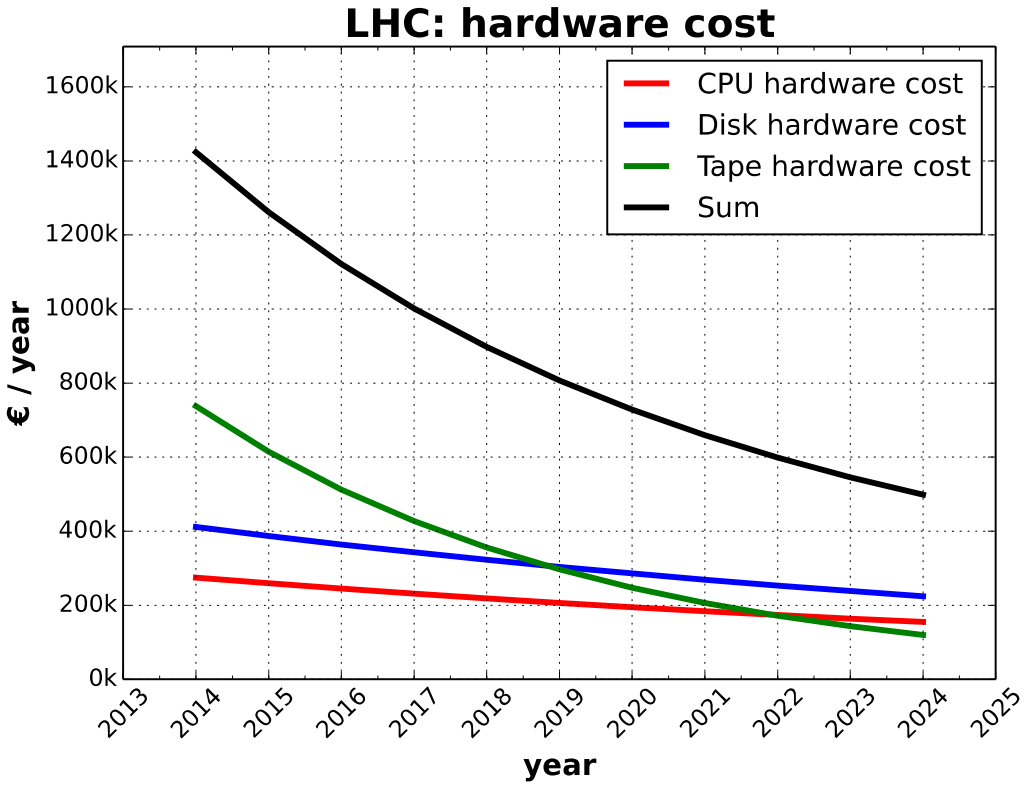


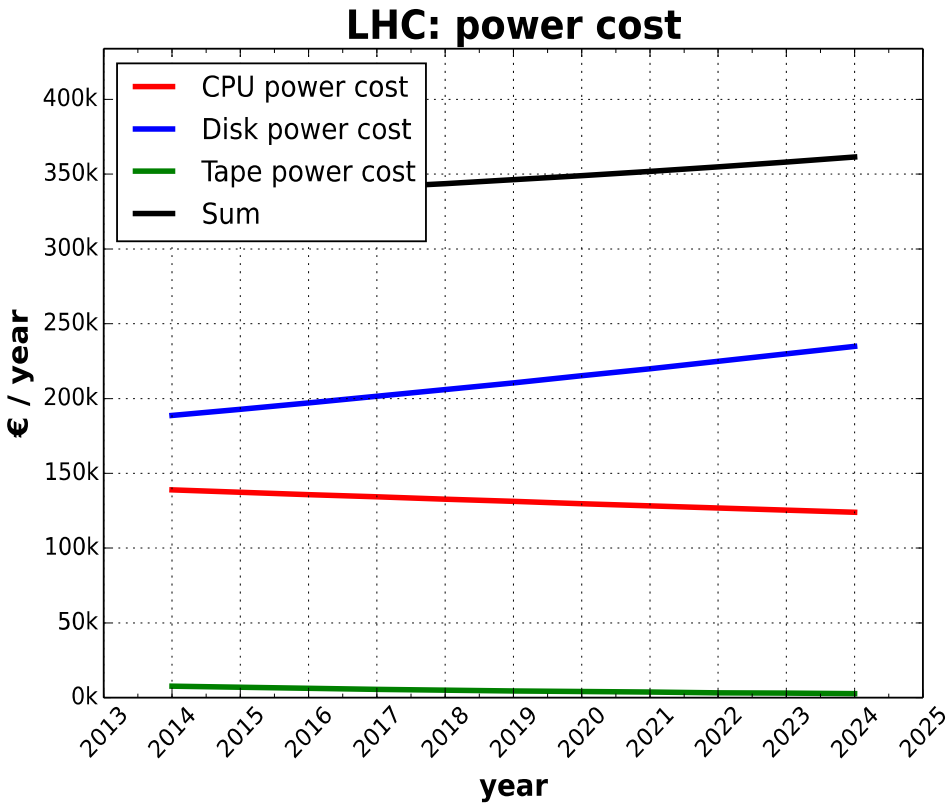
Example 1 : LHC



Assuming 20 % growth CPU
15 % growth Disk
15 % growth Tape
(see WLCG computing model update)

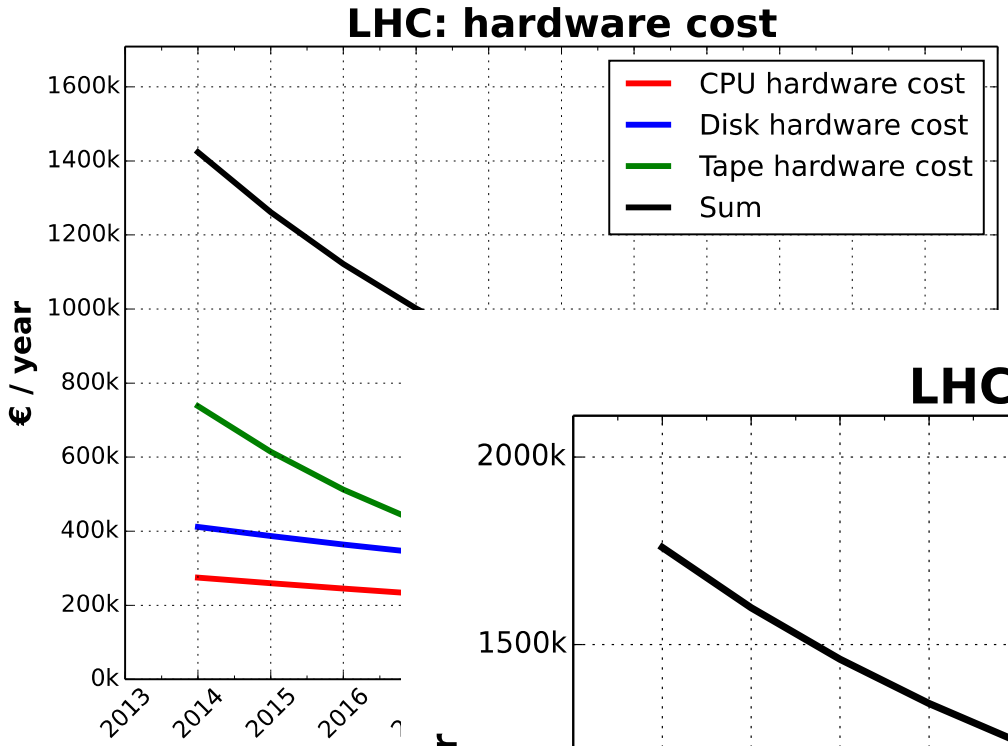
Example 1 : LHC

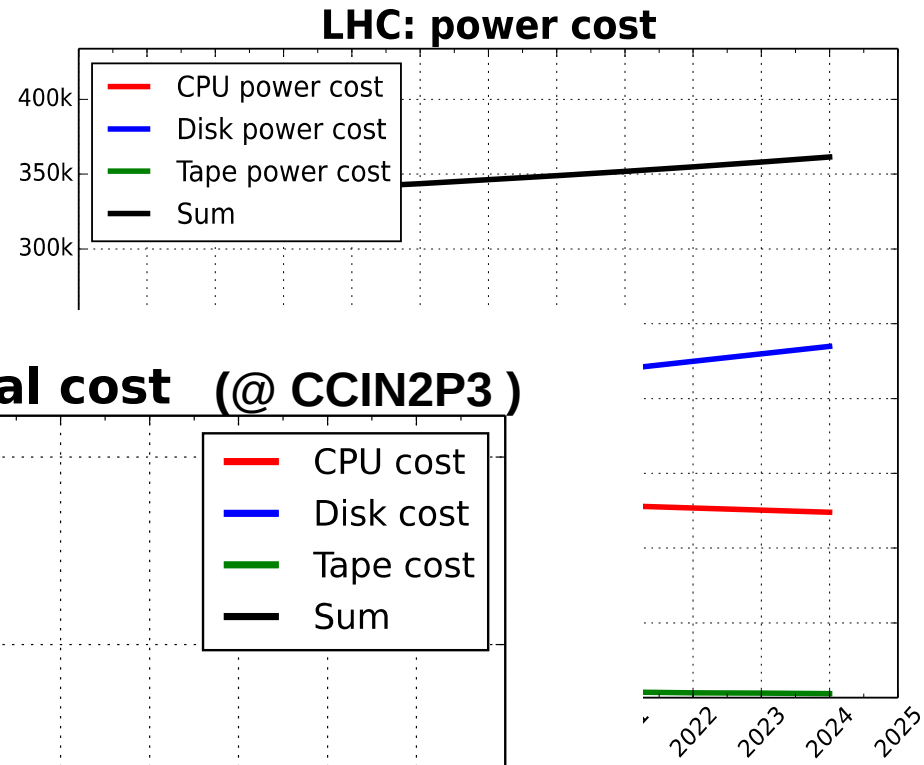


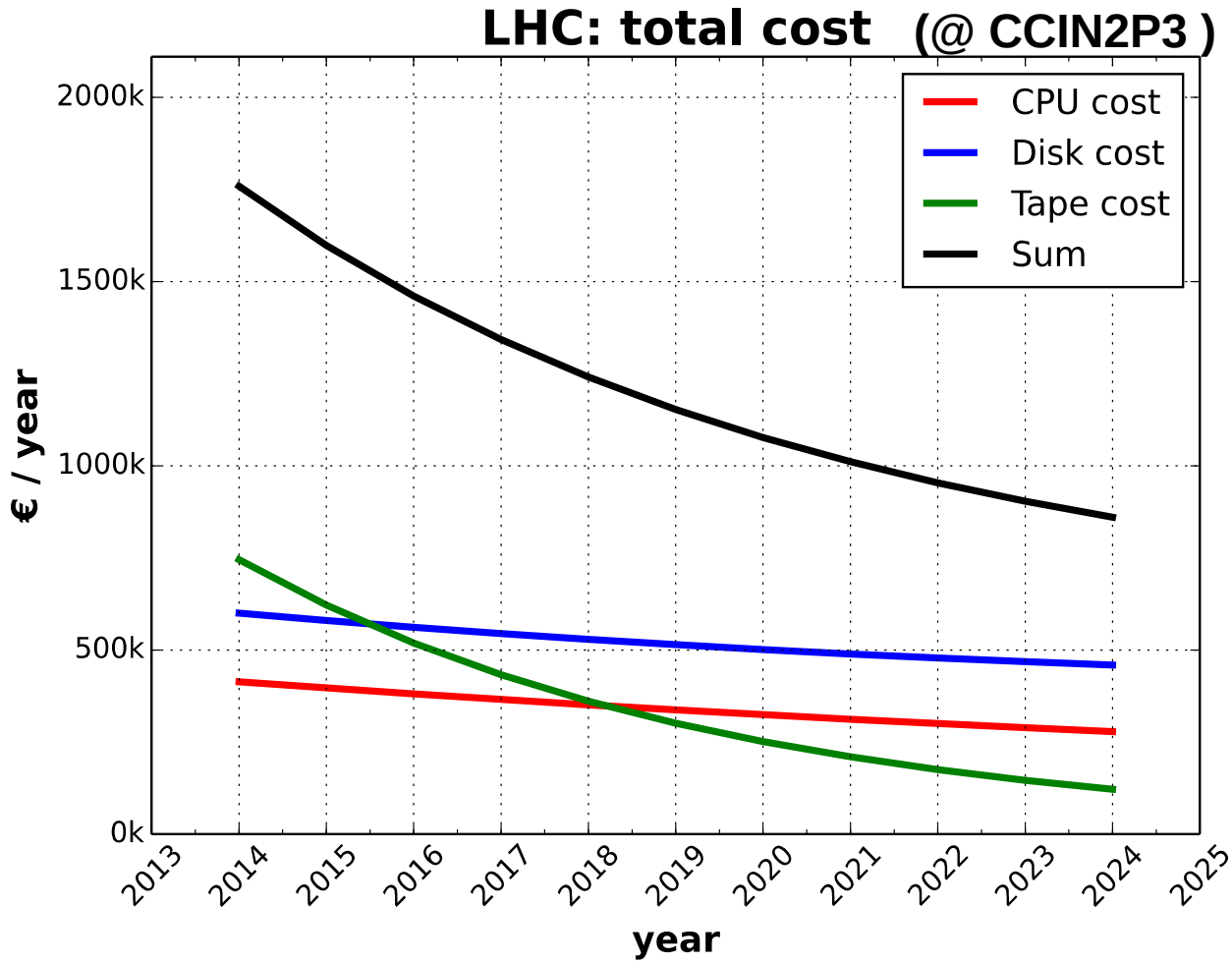


Will we arrive at a point where power costs more than hardware ?

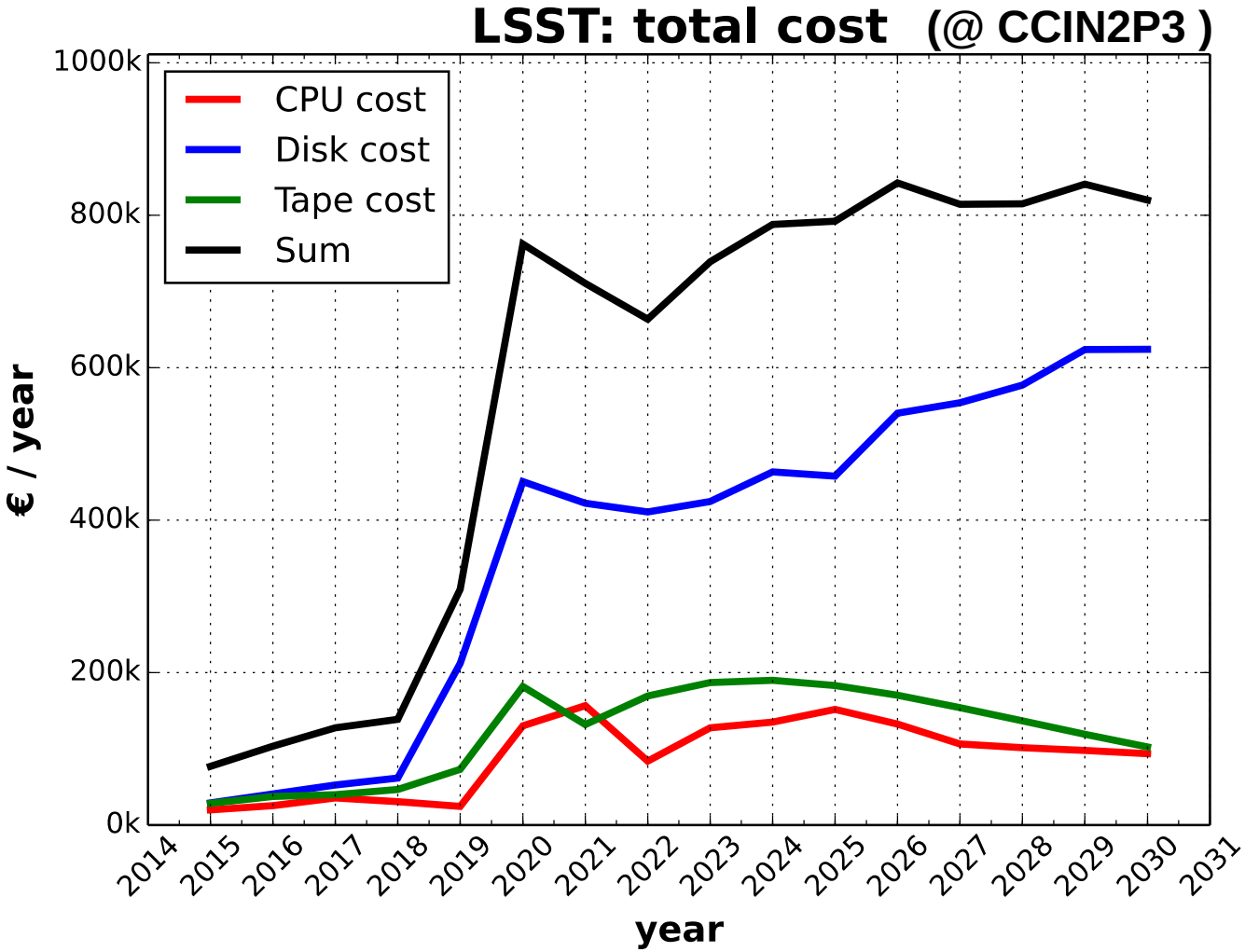
Example 1 : LHC







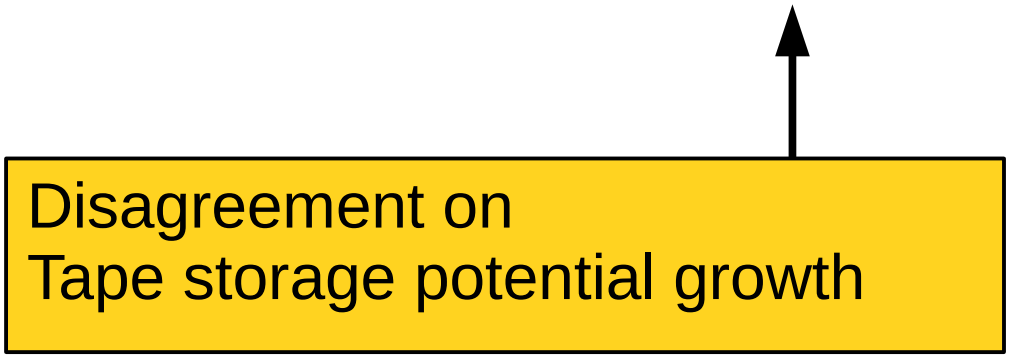
Example 2 : LSST



- Assuming flat budget
- What growth should we expect ?

	CPU	Disk	Tape
Cost model @ ccin2p3	25 %	18 %	38 %
WLCG computing model update	20 %	15 %	15 %

This is for CC-IN2P3
May change from site-to-site
- power price evolution
- tape storage system cost

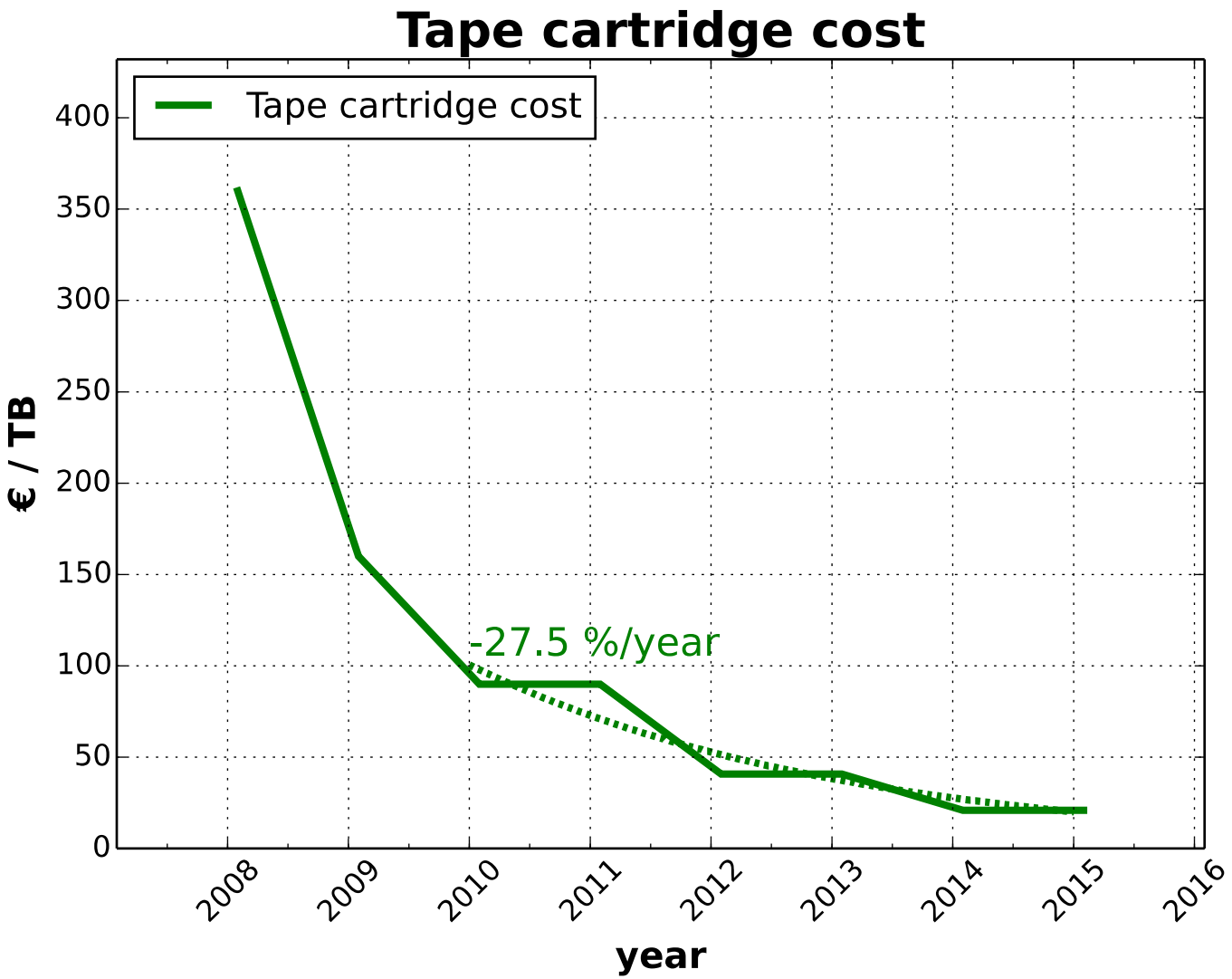


- A model that permits several things
  - Understand hardware and power costs of a data centre
  - Estimate funding needed for the future experiments
  - Tell me how much you need, I'll tell you how much it will cost

- Caveats to remember
  - Model smoothes things
    - Beware of year-to-year fluctuations in real life
  - Does not allow for major technology (r)evolutions

有難うございました

Cartridge cost



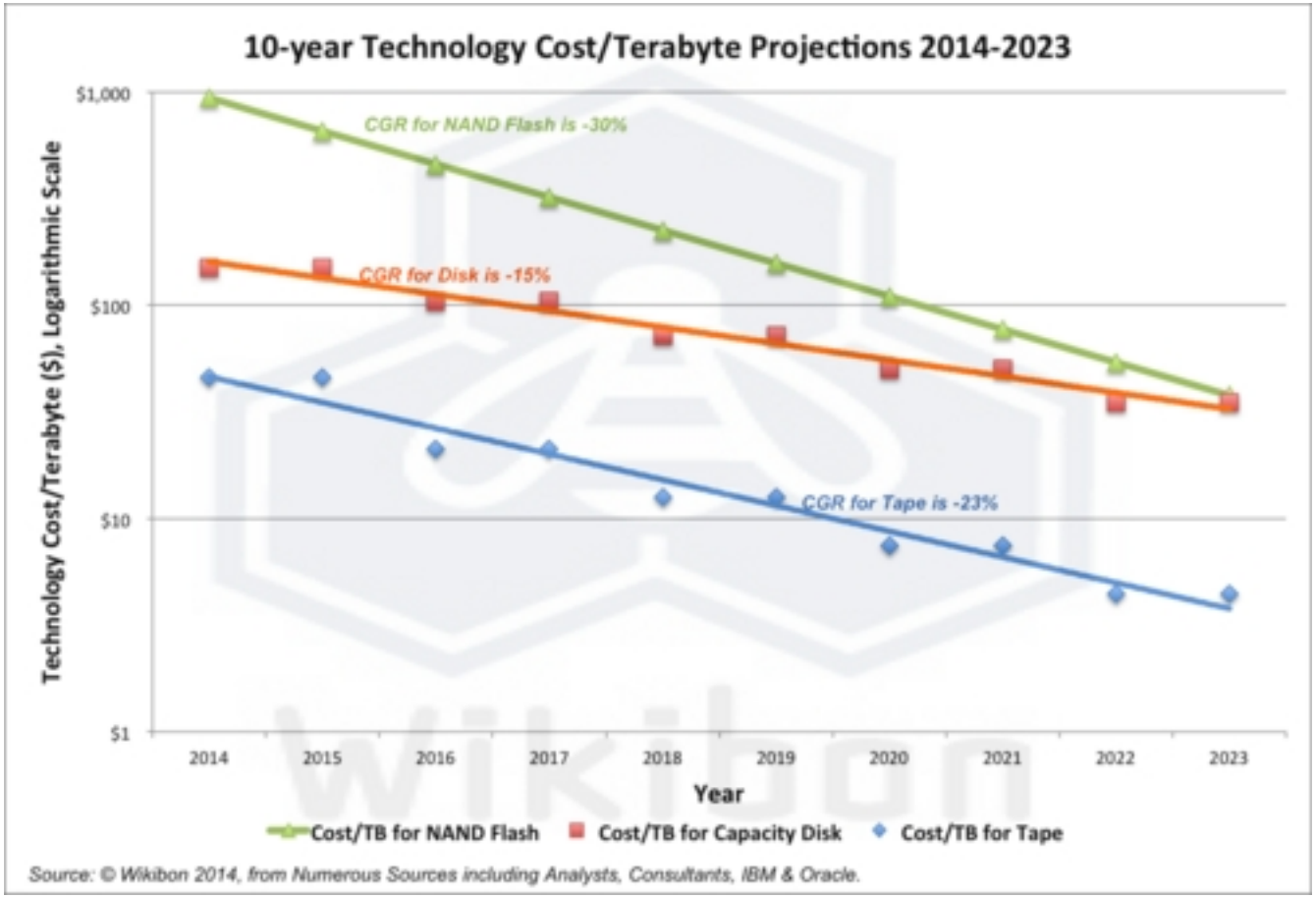
HPSS
T10K tapes

- Hypothesis :
  - Constant investment over time
  - Resource cost drops exponentially by « r % » per year (-CAGR)

$$p^*(t) = \frac{r}{f} \times \frac{p(t)}{1-(1-r)^{\tau}}$$

p*	:	the modeled unitary cost
p	:	the actual unitary cost at procurement time
f	:	fraction of the investment dedicated to pure resources
τ	:	hardware warranty time (years)
r	:	unitary cost decrease rate (eg 20%)

$$C(t) = C_0 e^{-\alpha t}$$



- IT evolutions in exponential profile
- Resource cost decrease by X % per year (CAGR)