HAL
archives-ouvertes.fr

Structures and regulatory frameworks of power sector : Which impact on effectiveness of carbon pricing?

Dominique Finon

▶ **To cite this version:**

Dominique Finon. Structures and regulatory frameworks of power sector : Which impact on effectiveness of carbon pricing?. World Bank's PMR Technical meeting " Interactions of Energy and Carbon pricing policies ", Santiago de Chile, Chile. 2014. <hal-01239111>

HAL Id: hal-01239111

https://hal-enpc.archives-ouvertes.fr/hal-01239111

Submitted on 7 Dec 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Structures and regulatory frameworks of power sector :
Which impact on effectiveness of carbon pricing?

Dominique FINON
CNRS-Paris (CIRED) & Chaire CEEM (Paris Dauphine Univ.)
with
Christophe de GOUVELLO (Energy Practice of the World Bank)

PMR Technical meeting
« Interactions of Energy and Carbon pricing policies »
Santiago (Chile), November 5, 2014

Introduction

Carbon pricing intersects energy policies

- Carbon pricing aims to influence :
  - directly the choices of fossil fuel users, and
  - indirectly the use of intermediary and final goods produced with fossil fuel inputs
    substitution with cleaner fuel, efficient process, electricity savings, etc.
- Important energy policies exist, which, in developing countries, are not related at all to emission reductions:
  - Low energy prices for economic and social development
  - Social equity (rural electrification, geographic price equalization, social tariff, etc)
  - Long term security of supply (among which consumers'protection against price variability of imported fuel)
  - Promotion of national energy resources (fossil fuel, renewables) for the sake of dependence limitation, industrial development, macroeconomic equilibria…
  - Inflation control, etc., etc.
- Carbon pricing interferes with these objectives, sometimes converges with, sometimes conflicts with …

Introduction

- Power sector which is the largest emitter of CO_2 (30% around in average) is a major field of energy policies
- It is typically the case of a sector subject to many regulations that reflect important energy policy objectives not related at all to emission reductions

- So importance to anticipate effects of the introduction of a carbon pricing mechanism(ETS, carbon tax)
  - Its effectiveness in matter of carbon emission reductions
  - Its effects on electricity prices with their eventual interference with other energy policies

1. Carbon pricing effects in the power sector

Carbon pricing can influence emissions from the power sector in three ways, via its effects on electricity generation costs and market prices

- 1.by turning the electricity generated by existing carbon intensive power plants more_expensive and thus less competitive against cleaner technologies :
  - this is the short term substitution effect (mainly dispatching effects)
- 2. by turning the investment in new carbon intensive power plants less attractive compare to clean energy investment:
  - this is the long term structural effect
- 3. by turning the electricity price more expensive for the final customer, and thus inducing a reduction in consumption and so in emitting generation,

But this raises redistribution issues (theoretical dilemna “efficiency” versus “equity”) **related to energy policy objectives:**

- economic development/industrial competitiveness
  - (Effects on energy intensive industries, so issue exemption/compensation)
- social welfare and affordability

The effects of carbon pricing are very dependent on the organisation and regulation of the power sector which differ widely

- differences of market competition at different levels
- difference of wholesale « spot market »
- difference of tariff regulation at the retail level

Indeed carbon pricing effects on electricity pricing depend on:

- the price setting :

  how the carbon price/cost is passed through in wholesale price and then in retail prices ?

- the wholesale and retrail price regulation :
  - how regulators organise the cost recovery of the retailers?
    - Possible exemptions for large consumers (issu of competitiveness)
  - What to do with windfall profit in case of free allowances

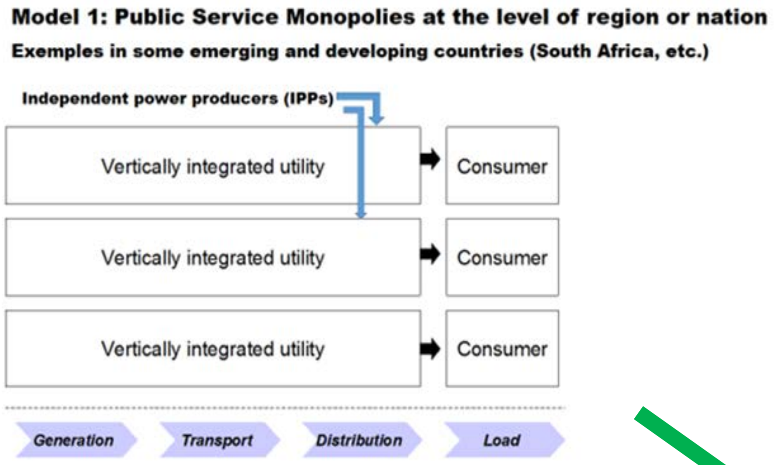
Here again carbon pricing intersects energy policies objectives.

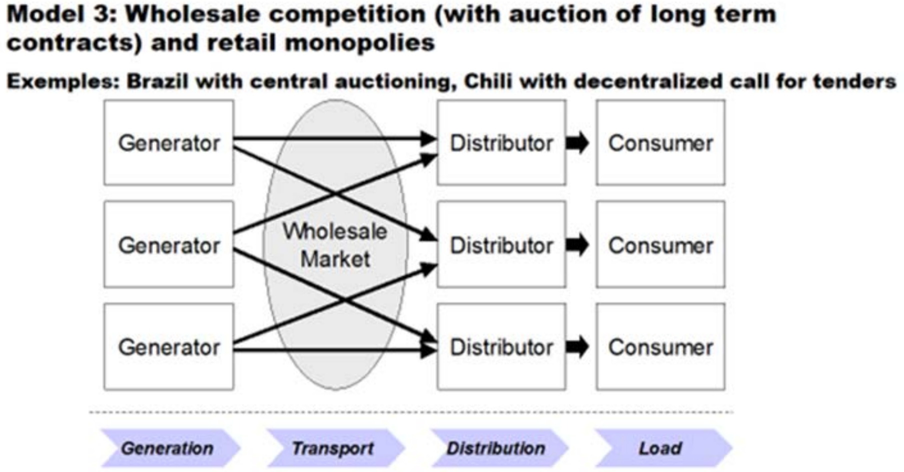
Indeed the adoption of a type of model answered to energy policy goals to place in each context

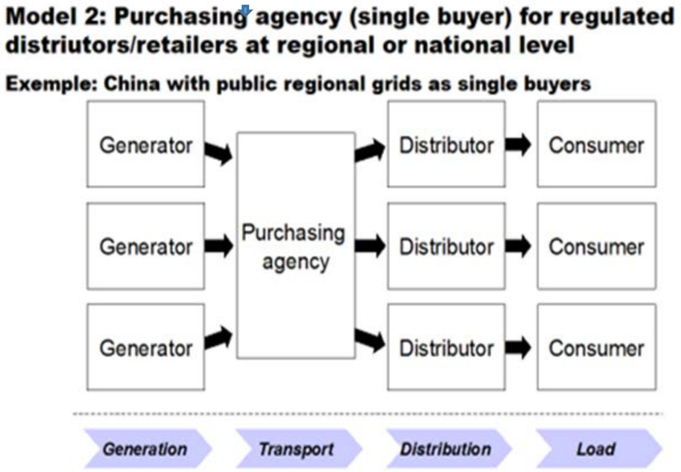
Competitiveness : to avoid economic inefficiency of regulated monopolies, public ownership, etc
Long term security of supply : to attract investors
Economic and social development: the control of long term cost and electricity prices

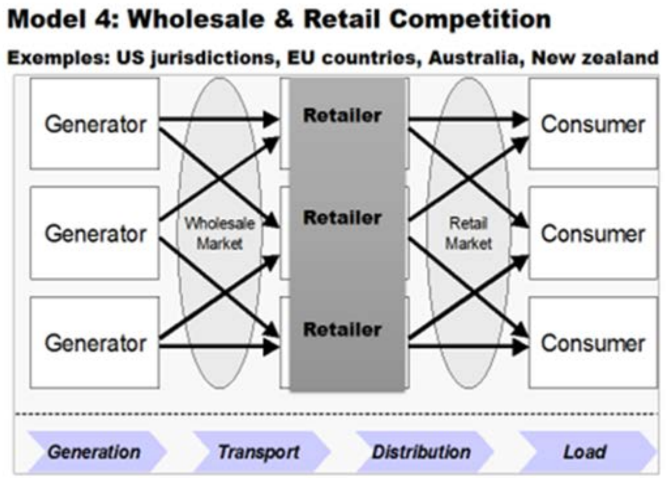
2. The choice between different models of regulation and organisation of power sector

Very different degrees of de-verticalisation, multi-level competition and privatisation but also « reform of the reforms »









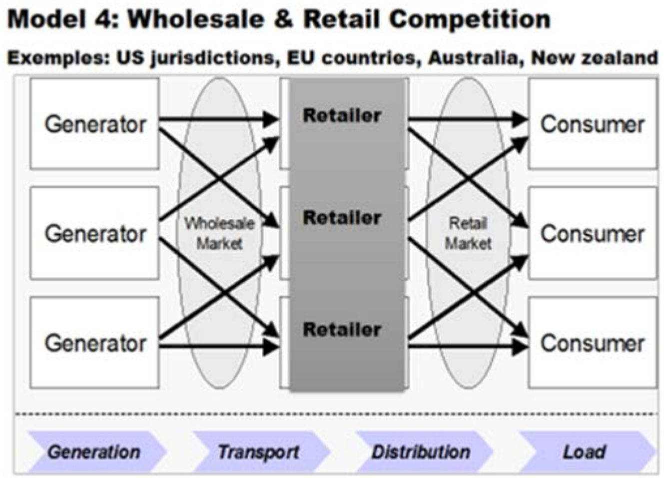
California, Brazil, Chili, columbia, Peru
Presently UK

1.1. Energy policy goals of reforms in the OECD countries

- Drawbacks of the model of vertical public service monopolies : overcapacity, overemployment, productivity issues
- Reform objectives:
  - Short term and long term efficiency by the pressures of competition
  - innovation dynamics
  - Benefits for the consumers (lower prices than in the former model)

Main characters

- Deverticalization and unbundling
- Free access to grids
- Free choice of suppliers and vice versa
- Bilateral transactions + power exchange



1.2. Policy goals of reforms in emerging and developing countries

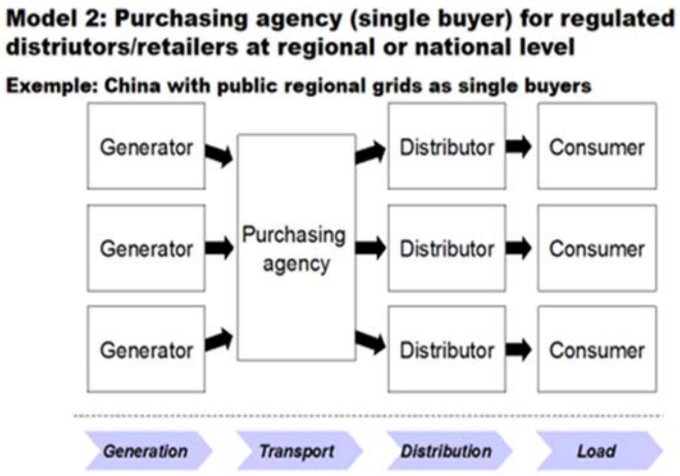
Goal: Economic developement and security of supply

Because public debt crisis, and financing constraints on national utilities:

- Degradation of the operating performance and the security of supply
- Impossibility to follow the demand growth

Privatisation and law change in order to attract private investors, and independent power producers (IPPs) and foreign utilities

- Putting at distance discretionary regulation by ministry regulation
- Change in the tariff regulation (to cover costs)



Answer by Single Buyer Model (model 2)

Many countries keep vertical integration combined with IPPs, India, Indonesia, Mexico, Malaysia, Pakistan, South Africa &Vietnam

Features in common:

■ Procurement of new generation by call for tenders is run by the vertically integrated utility

■Electricity supply is governed by long term Power Purchase Agreements (PPA) with the utility

Typical structure of Power Purchase Agreements

■Long term contracts for the life of the asset (25 to >40 years) with a typical allocation of risk:

■**PPAs have a typical payment structure that is based on two types of payments:**

Capacity charges and Energy charges which cover variable costs of the plant including fuel costs and all variable O&M.

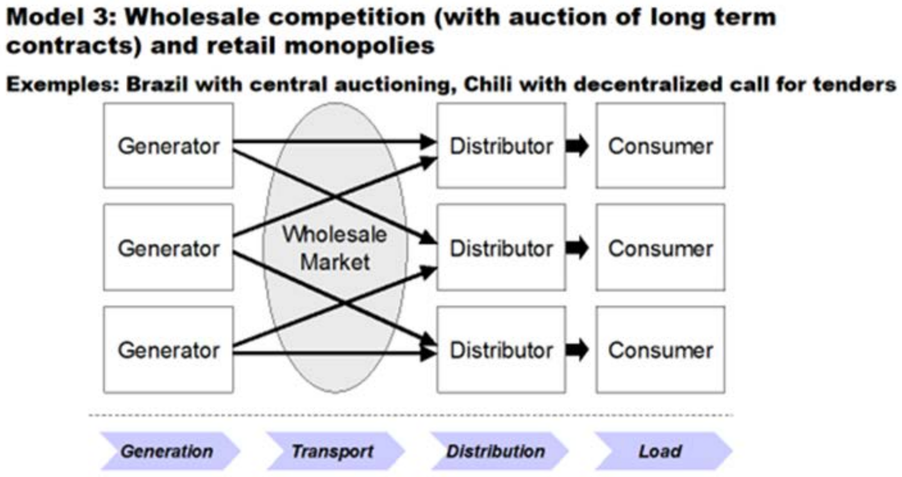
Effective development of new capacities:

The combination of risk allocation and payment structure means **that IPP projects are relatively low risk, which allows them to be project financed**

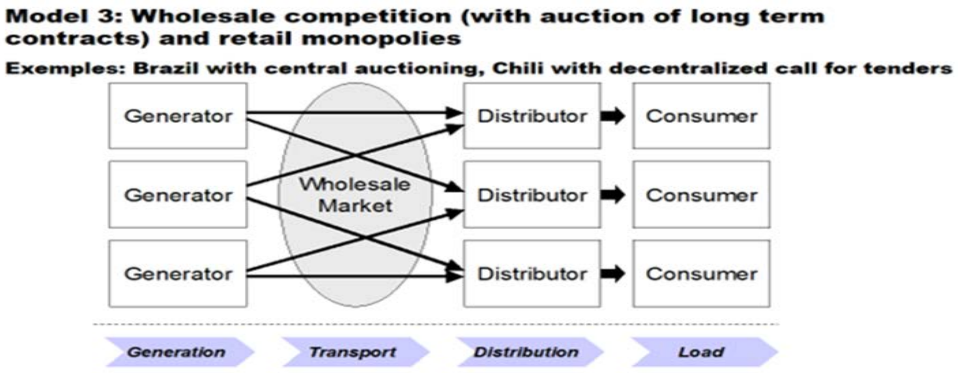
3. The re-reform in emerging countries: from Model 4 to Model 3

The goal : **long term security of supply**

- Crisis of the new markets (Brazil, California)
- Crisis related to the lack of investment because of market failures (risk management)
- Long term contracts to attract new investment (to guarantee revenue for fixed cost recovery)
- To get out the price setting aligned on short term marginal cost for a long term coordination based on expectation of complete costs by generators and investors
- Auctioning of long-term contracts as a way to conciliate the risk reduction for new investors with efficiency in energy procurement for regulated users.



Answer by Hybrid Model 3: planning + long term competition for contracts



The core of the new scheme lies on three main rules:

- All retailers and free consumers (>2-3MW), should be 100% contracted at any time
- All contracts should be covered by "firm energy" or "firm capacity" certificates.

Some contracts could last on 15 years and more

- Auction : Regulated users must acquire their energy supply contracts through auction. (Not free consumers but they should prove they have covered their sourcing by contracts)

Small role for the spot market : in fact a centralized cost-based dispatch and not a price dispatch +

Importance of remaining retail monopoly to regional distributors fro the long termcontracting

Effects of carbon pricing in these different structures

Short term substitution effect

by turning the electricity generated by existing carbon intensive power plants more expensive and thus less competitive against cleaner technologies

Short term substitution:

the impact of carbon pricing on the economic dispatching either by the spot market or by the dispatcher coordination

Long term effects

Turning the investment in new carbon intensive power plants less attractive compare to clean energy investment: this is the long term substitution effect

Long term effect:

It is not only an issue of relative cost-prices between technologies (levelized costs)

It is is also an issue of fixed cost recovery by revenue on the market

So anticipated revenue of generators depend on carbon price effects on the wholesale price or on price indexation in long term contract price

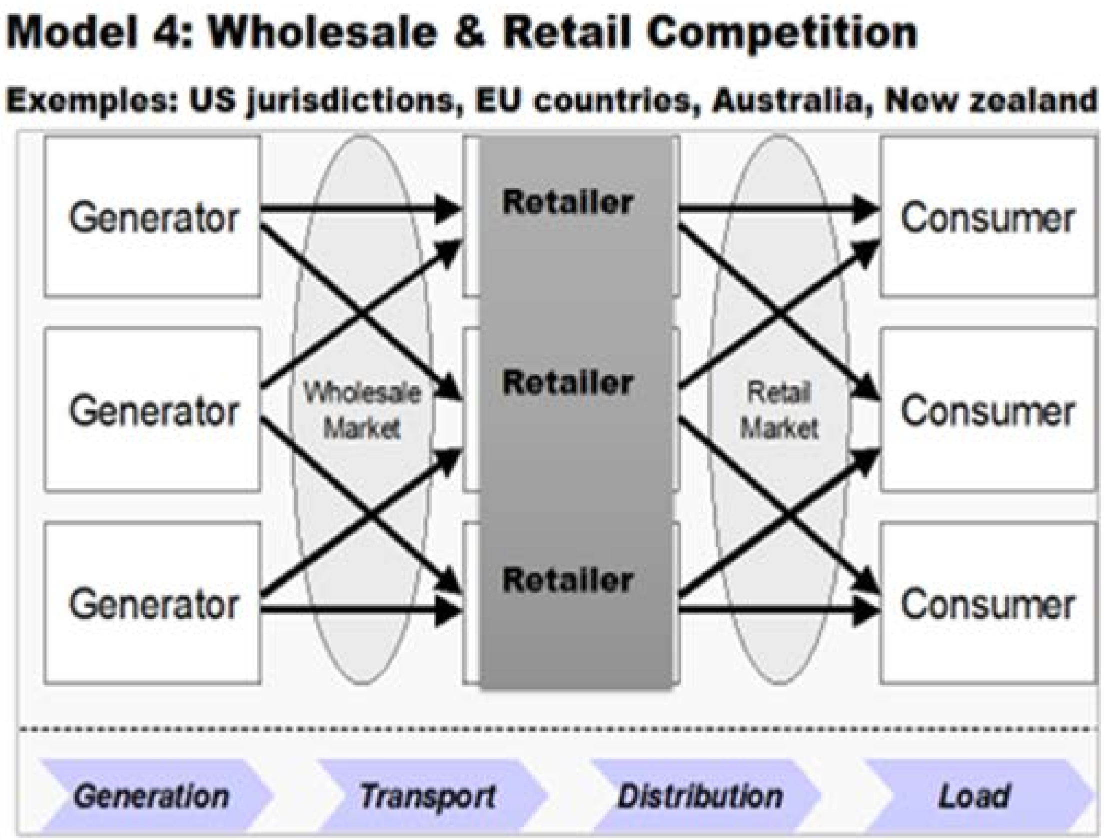
Effects on electricity consumers

by turning the electricity price more expensive for the final customer, and thus inducing a reduction in consumption and thus in generation

There is a redistribution issue of carbon pricing by ETS or carbon tax

- Retail prices increase (issue of the indirect costs on energy intensive industries)
- Specific redistribution effects in case of free allowances with an ETS: windfall profits on emitting plants

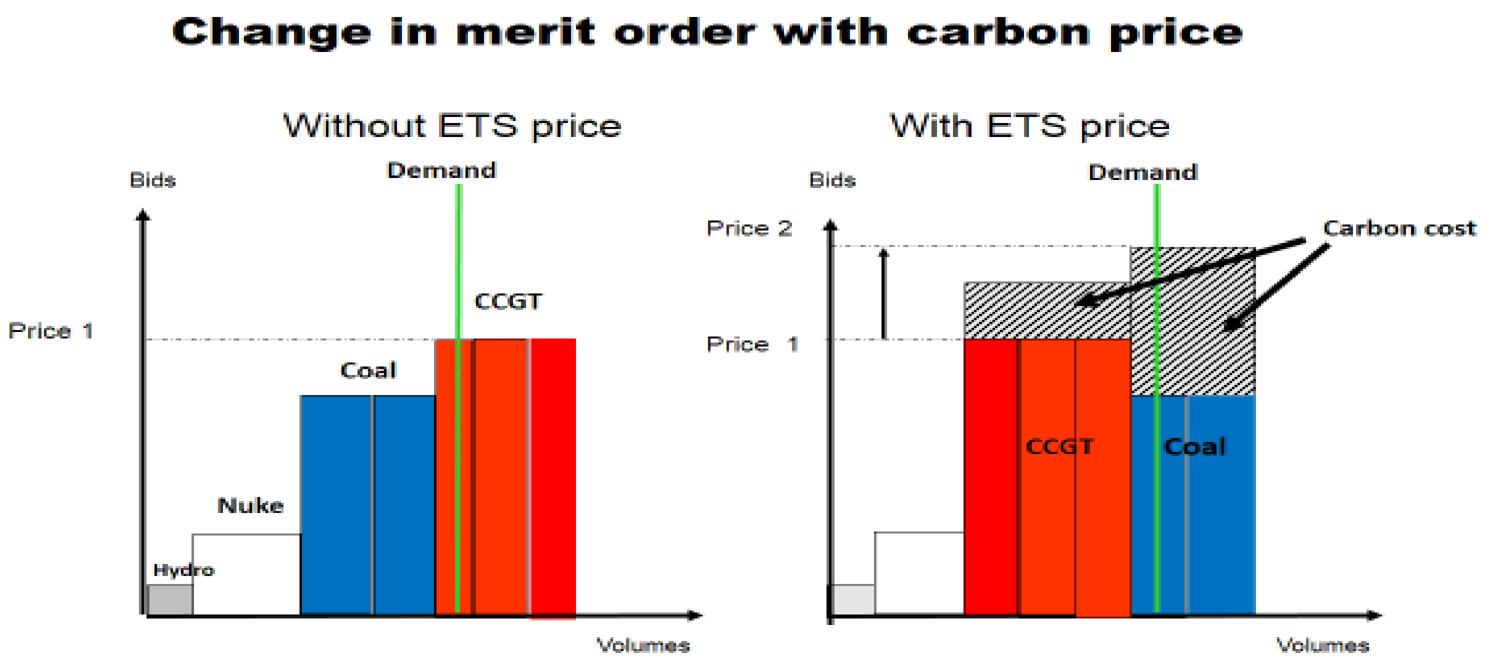
Section 2.Effects of carbon pricing in the Model 4



Expected effects of carbon pricing in the Model 4 (I)

- **Electricity markets are strutured in (semi-) hourly markets**

Short term effects on selection of equipment by the hourly markets : Change in the merit order on the hourly markets



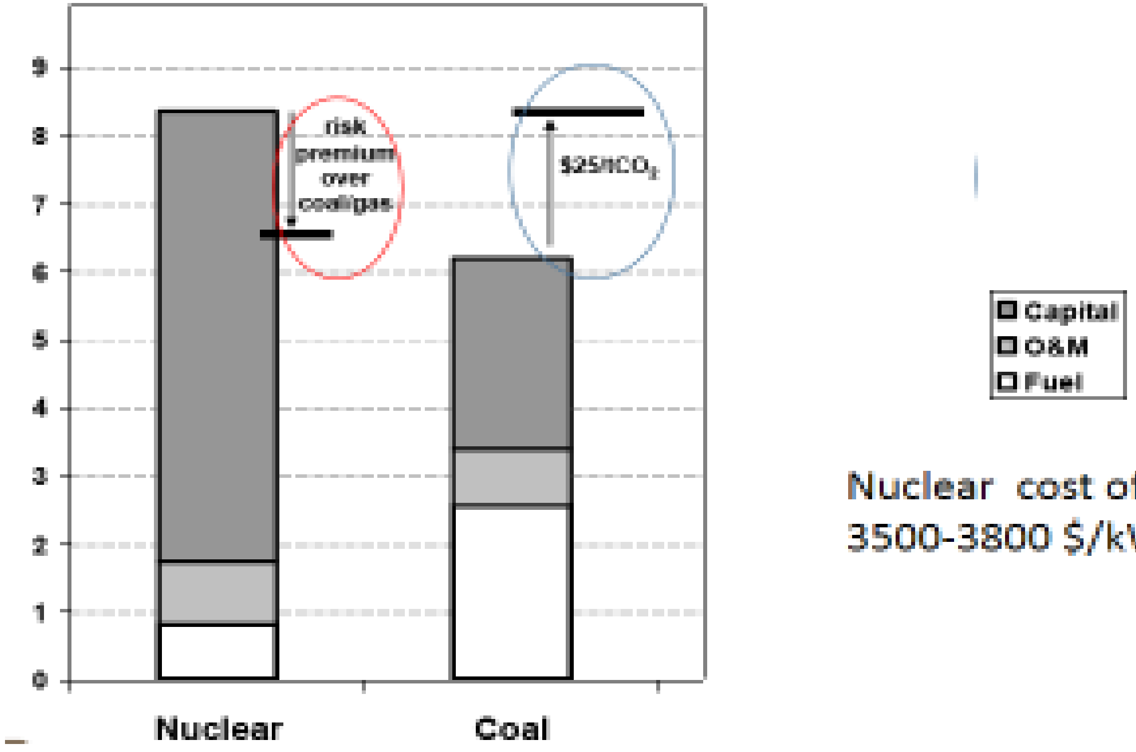
Long term effects : investment in low carbon technologies rather than in emitting plants

***Impact of the carbon price on the competitiveness of a low carbon technology in an OECD country: the case of nuclear** (only as an example)*

Capital cost for nuclear: 11%
With risk premium of 3%

Capital cost for coal plant: 8%

Source : 2009 MIT report update on nuclear .



Nuclear cost of investment: 3500-3800 $/kW

Even with risk premium of 3% : nuclear is competitive with new coal plant if carbon price = $25/tCO2

Long term effects : investment in low carbon technologies (II)

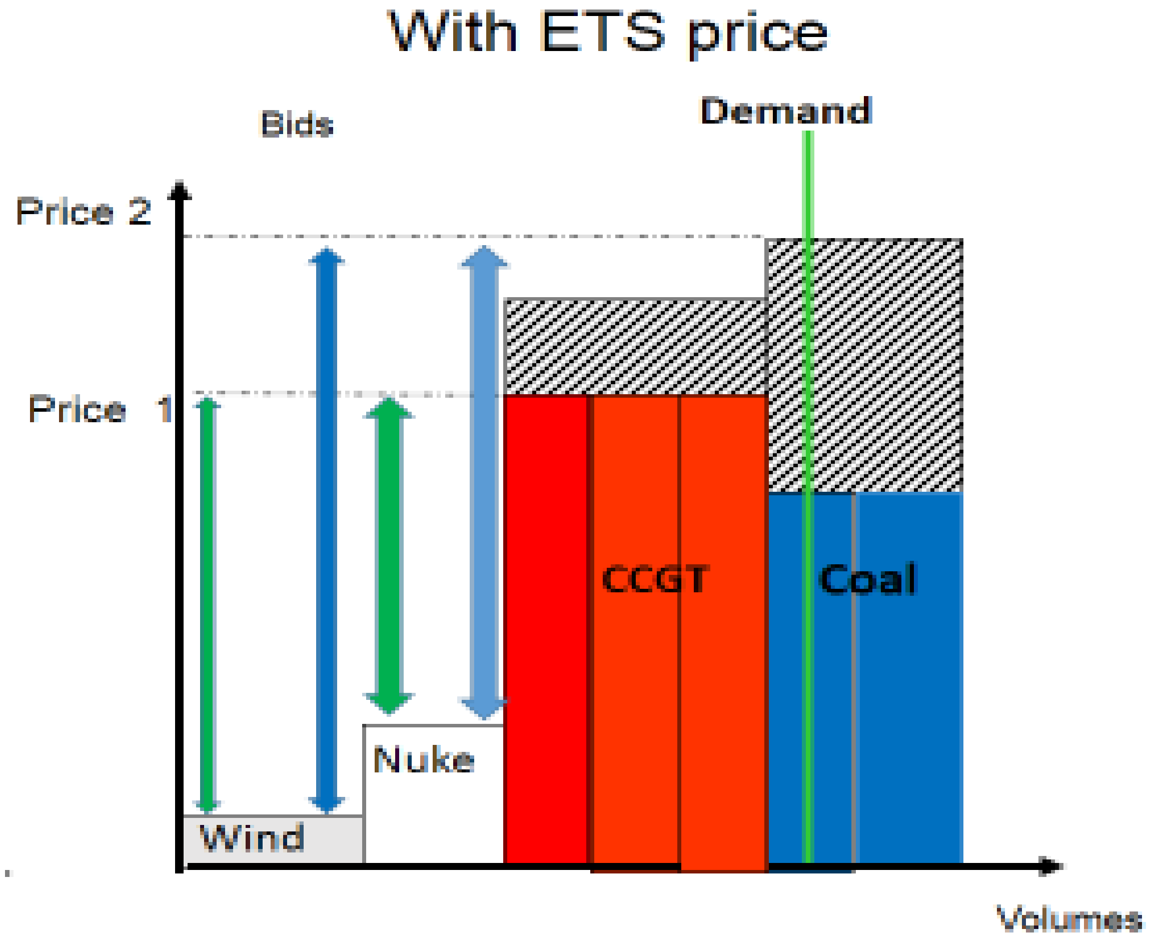
Not so simple:

- Sum of net revenues on hourly markets to recover fixed cost (to be anticipated on 10-15 y.)
- Low carbon technologies have larger fixed costs than fossil fuel plants

When calculation of net present value (NPV):

Prospect of higher surplus for low carbon plants on hourly markets

Note : issue of risk management for on electricity markets



Distribution effects of carbon pricing in the Model 4 (I)

- Increase of wholesale prices in annual average, but it is not so simple
  - Carbon price passthrough in the hourly price depending on the technology mix
    - Duration of annual periods when fossil fuel plants are the marginal plants on the hourly markets
    - With a large share of hydro, and nuke, hourly prices would increase only when fossil plants is needed

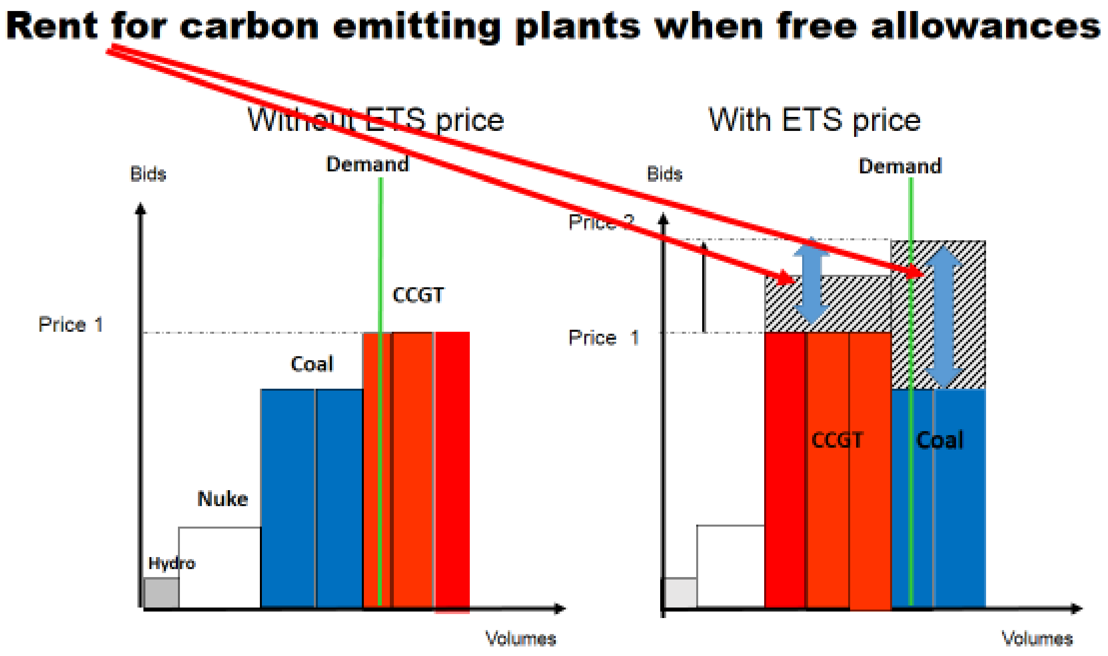
Increase of retail price: it is a legitimate signal addressed to consumers on their indirect responsibilities in carbon emissions,

- but redistributive effect raises the issue of acceptance (lobbying of energy intensives industries)

Distribution effects of carbon pricing

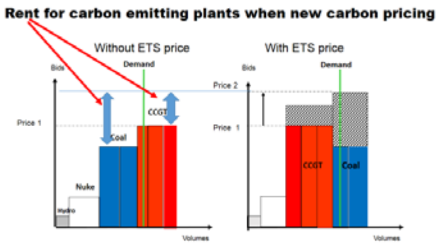
In case of free allowances, a hot issue: undue rent on existing emitting plants (I)

- Price bids on the market aligned not only the variable costs, but also include the market value of allowances
  - As if generator compare between production and use of the allownaces and sales of allowances on thehe ETS market,
  - opportunity cost is passed through in the price bids of every « fossil »competitor, and then in the hourly price



Distribution effects of carbon pricing

In case of free allowances, a hot issue: undue rent on existing emitting plants (II)



So very large redistributive effects in favor of electricity companies even with emitting plants

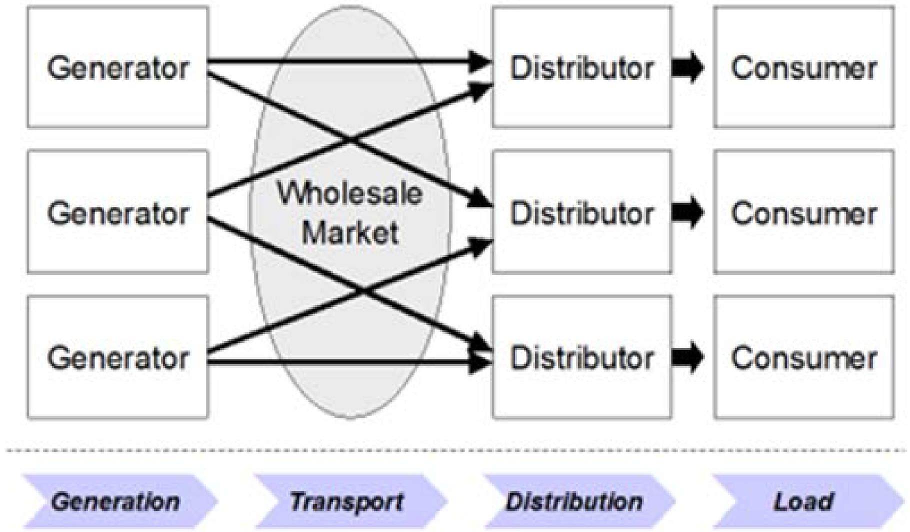
- To note: Difference of cost pass-through between power sector and other sectors (cement , chemical, steel…) exposed to international competition with competitors w/o carbon constraints

- The answer in the EU: to skip to full auctioning in power sector in the 3rd EU-ETS phase (2013-2020)

Section 3. Carbon pricing in Hybrid Model (Planning + long term competition for contracts)

Model 3: Wholesale competition (with auction of long term contracts) and retail monopolies

Exemples: Brazil with central auctioning, Chili with decentralized call for tenders



Model 3. Hybrid model : planning + long term competition for contracts

In the past decade, new reform wave in Latin America that relies on auctioning of long term contracts to attract new investment

■ Centralized cost-based dispatch (called “spot market”);

❑Remaining distributors monopoly (retail prices for consumers are regulated) except for very large consumers

■Addition of an auctioning of long-term contracts as a way to conciliate the risk reduction for new investors with efficiency in energy procurement for regulated users.

The core of the new scheme lies on three main rules:

- ■All retailers and free consumers (>2-3MW), should be 100% contracted at any time
- ■All contracts should be covered by “firm energy” or “firm capacity” certificates.

  Some contracts could last on 15 years and more in Brazil
- ■Auction : Regulated users must acquire their energy supply contracts through auction. (Not free consumers but they should prove they have covered their sourcing by cotnrats)

Differences in implementation in Brazil and Chili

■Brazil (2004) :

Centralized scheme with auction organized by government to select contracts for covering distribution company's needs

Standardized contracts: prices on energy and capacity

■Chile (2005):

Decentralized scheme : distribution companies manage their auctions

Non standardized contracts

Only energy contracts; addition of a regulated capacity price

---

To note: In the two organisations, minor role of the "spot market"

- Brazil: computational model to define each week three blocks price
- Chili: economic dispatching on the basis of the variable costs of the different plants

- **Short term effectiveness** : guarantee by the economic dispatching
- **Long term issues** : effectiveness of long term contracts to invest in low carbon technologies

but importance of the structure of the contracts (inclusion of carbon prices in the indexation formula)

importance of the criteria of the auctioning (not only electricity price but the indexation formula)

- **Distributive issue** :
  - The issue of carbon cost-passthrough if free allowances
  - The issue of rent on existing hydro plants: solution of taxation

Conditions of effectiveness of an ETS price

- Short term effect: No need of change in the economic dispatching process
  - In Brazil computation of short term price should include carbon price in the variable cost of the fossil fuel plants
  - In Chile economic dispatching shall normally include information of carbon price in the variable
  - An issue: if 90% free allowance, should we introduce rent for fossil fuel plants ?

- Long term and structural effects
  - ETS price is supposed to incite to invest in low carbon technologies ;
    - at least if fossil technologies are needed, to invest in the least emmitting ones
  - Long term contracts allow revenue aligned on complete costs and so recovery of fixed costs

But the structure of the contracts should be flexible to allow permanent alignement of prices on complete costs: ie pass through of carbon price variations in the price

Condition of long term effectiveness of carbon pricing in the case of Chile

- Generators and investors bid a specific price (£/MWh) and energy amount for each contract (with monthly peak and off-peak supply) to a distributor's auctioning.
- Indexing formulas are used in the contracts with the intention of hedging mid- and long-terms risks.
- Problem:
  - Assumptions on price projections are important for the auctioneer' bid price.
  - But auctioneers cannot propose the indexation formula when allocating, avoiding any type of risk assessment.

This point is important for two reasons :

- if carbon pricing is introduced, it should be necessary to readjust the indexation formula in existing contracts ;
  - Given the volatility of an ETS price, it adds to the risk on fossil fuel prices when the auctioneers have to anticipate the change in their variable costs.
  - If no re-adjustment of existing long term contracts, the risk is that a generator will close its equipment if it could not cover its variable costs when carbon price increases

- So it will be necessary to auction not only on price per MWh, but also the indexation formula in a way or another

Distribution effects of carbon pricing in the hybrid model

- Retail price regulations guarantee wholesale price change in the regulated tarifs

- Increase of the wholesale price in relation to the technology mix (number of hours when a fossil plant is marginal in the dispatch)
  - In systems with hydro (75% Brazil; 40% Chili), carbon pricing creates rent on hydro producers during hours when fossil plants are marginal (with and w/o free allowances)
  - It could be a problem if fossil plants are marginal during almost all the year (rent + competition issue)

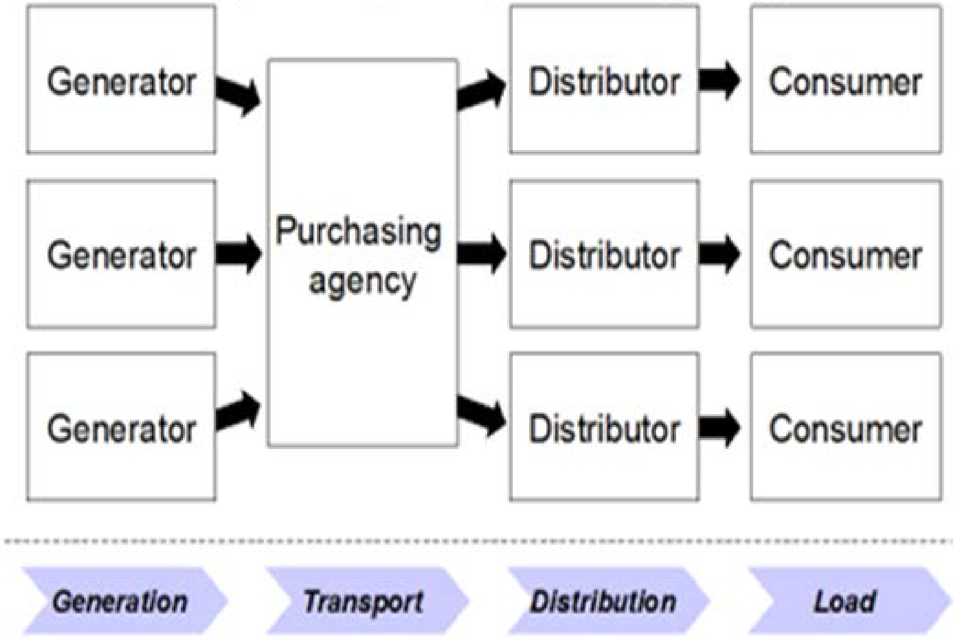
  Answer: tax on hydro rent

- Issue of rent if free allowances for the emitting plants

Section 4. Model 2 Single buyer
The need of a consistent electricity market design if carbon pricing

Model 2: Purchasing agency (single buyer) for regulated distriutors/retailers at regional or national level

Exemple: China with public regional grids as single buyers



Single Buyer Model

Many countries keep vertical integration combined with IPPs, e.g. India, Indonesia, Mexico, Malaysia, Pakistan, South Africa &Vietnam

Features in common:

■ Planning is run by a central agency—usually the utility—who forecasts demand

■ Procurement of new generation is run by the vertically integrated utility

■Electricity supply is governed by long term Power Purchase Agreements (PPA)

Typical structure of Power Purchase Agreements

■Long term contracts for the life of the asset (25 to >40 years) with a typical allocation of risk:

■PPAs have a typical payment structure that is based on two types of payments:

– Capacity charges: cover the fixed costs of the plant, including all capital costs and fixed O&M costs.

– Energy charges: cover the variable costs of the plant including fuel costs and all variable O&M costs.

Inflation risk: borne by the buyer through escalation provisions in the PPA

Dispatch of the independent plants is common with the dispatch of the utility single buyer: merit order of variable costs

Effects of carbon pricing

- **Short term effectiveness** : IPPs in economic dispatch by the single buyer

- **Long term effectiveness**:

  Need of flexible PPAs with full indexation of ETS price

- **Redistributive effects** :
  - The issue of carbon cost passthrough if free allowances

Strong limitation on carbon pricing effectiveness when uncomplete market-based reform

The Chinese case :

The goal: easing financing and entries face to important shortages

Adoption of a more decentralised model

- many generators, separation of grids and distributors
- Regional single buyers (regional grids) with very administered PPAs
  - initially fixed price/ no indexation formula,
  - fixed annual production planning
- Regulation with no cost pass through when change of fuel costs
  - When coal price was liberalized and increased , threat of numerous closures and risk of outages
  - Now just a yearly adjustment with long time-lag
- Special regime for small coal plants with bad efficiency

If an ETS is introduced (90% free allowances + 10% auctioned)

- Short term effects

  No economic dispatching, so no advantage for the most efficient coal plants (supercritical coal plants) to produce more, nor for the CCGTs

  Problem of introduction of variable ETS price: necessity to a flexible and reactive indexed price formula (coal price, carbon price)

- Long term effects

  No playing field between generation technologies because of the fixed price setting and the annual production planning

    limit revenues prospects +regulatory risks

  If free allowances and no cost passthrough, reduction of incentives to invest in low carbon technologies (Nuke, CCS, hydro, large RES-E) or more efficient coal plants

- Short term and long term effects of exemption of small and medium size coal plants (70 GW to 200 GW concerned),

- Problem related to the **absence of an economic dispatching** (via a power exchange or a dispatch market center)
- Problem related to the **rigidity of price adaptation (fuel price, carbon price) in the pseudo-PPAs**
- Problem with exemptions of inefficient plants

- **Redistributive effects** : Discretionay nature of regulation for the cost pass-through

5. Some remarks to conclude

Importance to anticipate effects of carbon pricing, not only the expected ones, in particular when energy policies is intersected.

Carbon pricing have different effects on carbon reduction and on electricity pricing , depending on the organisational model of power sector

Complexity of any of these models, so importance to understand the functioning of the power sector regulation in a country to anticipate effects of carbon pricing

Common conclusions

- Short term reduction effect: need of an economic dispatching either by the spot market or by the dispatcher coordination
- Long term effects :
  - Need to have an effective long term foreseeability of carbon price
  - Need of stability of long term revenues for investors in low carbon technology
- Redistribution effects: mind some redistributive issue (free allowances , hydro rents)

Some remarks to conclude
Limited lessons from mutual experiences

- Situations between OEcD countres with a mature markets and emerging countries with important need of investement are too different

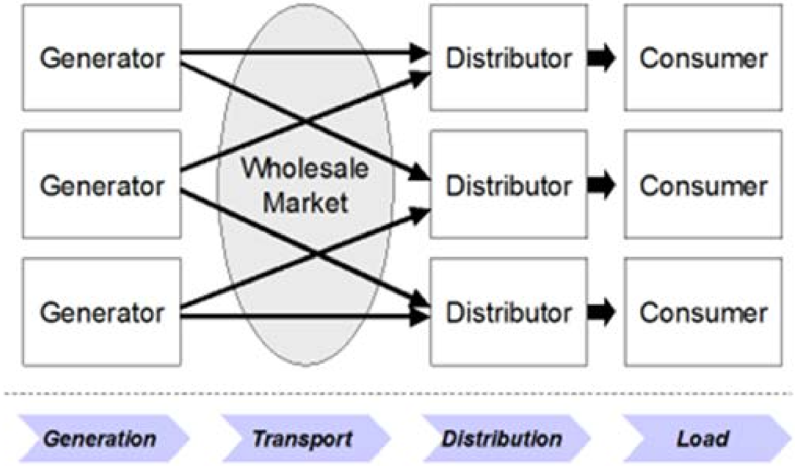
- Lessons from OECD countries to emerging economies:
  - Mind the redistributive issue (free allowances, hydro rents)
  - Not sure that carbon pricing could be the sole solution, and have a real effectiveness for low carbon investment
- Lessons from emerging economies to EU and OECD countries to decarbonize their electricity systems (with auctioning and long term contracts)
- The Hybrid Model appears to be the most adapted to countries' situation with a need of new capacities if they have a real commitment in carbon policy.
  - Carbon pricing should orient towards low carbon technologies with long term contracts
  - Attention should be focused on the structure of the long term contracts (indexation formula, because risks associated with ETS)

- Single buyer : for having a ETS which makes sense in the power sector, need to have a consistent market-based model

Appendix 1
Carbon pricing in Hybrid Model
(Planning + long term competition for contracts)

Model 3: Wholesale competition (with auction of long term contracts) and retail monopolies

Exemples: Brazil with central auctioning, Chili with decentralized call for tenders



Hybrid model : planning + long term competition for contracts

(To get out the price setting aligned on short term marginal cost, and to

In the past decade, new reform wave in Latin America that relies on auctioning of long term contracts to attract new investment

■ Centralized cost-based dispatch (called "spot market");

❑Remaining distributors monopoly (retail prices for consumers are regulated) except for very large consumers

■Addition of an auctioning of long-term contracts as a way to conciliate the risk reduction for new investors with efficiency in energy procurement for regulated users.

The core of the new scheme lies on three main rules:

- ■All retailers and free consumers (>2-3MW), should be 100% contracted at any time
- ■All contracts should be covered by "firm energy" or "firm capacity" certificates.

  Some contracts could last on 15 years and more in Brazil
- ■Auction : Regulated users must acquire their energy supply contracts through auction. (Not free consumers but they should prove they have covered their sourcing by cotnrats)

Differences in implementation in Brazil and Chili

■Brazil (2004) : centralized scheme with auction organized by government to contract distribution company's needs

contracts: price on energy and capacity; standardized contract, difference between existing and new equipment

Possible specific auctions for large projects or RES-E

■Chile 2005: decentralized scheme : distribution companies manage their auctions

only energy contracts, non standardized; addition of a regulated capacity price

---

To note: In the two organisations, minor role of the "spot market"

- Brazil: computational model to define each week three blocks price
- Chili: economic dispatching on the basis of the variable costs of the different plants

Conditions of effectiveness of an ETS price

- Short term effect: No need of change in the economic dispatching process
  - In Brazil computation of short term price should include carbon price in the variable cost of the fossil plants
  - In Chili economic dispatching shall normally include information of carbon price in the variable
  - An issue: if 90% free allowance, should we introduce rent for fossile plants

- Long term and structural effects
  - ETS price is supposed to incite to invest in low carbon technologies and at least if fossil technologies is needed, in the most efficient ones
  - Long term contracts allow revenue aligned on complete costs (or LRMC) and recovery of fixed costs
  - So the structure of the contracts should be flexible to allow permanent alignement of prices on complete costs: ie pass through of carbon price variations in the price

Long term contracts auctions and selection criteria are not so favourable if carbon pricing with ETS : the case of Brazil

- Generators bid not only on the option premium ($/MW) but also on the option strike price ($/MWh).
- Bids are compared on the basis of the expected benefit for consumers:
  - the government, by means of a simulation procedure, calculates(i) the expected value of their fuel cost reimbursements (in $/year), and (ii) the expected value of the short-term transactions at the spot market (in $/year).
  - the government estimates the plant usage and provides expected operation cost and spot market transactions incurred by the consumer.
  - Then a single unit energy cost–benefit index in $/MWh of firm energy is then calculated for each technology.
  - After selection, all contracts have full indexation to fuel prices and inflation.

- So for the long term effect of carbon pricing ,
  - importance of the way the carbon price expectation (including its volality) is taken into account in the calculation of the expected value of their fuel costs reimbursements in the selection process by the auctioning on one hand,
  - Importance of a full indexation to the ETS price beside fuel price and inflation

Long term carbon pricing effects: The case of Chili

- Generators and investors bid a specific price (£/MWh) and energy amount for each contract (with monthly peak and off-peak supply) to a distributor's auctioning.
- Indexing formulas are used in the contracts with the intention of hedging mi- and long-terms risks.
- Problem:
  - Asumptions on price projections are important for the auctioneer' bid price.
  - But auctioneers cannot propose the indexation formula when allocating, avoiding any type of risk assessment.
- This point is important for two reasons :
- if carbon pricing is introduced, it should be necessary to readjust the indexation formula in existing contracts ;
  - given the volatility of an ETS price, it shall add to the risk on fossil fuel prices when the auctioneers will have to anticipate the change in their variable costs.
  - If no re-adjustment of existing long term contracts, the risk is that a generator will close its equipment if it could not cover its variable cost

    (when the carbon pricing is implemented and when it increases significantly during a long period)

- So it will be necessary to auction not only on price per MWh, but also the indexation formula in a way or another

Distributional effects of carbon pricing in the hybrid model

- Retail price regulation guarantees wholesale price change in the regulated tarifs)

- Increase of the wholesale price in relation to the technology mix (number of hours when a fossil plant is marginal in the dispatch)
  - In systems with hydro (75% Brazil; 40% Chili), carbon pricing creates rent on hydro producers during hours when fossil plants are marginal (with and w/o free allowances)
  - It could be a problem if fossil plants are marginal during almost all the year (rent + competition issue)

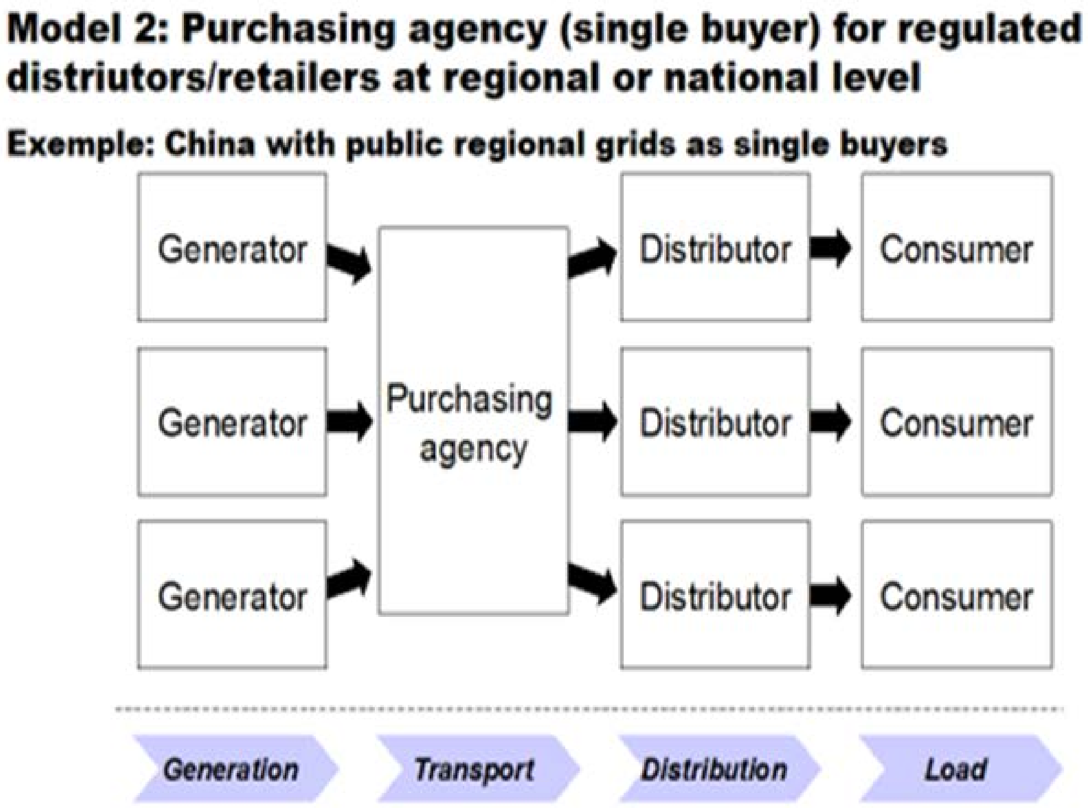
- Issue of rent if free allowances for the emitting plants

- Note about competitiveness issue
  - Acceptance of electricity price increase by energy intensive industries could be solved by the rules of contracting of free conumers (>2-3MW)
  - Direct effects of carbon price on their contractual price with producers

To sum up

- **Short term effectiveness** : Importance of the power exchange/economic dispatching
- **Long term issues** : effectiveness of long term contracts but importance of the structure of the contracts (inclusion of carbon prices in the indexation formula) and the criteria of the auctioning
- **Distributive issue** :
  - The issue of carbon cost-passthrough if free allowances
  - The issue of rent on exisiting hydro plants

Appendix 2.
Carbon pricing in Single buyer model



Single Buyer Model

Many countries keep vertical integration combined with IPPs, e.g. India, Indonesia, Mexico, Malaysia, Pakistan, South Africa &Vietnam

Features in common:

- Planning is run by a central agency—usually the utility—who forecasts demand
- Procurement of new generation is run by the vertically integrated utility
- Electricity supply is governed by long term Power Purchase Agreements (PPA)

Typical structure of Power Purchase Agreements

- Long term contracts for the life of the asset (25 to >40 years) with a typical allocation of risk:
- PPAs have a typical payment structure that is based on two types of payments:
  - Capacity charges: cover the fixed costs of the plant, including all capital costs and fixed O&M costs.
  - Energy charges: cover the variable costs of the plant including fuel costs and all variable O&M costs.

  Inflation risk: borne by the buyer through escalation provisions in the PPA

Dispatch of the independent plants is common with the dispatch of the utility single buyer: **common merit order of variable costs**

- **Short term effectiveness** : IPPs in economic dispatch by the single buyer
- **Long term effectiveness**: Need of flexible PPAs with full indexation of ETS price
- **Redistributive effects** : The issue of carbon cost passthrough if free allowances

Strong limitation on carbon pricing effectiveness when inconsistent market –based reform

China: inconsistent market design of power sector reform

- The goal: easing financing and entries face to important shortages)
- Adoption of a scheme with many generators, separation of grids and distributors
- Regional single buyers (regional grids) with regulated PPAs
  - with fixed price/ no indexation formula, and
  - with fixed annual production planning
- Regulation with no pass through of fuel costs change
  - When coal price was liberalized and increased , threat of numerous closures and risk of outages
  - Now just a yearly adjustment with long time-lag
- Special regime for small coal plants with bad efficiency

If an ETS price is introduced (90% free allowances + 10% auctioned)

- Short term effects
  - No economic dispatching, so no advantage for the most efficient coal plants to produce more, nor for the CCGTs
  - Problem of introduction of a variable carbon price: necessity to a flexible and reactive indexed price formula (coal price, carbon price)

- Long term effects
  - Exemption of small and medium size coal plants (68 GW/ 138GW), so no obsolesence effects
  - No playing field between generation technologies because of the fixed price setting and the annual production planning which limit revenues prospects +regulatory risks
  - If free allowances and no cost passthrough of them, reduction of incentives to invest in low carbon technologies (Nuke, CCS, hydro, large RES-E) or more efficient coal plants
  - No signal effects to electricity intensive industries to improve their process

If an ETS price is introduced…..

Distributive effects

Powerful regulation with important discretion

Easy to exempt inefficient small coal plants, to manipulate individual allocations

Easy to limit the cost passthrough to the 10% auctioned

Blockades of possible 100% to be auctioned

Interactions with other energy policies

Possible exuberance of RES-E subsidization policies: which effects on the ETS price?
(which consideration in the definition of the evolving quota allocation to the power sector?)

ETS carbon pricing would only make sense in the Chinese power sector if there is a clear jump the Hybrid Model 3

But in the present regulatory environment, ETS pricing would have distortive effects. Carbon tax would be a better signal