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CENTRE  
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# Financing new nuclear build in liberalized markets: The best combinations of financing and organisational arrangements

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CeSSA Conference

Cambridge, December 13-15, 2007

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# 1. Introduction

- 1. Financing community interested by economic prospects for nuclear (CO<sub>2</sub> advantage, fuel cost, etc.)
  - Recent announcements of nuclear merchant plants combined with project finance in the USA (NRG Energy, Constellation, etc.)
  - Would combination of this business model and project finance be adapted to new nuclear equipment?
- 2. Deterrence on lenders and producers to invest in nuclear technology in the decentralised market model
  - specific risks to nuclear technology
  - but also market risks magnified by high fix cost/variable cost ratio

# 1. Introduction (following)

- 3. Some legitimate solutions of risk transfer on government for specific risks to nuclear technology and re-learning
- 4. Different combination of financing arrangements
  - Different contractual and organisational arrangements to transfer risks from producers,
    - They depend upon the industrial models of reform
    - Some are far from decentralised market model
  - Financing arrangements are adapted to these arrangements

# Content

- 1. Introduction
- 2. Specific risks of a nuclear investment in liberalised market
- 3. Financing arrangements of nuclear investment in different institutional and organisational models
  - The model of « nuclear merchant » with long term contracts
  - The model of the cooperative of consumers
  - The model of dominant vertical firm
  - Nuclear Investment by oligopoly of middle-size firms

## 2. Risks specific to nuclear investment

Which risks to be transferred to governments?

# Specific risks in investing in nuclear projects

- **Usual risks of electricity generation investment**
  - **Construction risks**
  - **Operating risks**
  - **Market risks in liberalized electricity markets**
    - Price risks
    - Volume risks

## **Specific risks of nuclear investment**

**Difficulty of siting and planning**

**Regulatory and political risks during construction**

**Risk of re-learning process**

- Risk of scarcity of manufacturing and E&C

**Amplification of construction risks and operating risks**

(size, lead time, capital indivisibility)

**Amplification of market risks:**

- no correlation between market prices and construction costs
- CO2 risk

## **2.1. Political and regulatory risks**

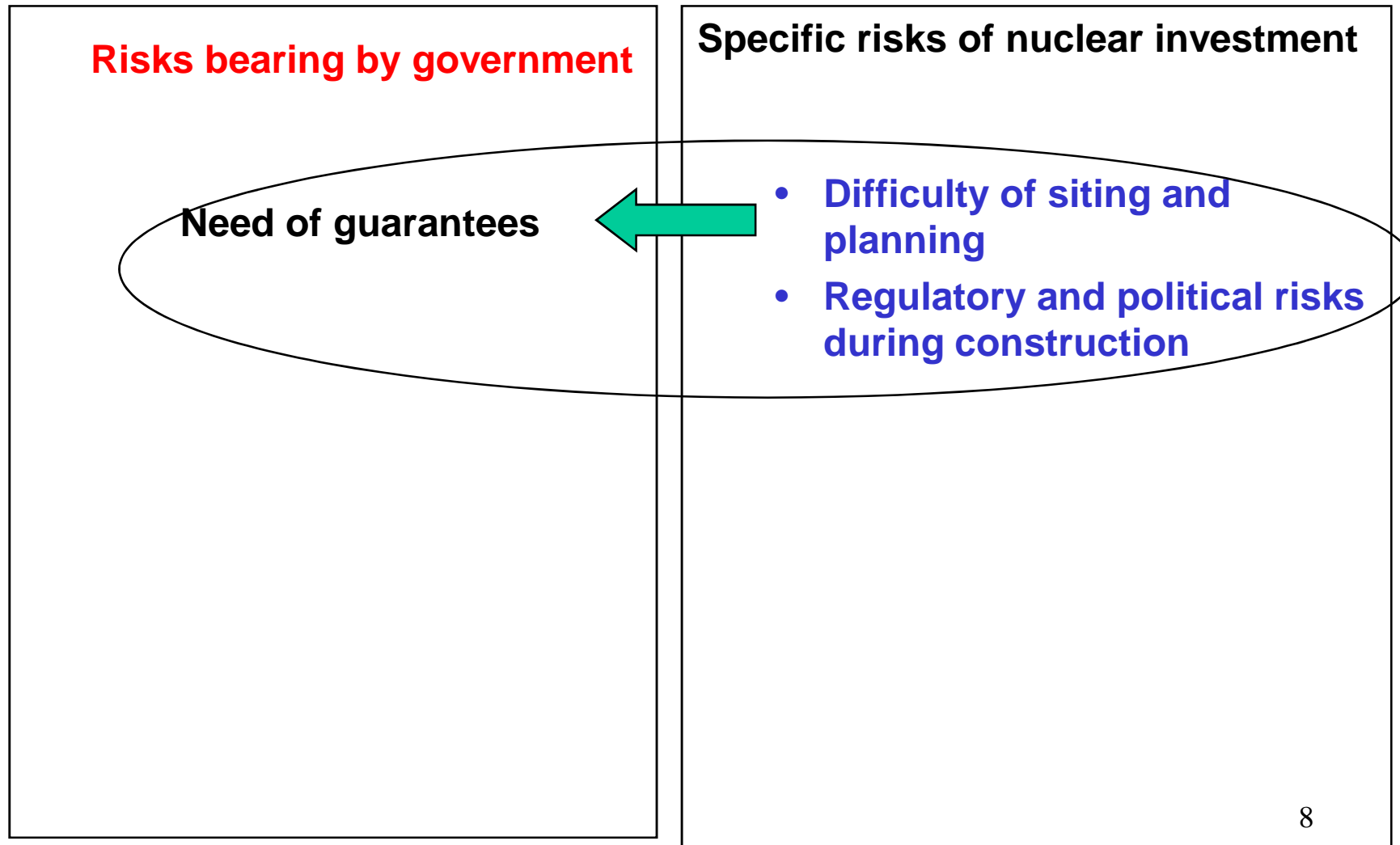
**Nuclear reactors and fuel cycle are not a politically neutral technological system,**

- **Contrast with concurrent generation technologies (CCGT, clean coal, etc.)**
- **Risk of licensing and siting**
- **Risks with acceptation of any waste management solution**

When a government wants to re-open nuclear option, investors identify the risks coming from the side of the State

- **Need of credibility of its commitment in the nuclear option**

# Nuclear investment risk mitigation by government I



## So, for nuclear investors , strong political leadership is needed

- **A. Political process allowing acceptability**
  - **Stability of the overall policy**
    - Rationales: climate policy, energy security, electricity price stability
    - **Crucial in the UK** (2 or 3 electoral cycles before first commissioning around 2020)
  - on siting
  - on nuclear waste management
- **B. Creating the conditions of cost control**
  - Reaching stability of the safety regulation
  - Pre-licensing several “standard” designs to maintain competitive choice
  - To allow learning effects and standardisation
- **C. Assuming the regulatory risks**
  - Risks In siting
  - Risks control during the construction

## Government must assume the regulatory risk

- Cf. US policy (insurance up to \$600 million for the first ones)

- **But**

If governments keep large size companies in the electricity system:  
companies are able to bear this risk (France , Japan)

- In some exceptional case, the manufacturer/ E&C company could bear part of this risk for the FoAK
  - AREVA assume effects of Finnish regulator's stringent controls on OK3 build

## 2.2. Costs and risks of new learning

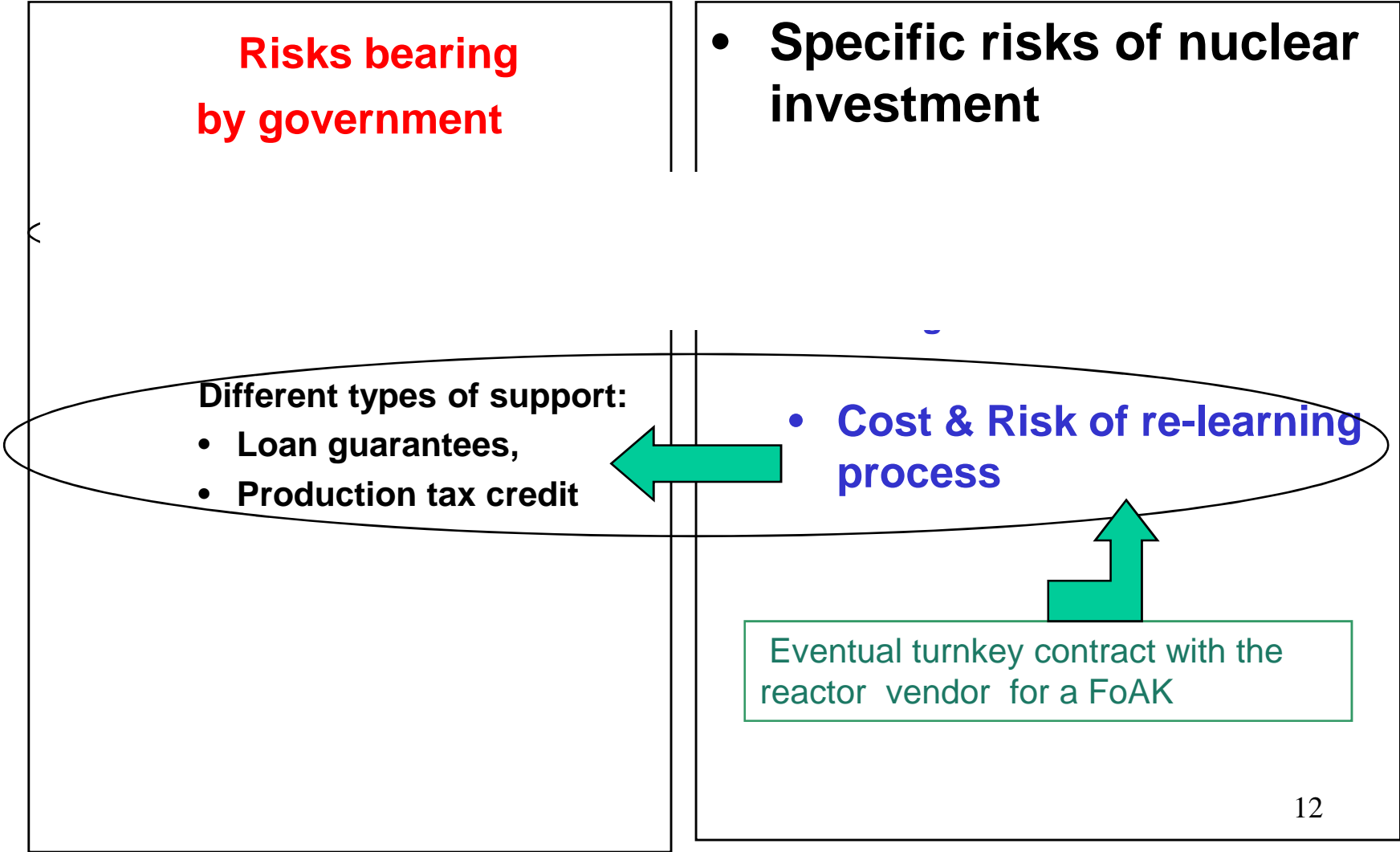
After two decads of industrial inactivity, nuclear renaissance means

- to re-develop skills,
- to recreate industrial momentum on advanced LWR designs

Problematic of public support to nuclear identical to the support to renewables production

- Rationale by the **CO2 advantage** and the **long term energy security**

# Nuclear investment risk mitigation by government II



## Governments are legitimate to support re-learning costs

Support for the initial stages on initial series of First-NoAK and industrial re-learning

- Subsidization of the first reactors
  - US exemple: Subsidies to the production on the 8-year (Production tax credit of \$18/MWh)
- US: Loans guarantees of up to 80% of a project
  - ***Loan guarantees allow access to guaranteed debt, which has therefore a lower interest rate.***
  - ***Increase the leverage of a project, using up to 80% of debt as compared to 50% of debt in case in which debt is not guaranteed.***
  - ***Strong impact on the cost of capital***
- **But possibility that manufacturer and E&C bear part of the construction risk for the first FoAKs**
  - AREVA in Finland
  - GE-Toshiba with ABWR of South Texas project (?)

## 2.3. New risks to invest in liberalized electricity industry

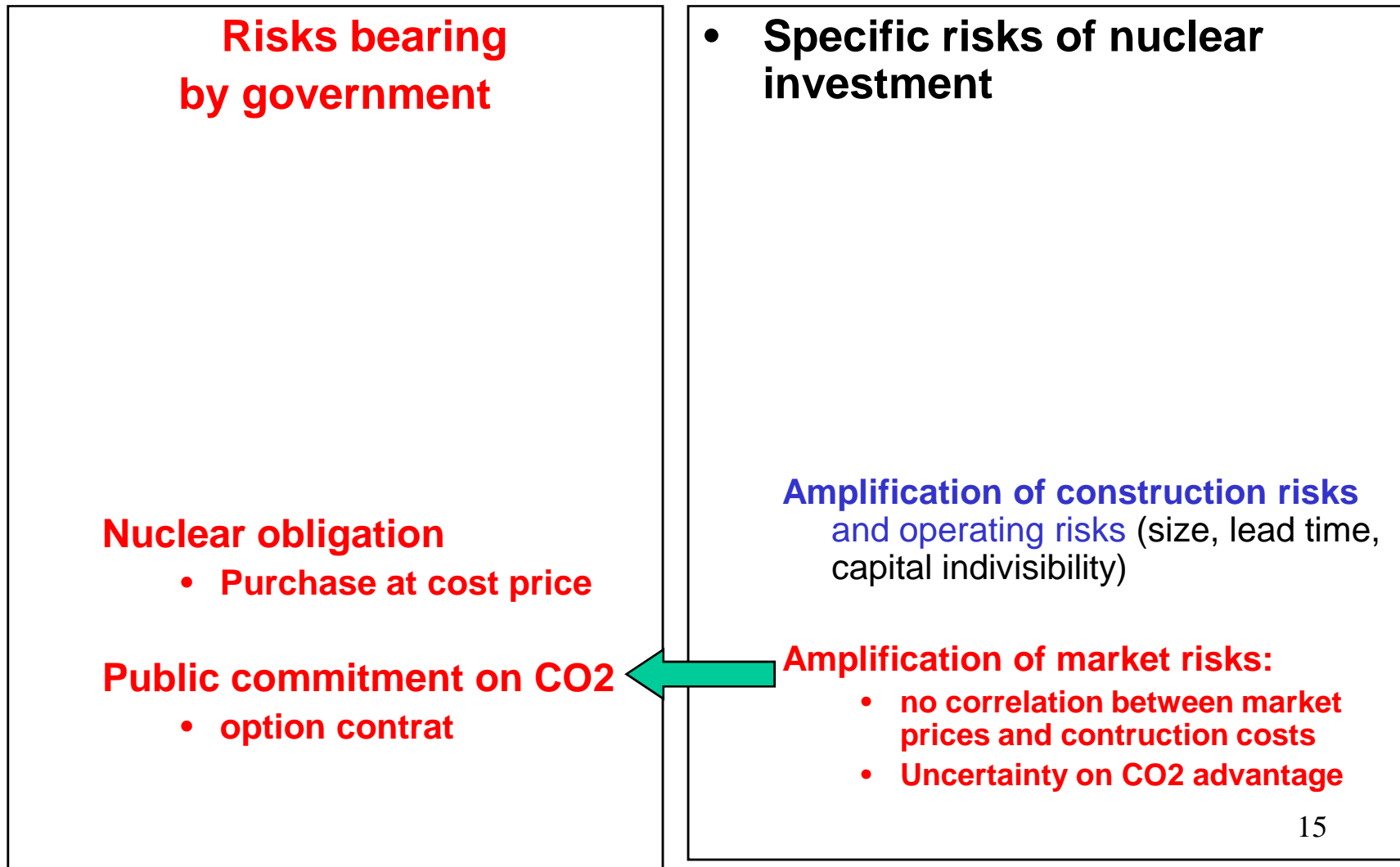
### I. Market risks are amplified by the characters of nuclear technology

- Capital intensiveness and indivisibility
- Long lead time in construction:
  - Difficulties to anticipate net cash flow when commissioning
  - Greater difficulties to anticipate period of price spikes at the moment of commissioning
- **Low marginal cost, high fixed costs:**
  - For a “merchant plant”, problem of **expected post-construction cash flow: Constraints of debt repayment schedules**
  - **High operating leverage:**
    - small changes in revenue lead to large changes in profits
    - greater risk of bankruptcy if low price
- Greater need for **risk management** than non-nuclear generation

### II. Design of environmental policies amplifies market risks

- quantity instrument (quotas) and not price instrument (tax) = **uncertainty on CO2 price**
- ETS to be long term foreseeable

# Nuclear investment risk mitigation by government III



## Need of risks allocation on other stakeholders than the producer

### A first solution: to shift some market risks on the government

- To put new nuclear generation out of electricity markets:
  - Nuclear obligation with mandatory purchase at fixed electricity price
  - To offer protection of options or long term forward contracts
    - Public agency could act as a broker (example of the Brazilian system for hydro projects )
    - Parallel with production tax credit or RES-E feed-in tariffs
- To guarantee the monetary valuation of CO<sub>2</sub> advantage
  - with CO<sub>2</sub> option contracts before construction

## Another solution :

### To get outside the decentralised market model

- long term contracts « nuclear generator-consortium of industrial consumers »
- long term contracts « producers-historic suppliers »
- vertical integration

**3. Financing arrangements of nuclear investment  
in different institutional and organisational models**

### 3.1. Three models of industrial organisation under consideration

1. De-centralised market model: Some American regional markets, Nordic markets

- **IPPs on nuclear project with long term contract**
- **Cooperative of industrial consumers and suppliers**

2. Oligopolistic model of re-integrated firms (UK case)

- Re-integration after a first stage of structural shake-out in UK )
- Middle-size firms
- **Consortium on nuclear project**

3. Imperfect market reform : preservation of former vertical and horizontal structures :

France , Germany , Spain, Central European markets, Japan

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4. For the record : Utility in « cost of service » regulation

- Domestic franchise
- Traditional regulation remains in half of the US states
- Some forms of incentive regulation could put some risks on the utility (Joskow, 2007)

## The model of pure merchant plants/project finance is not viable, even for CCGT

Definition: “*Merchant Plants*” are Independent Power Producers having not contracting for their output.

- **Investors bet on the price spikes after the commissioning of the equipment**
- New units can only cover all their costs and **enjoy returns during the price spikes**
  - So importance of the timing of the commissioning on the financial performance
  - Higher ratio of interest, given higher risk premium
- Project finance with high leverage 20/80 increases the difficulties
  - Net cash flow must cover high debt repayments and interests
  - Risk of bankruptcy if equipment is less dispatched after fuel price increase or market price downturn
- Failures of the decentralised market model (pure producers-pure suppliers)
  - **Bankruptcy of merchant plants in project finance** with CCGT despite being the easiest technology for risk management
    - 130 GW in the US, re-integration in the UK)

**Whatever the model, needs of securitization  
of vertical arrangements for any generation investment**

- **To transfer the risks on suppliers and consumers**
- **Long term contracts with large consumers :**
  - Large on-site and common projects
  - Consortium of power purchase
- **Need of long term contracts with large suppliers**
  - But problem if suppliers without a large segment of sticky consumers
  - Historic suppliers
- Characters of nuclear technology reinforce the need of vertical arrangements

### 3.2. The model of « nuclear merchant » with long term contracts

Market model	<b>Imperfect “decentralised market model”</b> <b>Variety of firms: IPPs, integrated suppliers, municipalities</b>
Reference case	<b>NRG projects in Texas</b> <b>(South Texas Project of two ABWR)</b>
Characteristics of the project	not exactly Merchant project <b>But</b> with long term contracts with historic LSEs and municipalities
Structure of financing	<b>Project financing</b> Helped by <b>production tax credit during 8 years</b> <b>and loan guarantees</b>
Leverage ratio equity/debt	Intrinsically moderate degree of leverage because of risks  But possibly 20/80 because credible state support and guarantee
Risks management	Portfolio approach (NRG has 23 GW of capacity in CCGT and coal)  Allocation on consumer: Specific contracts with distributors
Viability	<b>Yes</b> <b>because PPAs and government guarantees</b>

## **A « nuclear merchant »**

### **Backed on long term contracts and state guarantees**

- The South Texas project of NRG Energy
- The context : Texas, a liberalised de-integrated market but with monopolies « islands » (large municipalities)
  - interest to be non-regulated producer (higher opportunity of higher price than the regulated price)
- The promoter of the project: NRG Energy ((23 GW):
  - an IPP company with a diversified portfolio in technologies and on different markets
- **Capital structure:**
  - The merchant company NRG : 44% i.e. equivalent of 1200 MW
  - Partnership with large and monopolist municipalities :
    - Austin Energy : 16%
    - CPS energy of San Antonio : 40%

## The case of the South Texas project of NRG Energy (following)

- **Securitizing by :**
  - 1. offtake by municipalities: 56%
  - 2. NRG energy's share (54%): offtake by long term contracts on 75%
  - NB. **Only Short term sales on 10% of the production** in order to extract value from future CO2 restriction policies
- **Securitizing by « Long term contracts » with government**
  - Federal government loan guarantee
    - (as for the other six first ones of the EAct 2005)
  - Subsidization of production by the PTC of 1,8 c\$/kWh on 8 years
  - Regulatory risk borne by Federal state (EAct of 2005)
- **Construction risk control**
  - **A trump card:** a cautious choice of a tested technology,
    - the General Electric ABWR developed in Japan and Taiwan (four reactors) : know-how of Toshiba ( and Hitachi )

## Question: reproductibility of this model?

- **Other IPP candidates to develop merchant nuclear generators :**
  - Constellation Energy, with a project of \$2400 /kW
  - Exelon
  - TXU
- High Probability of project finance for the first group of six supported projects in the USA
- **But problem of the perennity of the model of « nuclear merchant plant » after the sixth project**
  - Banks agree to lend in project finance for plants installed in liberalized markers
    - because of the federal support
    - because the possibility of shifting risks by long term contracts on the consumers
  - It is possible that the IPP companies resell plant to a nuclear operator when the project is running
- **As the butterflies, this model is ephemera**
  - There is not any project finance for conventional electricity project in the US
  - PPAs with regulated LSE or historic LSE is a crucial condition
  - Only corporate financing with large IPPs

The model of nuclear merchant plant will disappear after the first wave of Six supported reactors in the US

### 3.3. The model of the cooperative of consumers

<b>Market model</b>	<b>Decentralised market model</b>
Reference case	Finnish plant OK III
Characteristics of the project	Cooperative of large consumers
Structure of financing	Hybrid of corporate/Project financing
Leverage ratio equity/debt	high degree of leverage (25/75)
Risk management	<ol style="list-style-type: none"> <li>1. PPA with participants in cooperative</li> <li>2. Turnkey contracts</li> <li>3. portfolio with write-off nuclear plants</li> </ol>
Viability	Yes if ....

# The cooperative of producer-consumers

(the Finnish case)

## Exemple of the Finnish TVO project:

- cooperative of large consumers (pulp and paper) and municipal utility companies
- TVO owns thermal plants and two nuclear power plants already in operation

## Securitization by long term PPA at flat price (cost-price)

- It sells electricity “at cost” during the life of the plant (40 years) to its investors in proportion to their contribution to the investment
- This structure of investment ensures very stable prices as well as exemption from carbon issues

**Finance** : Consequently an hybrid of corporate finance/project finance with very favourable conditions

- A leverage identical to a project finance (20/80):
- Refinancing: Stand-by credit contract with very low interest rate (2.6%) by the German bank Bayern and the French COFACE
- The key elements: the **PPAs at cost-price on 40 years and the turnkey contracts**
- **Consequence: a low WACC of 6%**

## Learning risk : Constructor bears the risks

- Turnkey contracts with AREVA for installing an EPR to be commissioned in 2012
- AREVA in the **unusual** role of E& C company
- Operating risks on AREVA ,
  - penalty on the manufacturer when performance below to 90% on 40y (Important normal risks for the FOAK)
  - Effectivity of the provision: AREVA provision of around € 0.8 billion

# Which reproductibility of this model?

- **1. Which reproductibility without the construction risk borne by the reactor vendor**
  - What else with new announcement of Finnish projects ?
    - **New Consortium Fenmovia of industrial and energy companies for a 1500MW (2016-2018)**
- **2. Consortium of industrial consumers with common interest :**
  - **to have a guaranteed and stable price**
  - **to hedge against volatility of electricity price and the CO2 price**
- **But Difference of Time-span of the contract with nuclear lifetime**
  - experience of the present consortiums Exeltium, Blue Sky with up-front payment
  - 15 years instead of 40 years for TVO
- **Risk for new nuclear plant with PPAs with consortium**
  - Problem of opportunism of the purchasing parties
    - Bet on long term market prices with fuel and CO2 price increase
    - What else if elec price downturn : opportunity cost?
  - Problem of the stability of the consortium
  - Compatibility of horizon of the industrial firms : time of Investment cycle
    - (risk of delocalisation, of closure in case of mergers, etc.)

NB in the Finnish case, location of resource (forestry) and long investment cycle<sup>29</sup>

### 3.4. The model of dominant vertical firm

<b>Market model</b>	<b>Oligopoly</b> <b>Large and vertically integrated companies</b>
Reference case	French EPR Flamanville 3 Japanese projects
Characteristics of the project	Eventual minority shareholder
<b>Structure of financing</b>	<b>Corporate financing</b>
Leverage ratio equity/debt	50/50
Risk management	1. Portfolio 2. <i>Possibility to increase price cost margin by market power when investment is needed (?)</i> 3. risks allocation to consumers :High/medium if large base of sticky consumers
Viability	Yes Advantage scale economies (E&C costs)

# Investment by dominant oligopolistic firms

The advantage of vertical integration :

- to shift the market risks on the supply and the consumers (historic distributors)

The advantage of horizontal concentration large size:

## A. Scale economies in risk management

- 1. Portfolio of different types of assets
  - Possibility of cross subsidization between equipment on short term market
- 2. Ability to operate in different markets (compensation of market risks)
- 3. Possibility to cross-subsidize by downstream business and transfer risk on consumers consumers : shifting risks
- 4. Better financing conditions than mid-size firms' project or merchant plant
  - Corporate financing instead of project financing
  - Complementary advantage of ownership of Write-off nuclear assets
    - » Good Financial rating

## B. Scale economies in control of construction cost

- Skills to control costs (n E&C intermediary)
- Bargaining power with constructors

## The case of EDF's EPR Flamanville III

- **No turnkey contract**
  - Electricity Company bears the construction risk
  - Capacity to control E&C (and to restore it in the future)
- **Normal corporate finance**
  - not so low WACC because high ROE
  - Association of ENEL (12.5%) , but not Electrabel-Suez, a more dangerous competitor

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### • **Reproductibility of the model**

- The new case of Suez electrabel's EPR project Tricastin 5
- The case of Central European projects (weak competition)
  - 2 VVER ordered to Rosatom in Bulgaria
  - Slovakia
  - Czech after Temelin

### **3.5. Nuclear Investment by oligopoly of middle size firms: The Case of British nuclear projects**

- Vertical oligopoly of middle-size companies
- **Corporate financing**
- **Solution:**
  - Consortium with owner of nuclear sites(British energy)
  - Consortium of two competitors (?)
- **Needs of guarantee at least on the political risk**
- **Market risks**
  - Vertical integration with stocky customers
  - PPAs with obligated suppliers (nuclear obligation)
  - Carbon contracts
- **Construction risks:**
  - Could the construction risk be alleviated by the E&C capability of the parent company ?

Reference case	UK projects
Characteristics of the project	Single company or Consortium of Producer with British Energy
<b>Structure of financing</b>	<b>Corporate financing</b>
Leverage ratio equity/debt	50/50
Risk management	Portfolio Risk allocation to consumers by vertical integration
Viability	Yes if regulatory and political risks assumed by government.  Much better: <ul style="list-style-type: none"> <li>• if turnkey contract for the FoAK in UK</li> <li>• If CO2 price guarantee</li> </ul>

## 5. Some conclusions

- Necessity to transfer major part of risks from producers
- Allocation of risks through contracts, industrial structure and politico-institutional arrangements is critical :
  - to create a level playing field for capital intensive technologies in liberalized markets
- They depend upon the industrial models of reform
  - Some are far from decentralised market model
- Financing arrangements are adapted to these arrangements

## Some conclusions

But in fact new nuclear build in liberalised markets likely to be developed by large and vertically integrated companies...

In countries without large companies ,

- ⇒ institutional arrangements are crucial,
- ⇒ governments must bear part of risks

- Support on production for the NoAKs
- Stability of forward CO2 price by option contracts
- “Cheap financing” by loan guarantees
- Long term contracts

Difference of the cost of capital

- It reflects difference of risk premium
- High cost of capital makes uncompetitive nuclear project

## Difference of WACC in different financing arrangements

	Return on equity before tax	Interest on debt	WACC before tax
<i>Corporate financing Leverage 50/50</i>	13.6% (EDF)	6%	<b>9.7%</b>
<b>Project finance CCGT Leverage 20/80</b> -----	12%	6%	<b>7.2%</b>
Hybrid financing Finnish project Leverage 25/75	6% (after tax)?	6%	6%(?)
<b>Project finance 40/60 CCGT</b>	12%	8%	<b>9.6%</b>
<b>Project finance Nuclear project 50/50 Ref. MIT study</b>	15%  Risk premium 3%	8%	11.5%

# Sensitivity of nuclear, coal and CCGT costs to WACC

(real WACC after tax = rate of discount)

Levelised generation costs versus Discount rate  
Gas \$6/MMBTU, coal \$2.2/MMBTU

