

# On the Economics of nuclear power – an update



## Reinhard HAAS



Energy Economics Group, TU Wien



# Salzburg, 15 October 2019

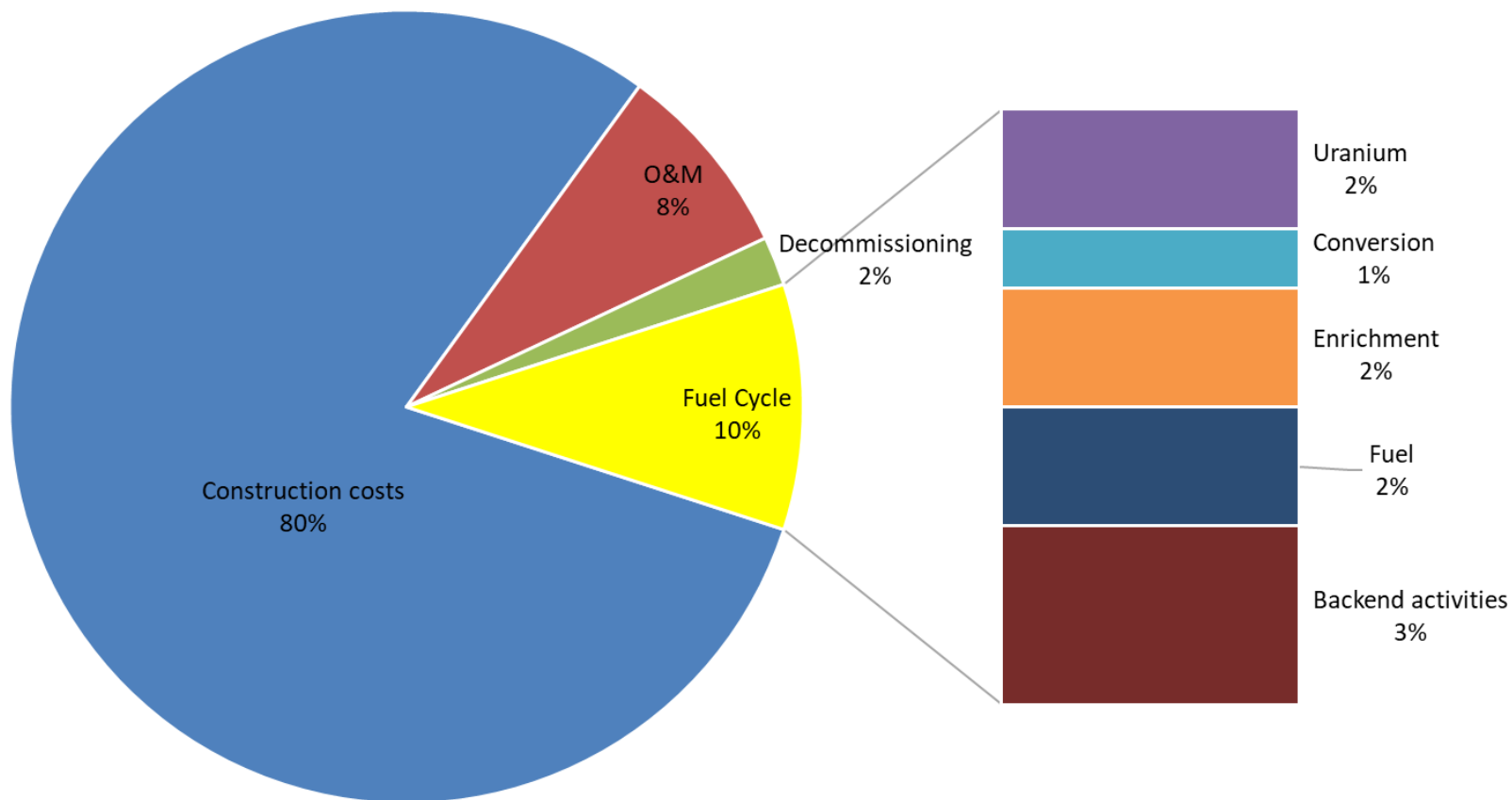
- 1. Introduction: Motivation**
- 2. The economic impact of delays**
- 3. Historical cost developments**
- 4. Technological Learning**
- 5. Developments in Europe**
- 6. Construction times**
- 7. Historical costs: The big picture**
- 8. The impact of renewables**
- 9. Conclusions**

## Motivation:

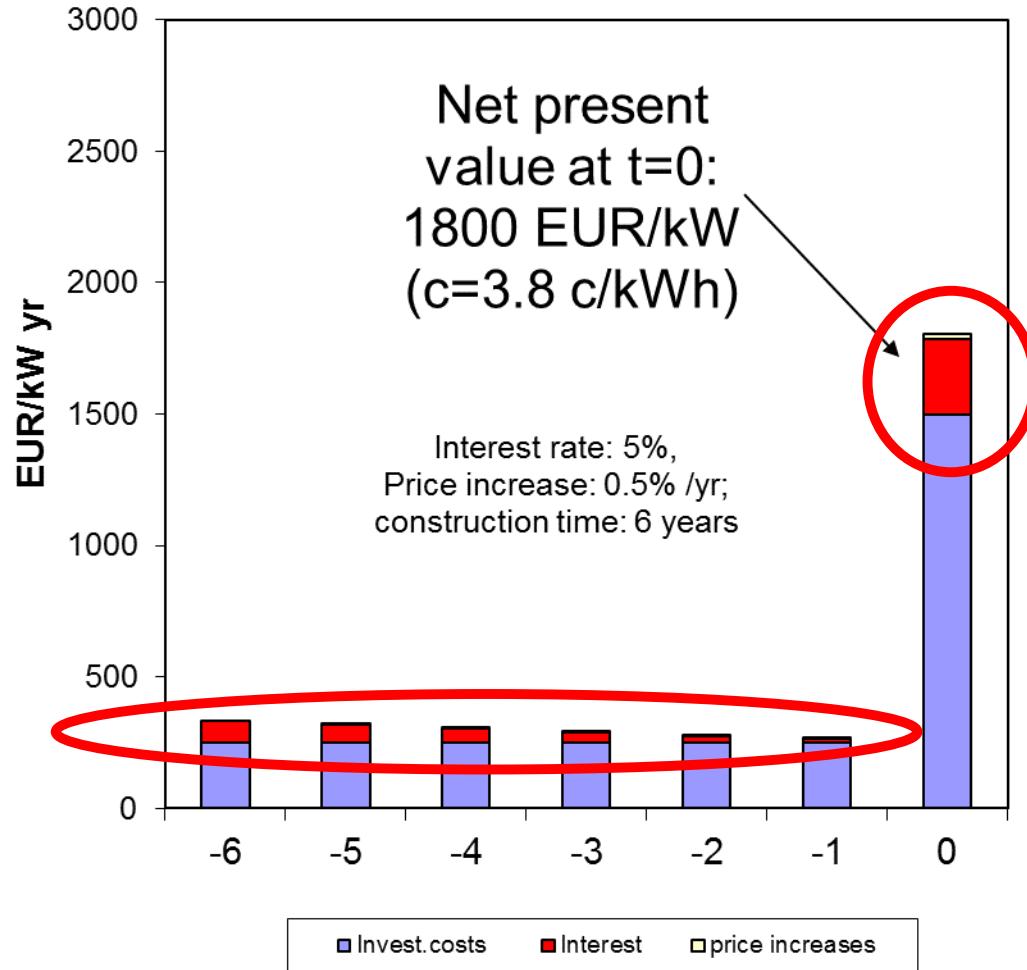
- **Atoms for peace →**  
    **→ Too cheap to meter**
- **Cost escalations**
- **Competition & democracy**

# COST STRUCTURE

Cost structure of nuclear power plants

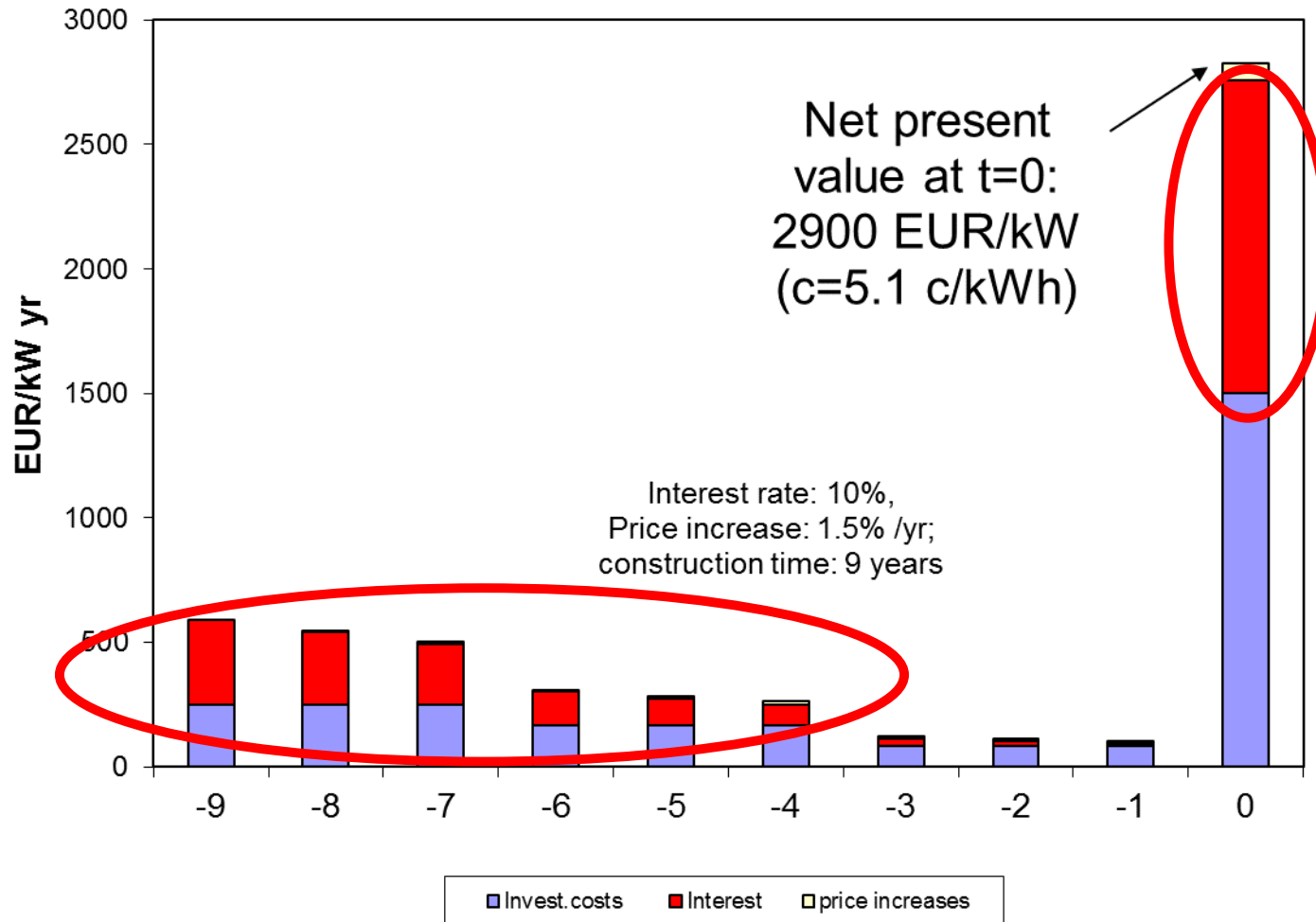


**Nuclear: overnight costs = 1500  
EUR/kW: favourable case**



# Problem of delays

Nuclear: Overnight costs = 1500 EUR/kW: less favourable case

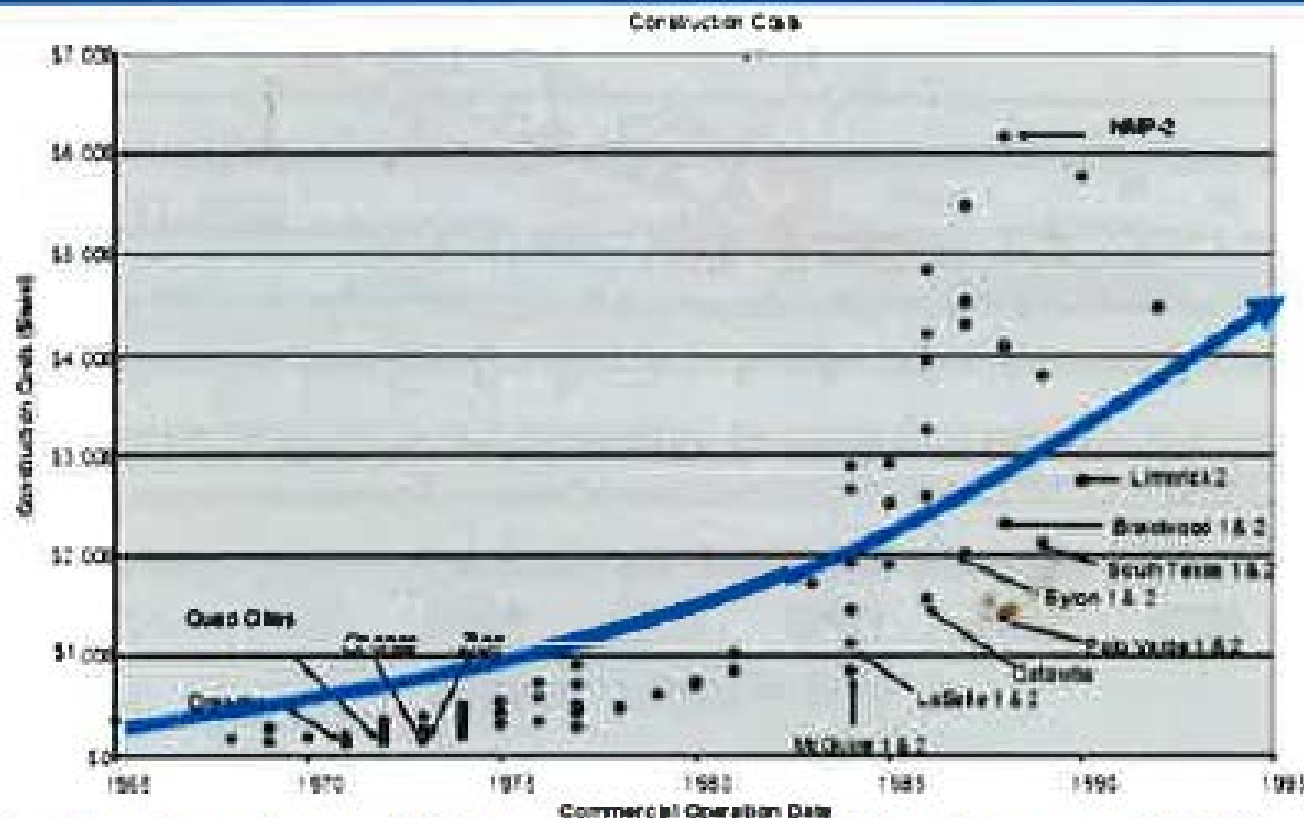


# 3. HISTORICAL COSTS DEVELOPMENTS

# JIM HARDING: U.S. COSTS DEVELOPMENTS



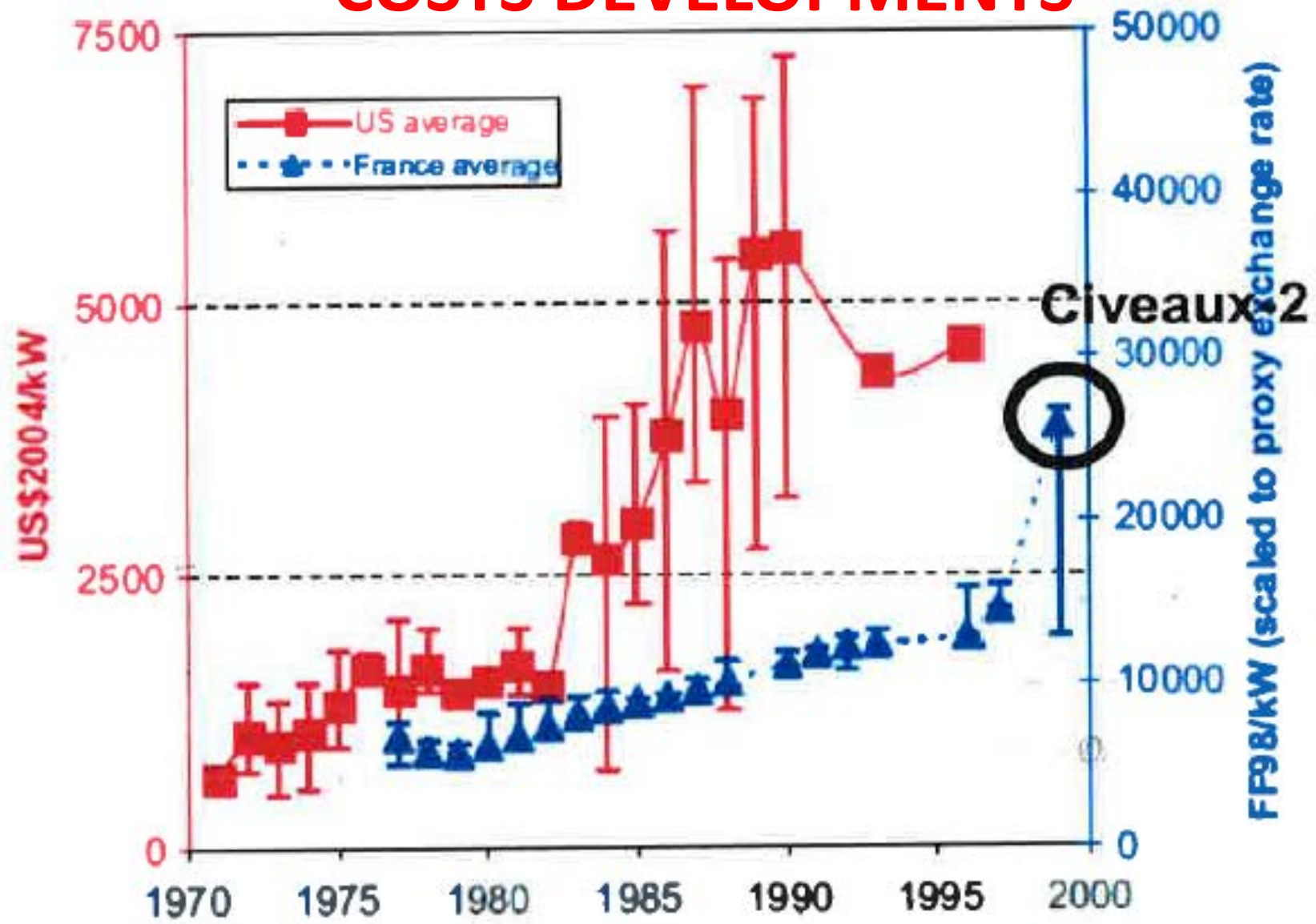
## Background - Industry Experience "Last Time"



Source: Jim Harding: Seven Myths of the Nuclear Renaissance (2007)



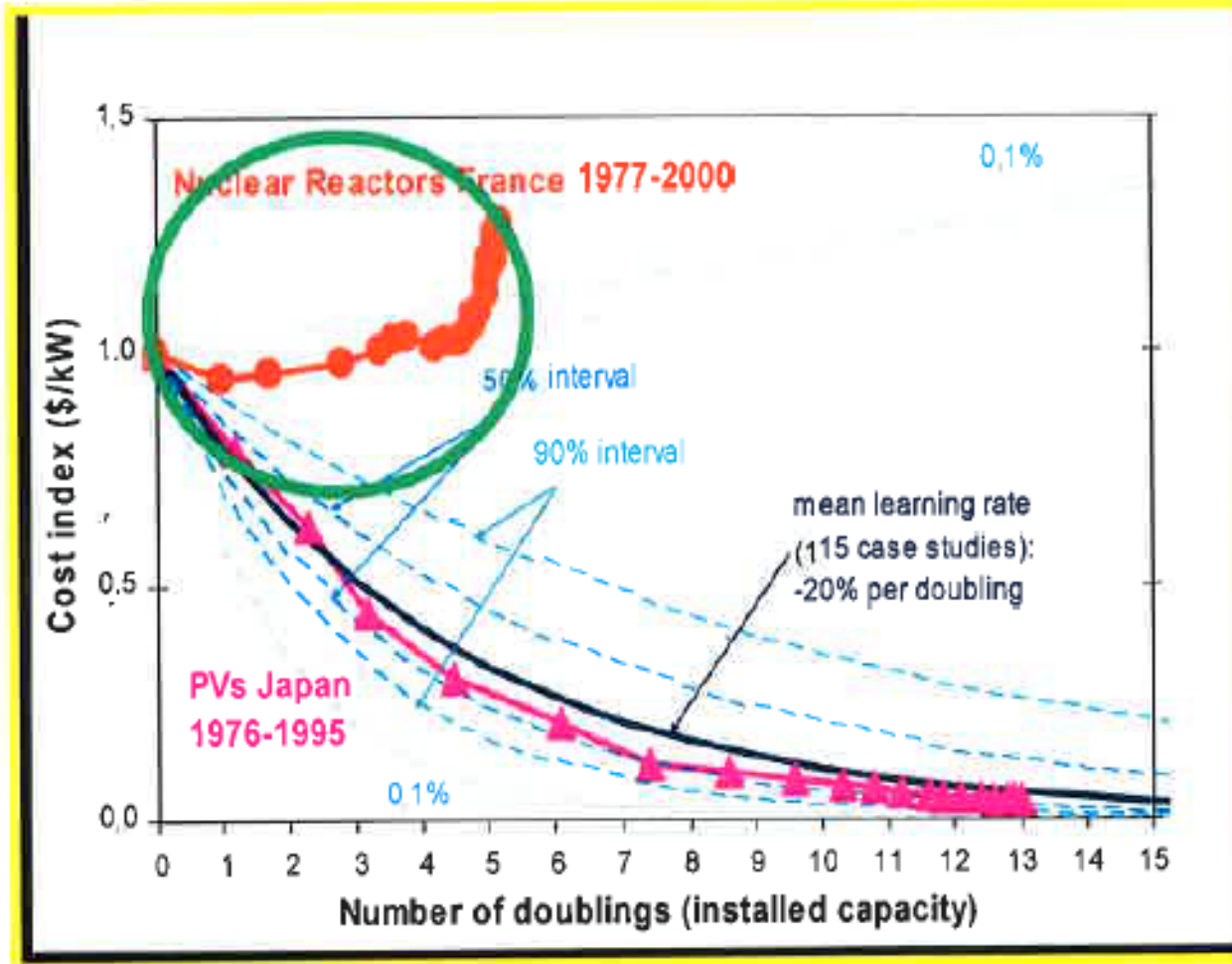
# ARNULF GRUEBLER: U.S. AND FRANCE COSTS DEVELOPMENTS



Source: Grubler 2010

# 4. TECHNOLOGICAL LEARNING: WHY NOT FOR NUCLEAR?

Technological Uncertainties:  
Learning rates (push) and market growth (pull)



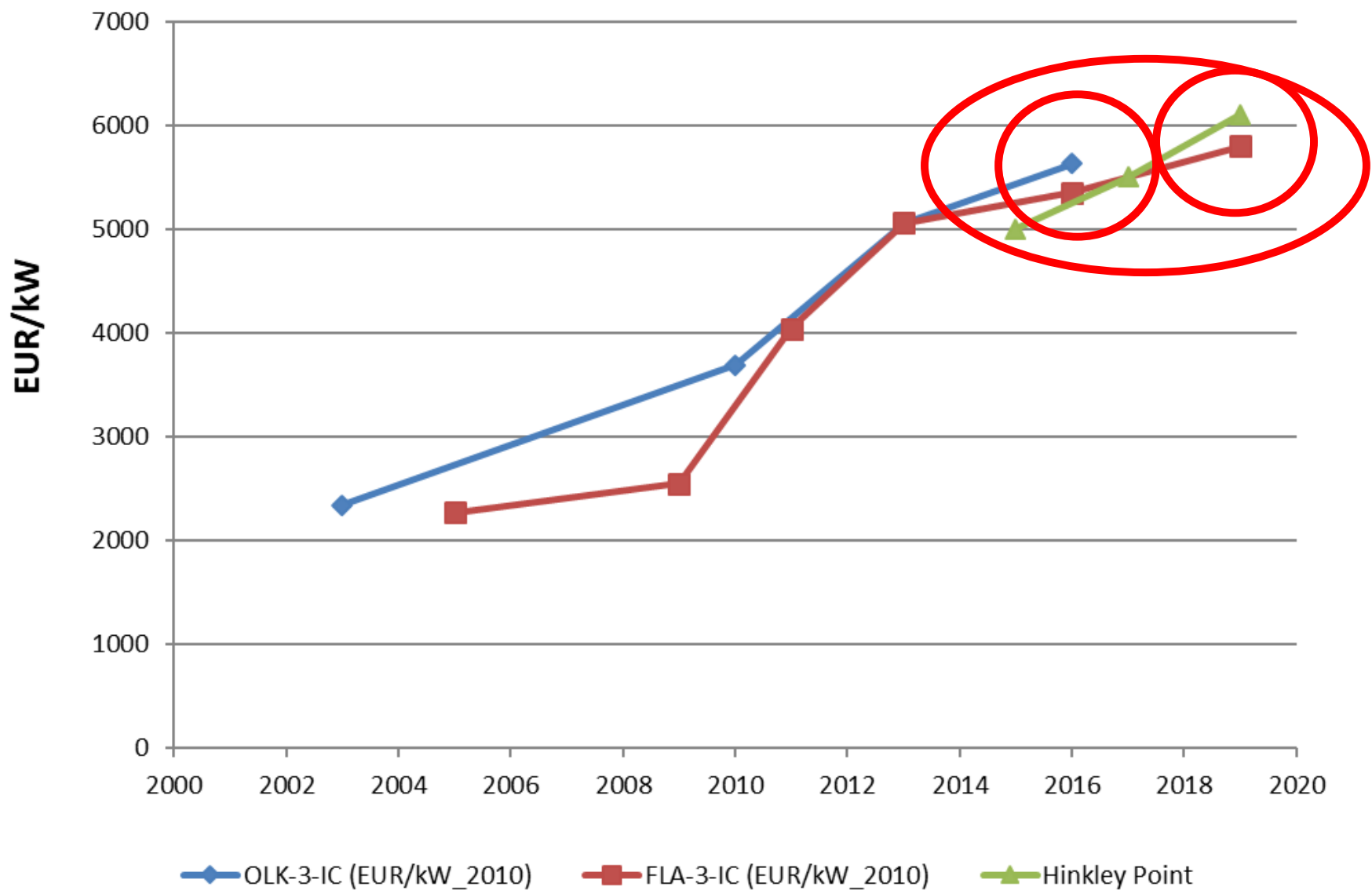
Source: Nakicenovic, Schratzenholzer, Grübler various papers

# 5. COST DEVELOPMENT OF OLKILUOTO-3, FLAMANVILLE-3 AND HINKLEY POINT C

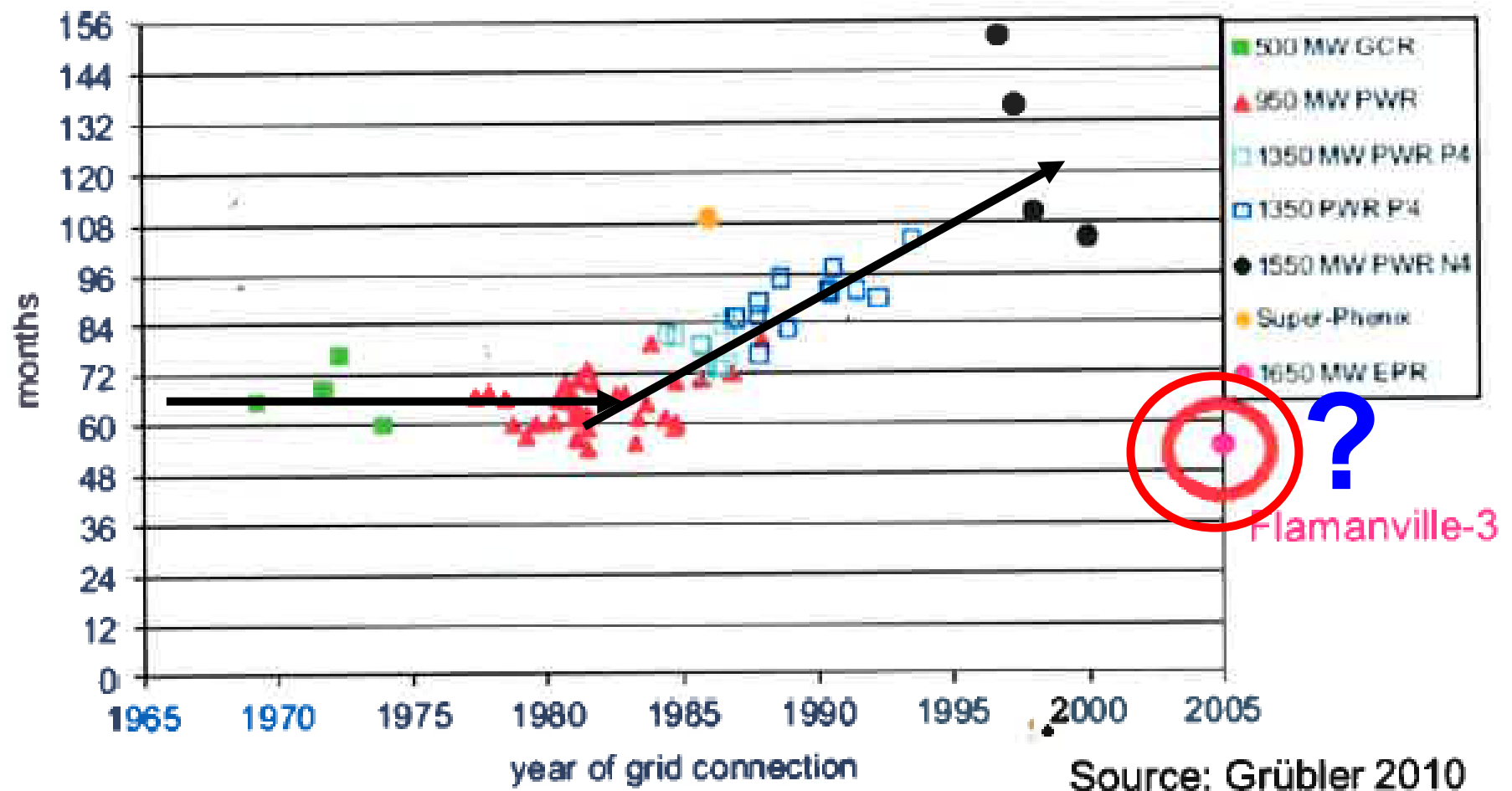
- **Olkiluoto:**  
July 2019: another 6 months delay confirmed, pushing operation start into 2020
- **Flamanville:**  
July 2019: welds in containment area must be repaired; rumors that commission could be pushed back to 2022; Addit. Costs of €1 billion added to the const. cost budget;
- **Hinkley Point:**  
Construction start in April 2019, in September 2019 cost increases to 22.5 Billion BP, internal rate-of-return declines from 8.5% to about 7.7%

→ **Why Hinkley Point is different**

# Development of Investment costs

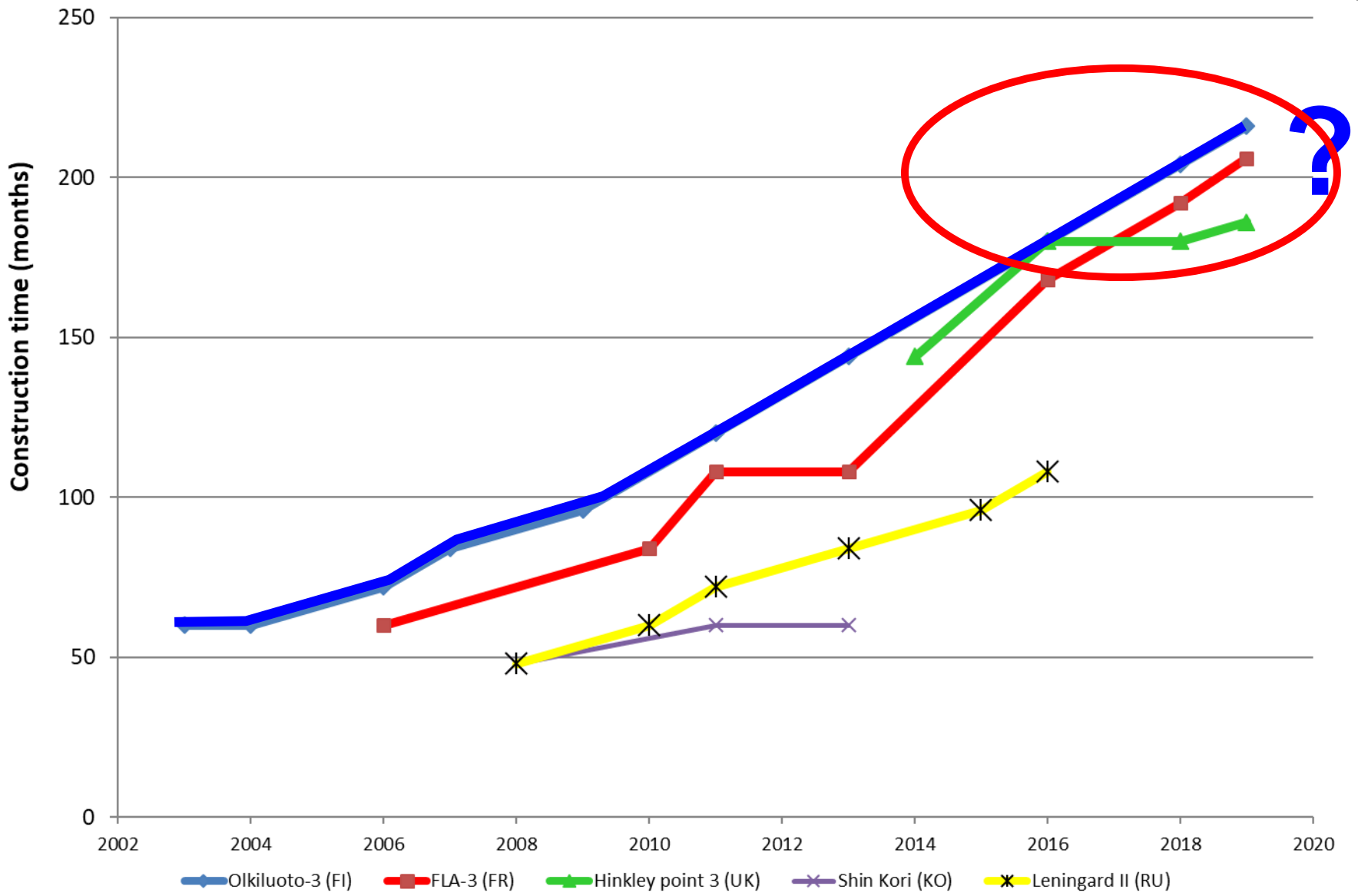


# 6. DEVELOPMENT OF CONSTRUCTION TIMES

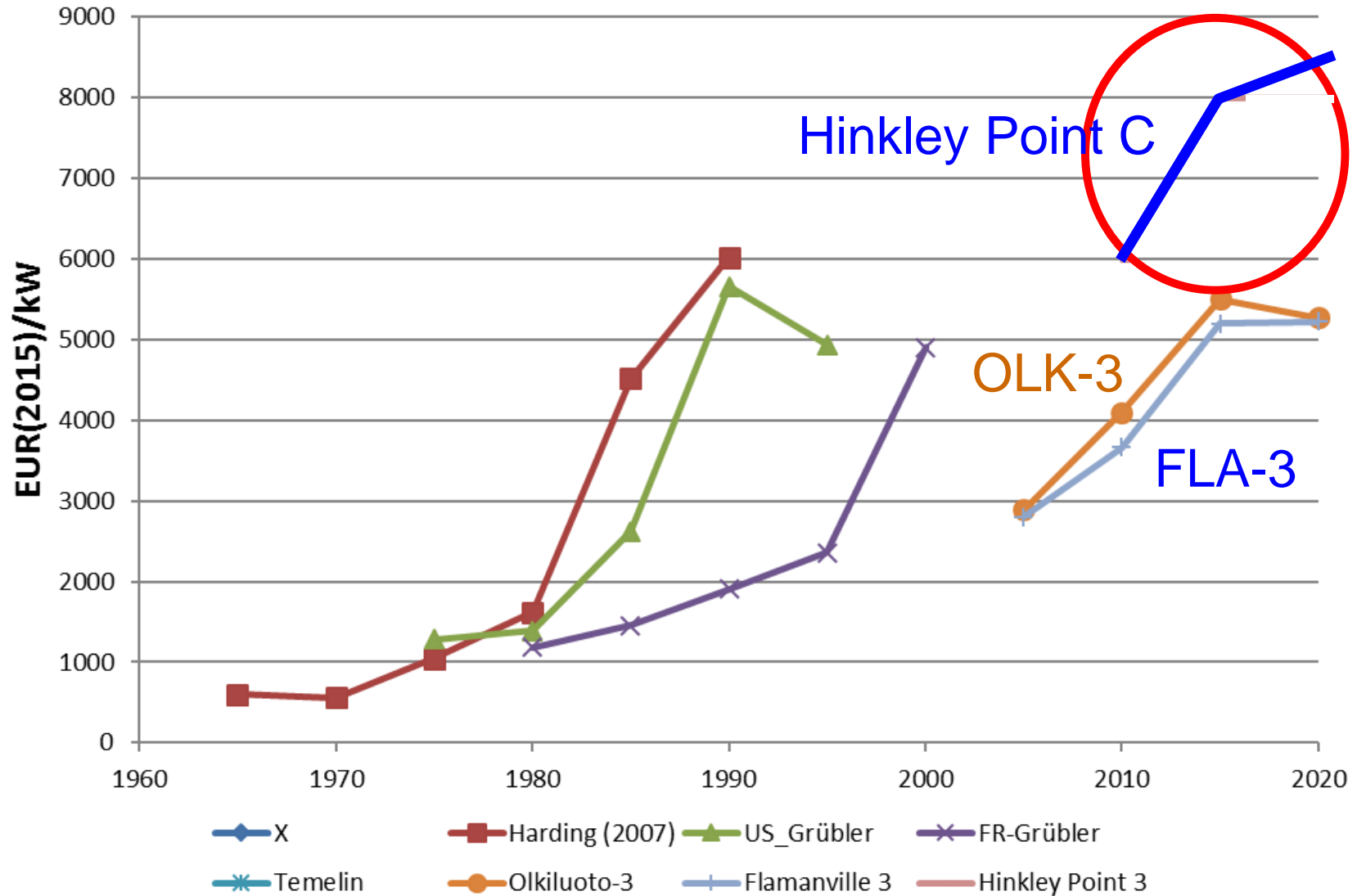


Source: Grüber 2010

# Recent dynamics of construction times



# 7. HISTORICAL COST DEVELOPMENT: THE BIG PICTURE

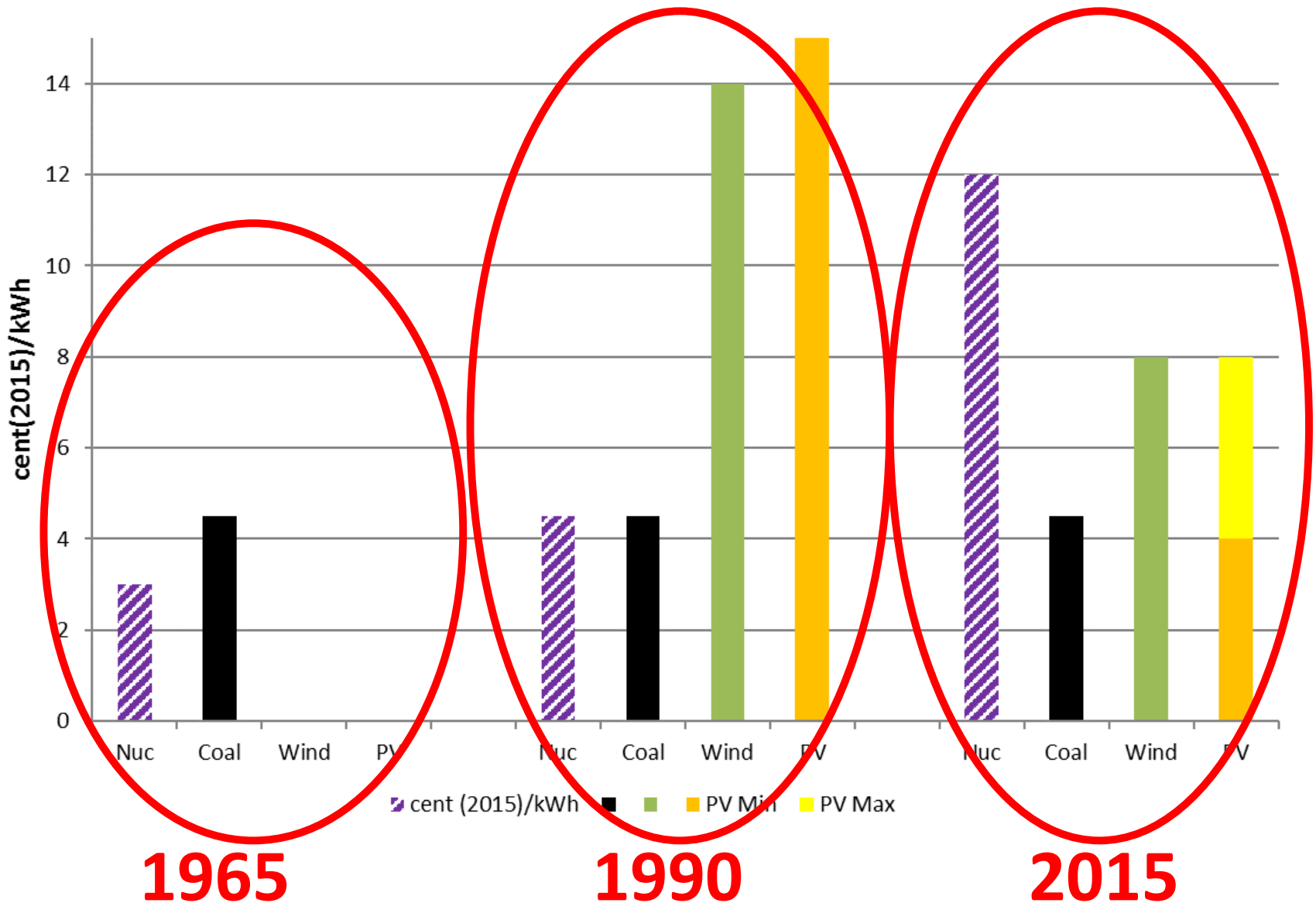




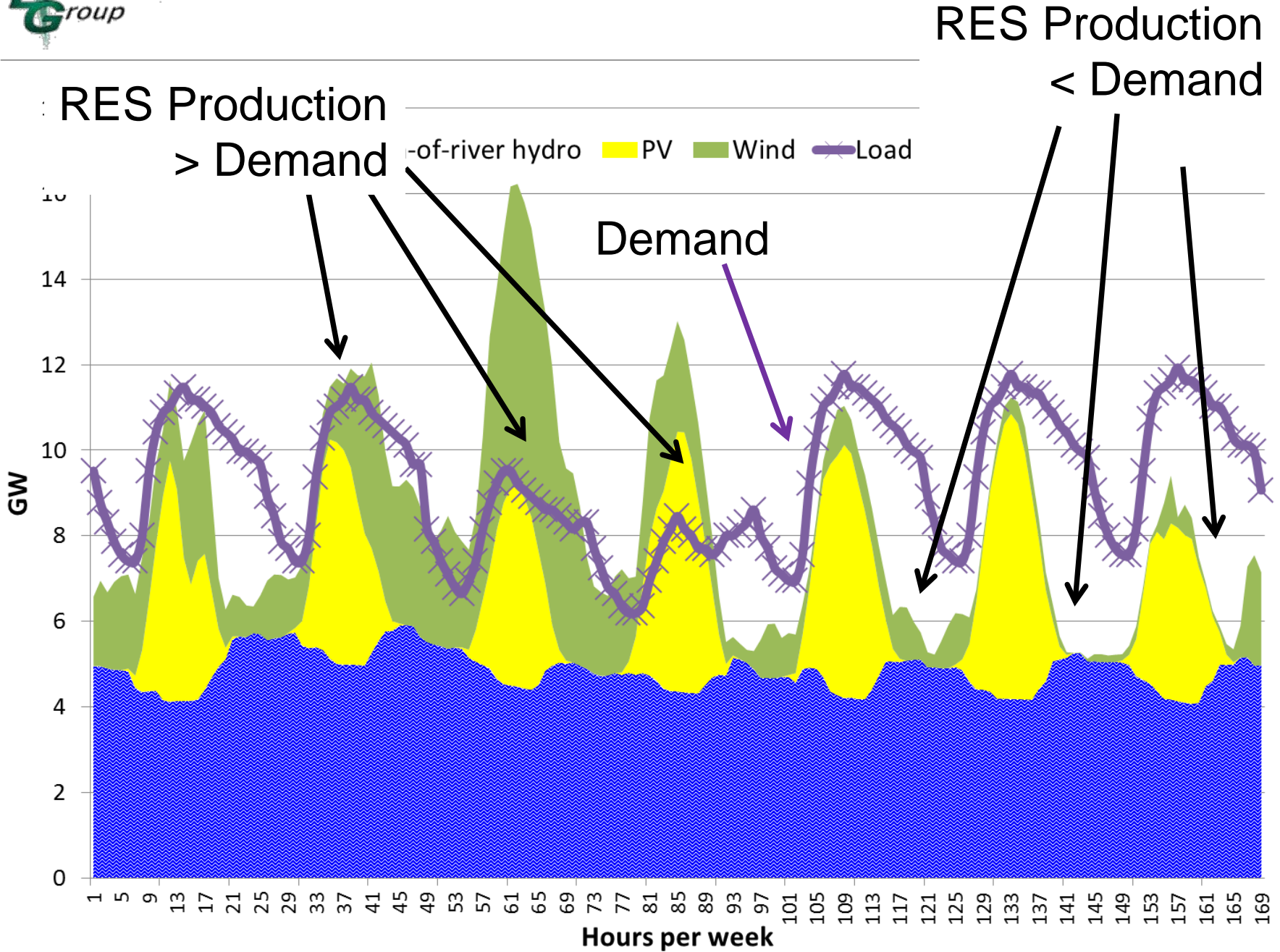
# MAJOR REASONS FOR COST INCREASES

- additional safety requirements (in France : 50% for 1970-1990)
- better quality materials than in the 1970s/1980s
- Increases in labour and material costs → major cost driver for France (Leveque (2015))
- Strategic systematic underestimation of construction costs & construction duration
- things simply have gone wrong → Do Western companies simply not have the skills anymore to complete huge projects on time?
- Longer construction duration → higher interest payments ! (Difference between Overnight costs and Total costs!)
- interest rates for financing itself → no impact in any study

# 7 ECONOMIC COMPARISON OVER TIME

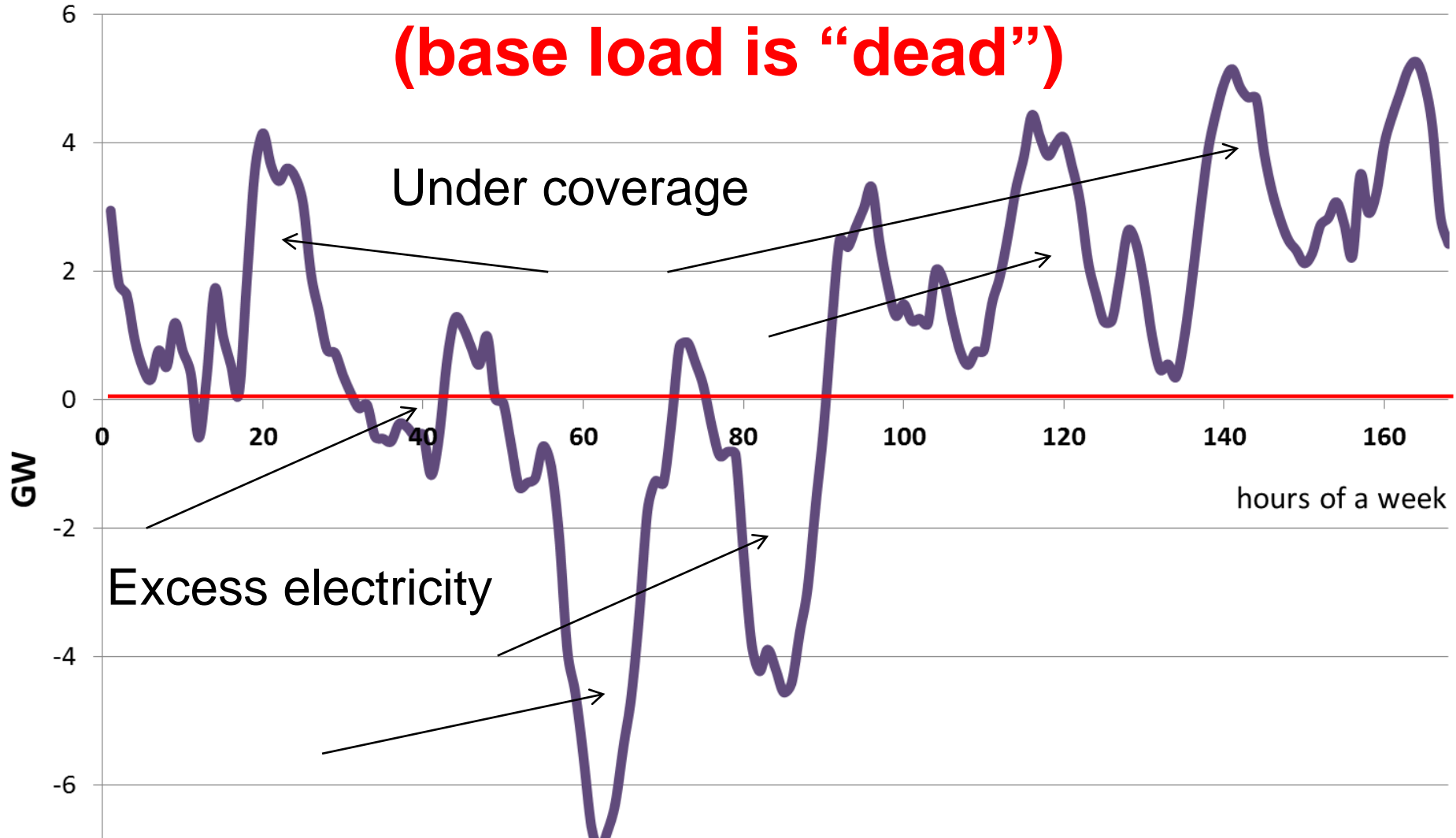


# 8 HOW VARIABLE RENEWABLES IMPACT THE ELECTRICITY SYSTEM

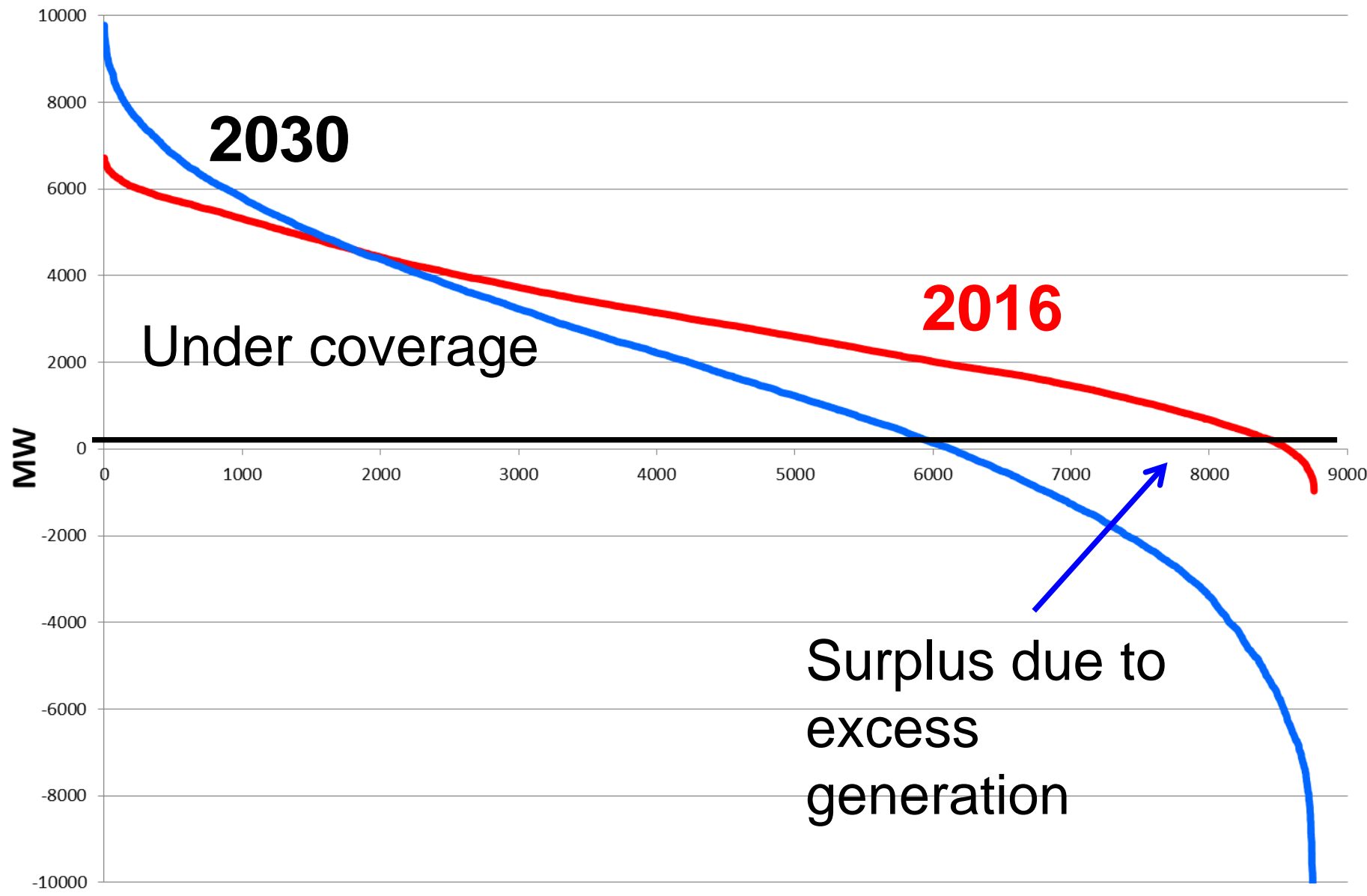


# Key term of the future: Residual load

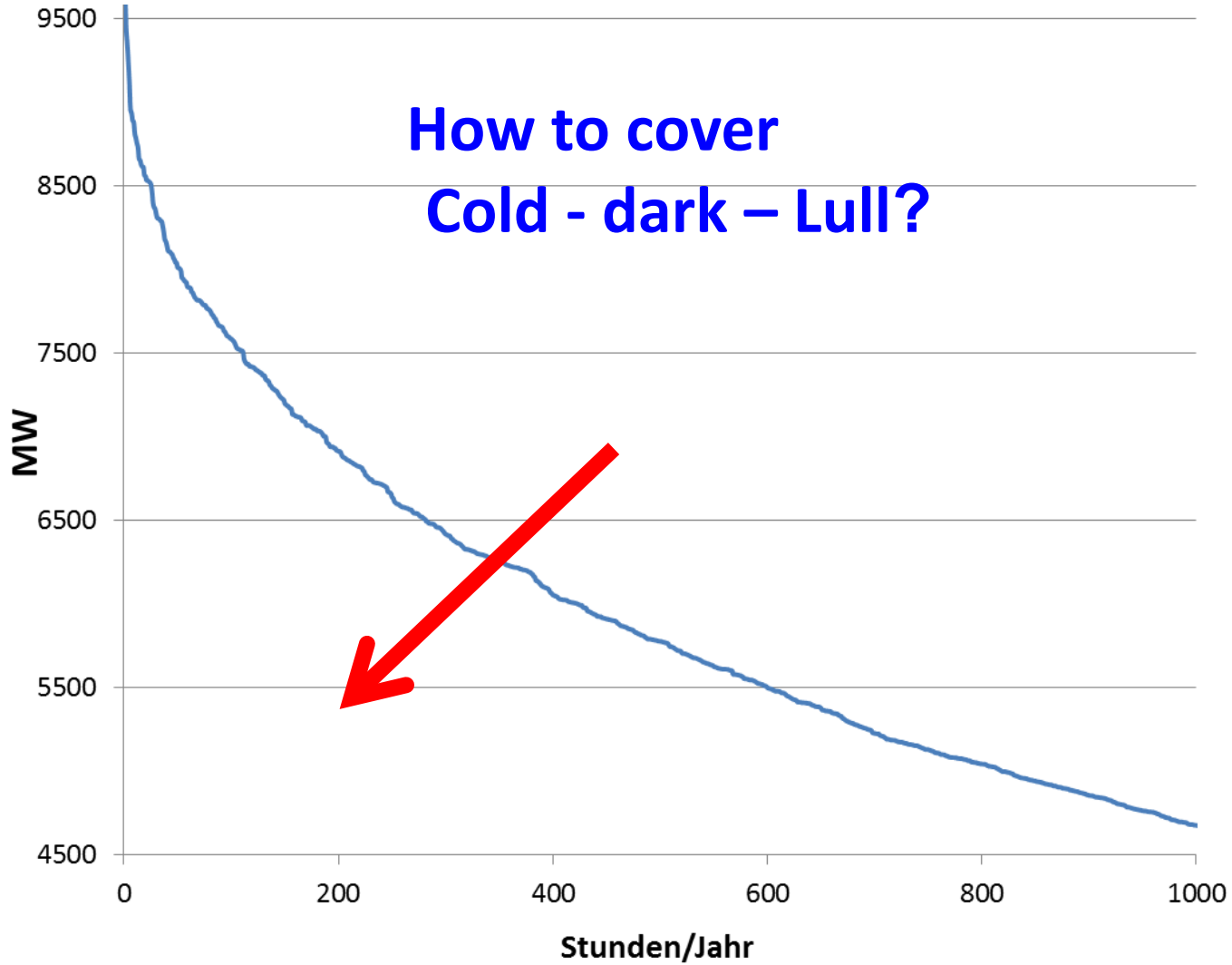
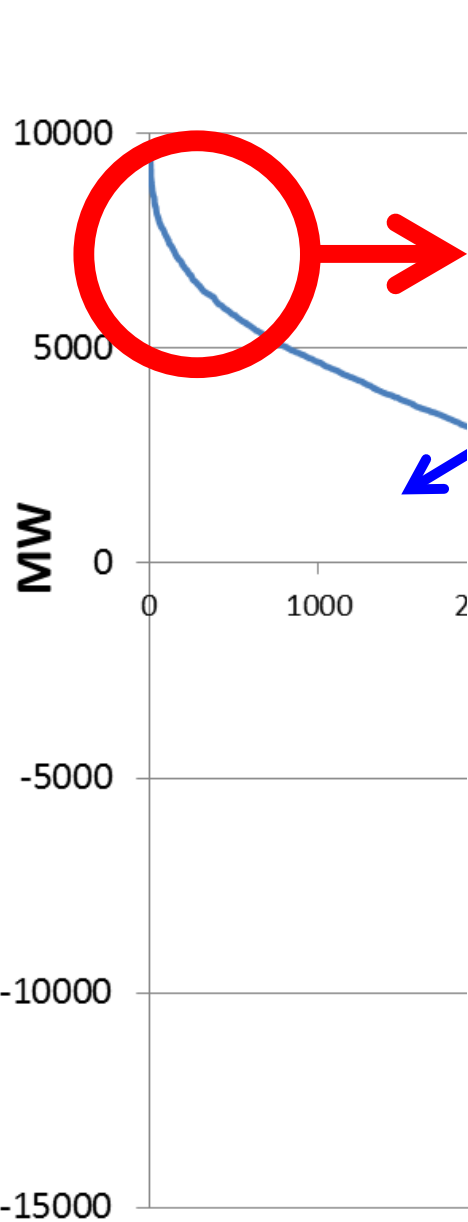
(base load is “dead”)



**Residual load = Load – non-flexible generation**



# Classified residual load



**By a regulated capacity payment with STMC pricing?**

or

**By competition between supply-side and demand-side technologies and behaviour (incl. Storages, grid and other flexibility options) with correct scarcity pricing signals?**



# THE CORE PROBLEMS OF CAPACITY PAYMENTS

**All regulatory capacity payments for power plants distort the EOM and lead to wrong price signals for all other options**

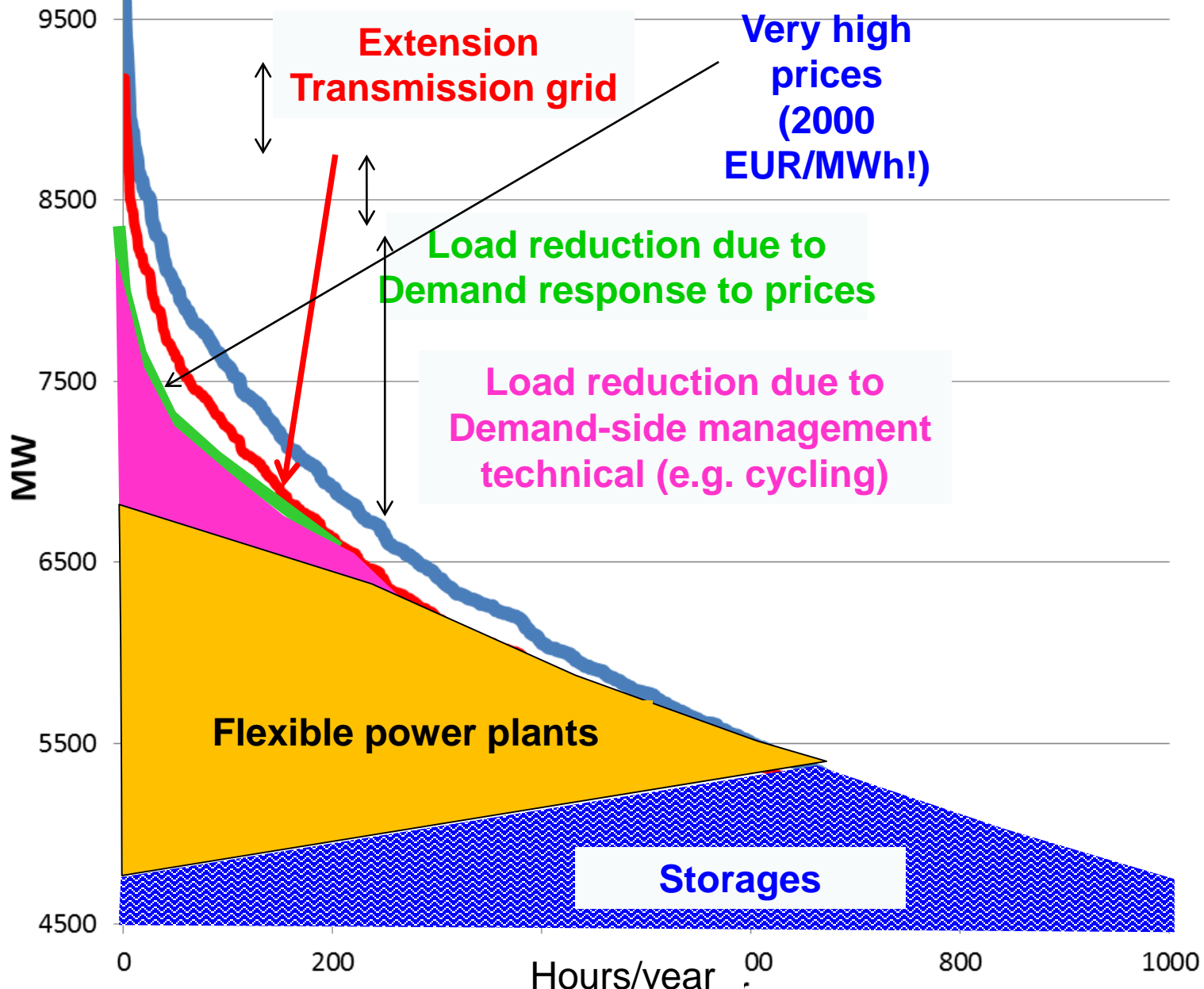
**Price peaks at times of scarce resource should revive the markets and lead to effective competition**

**The higher the excess capacities, the lower is the share of RES**

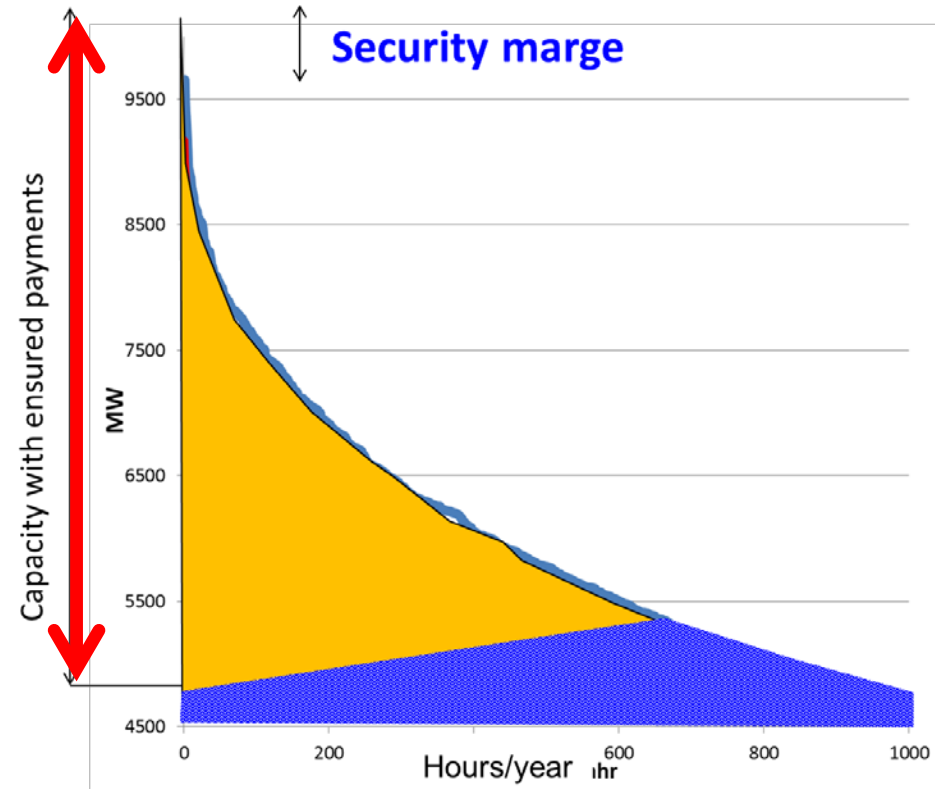
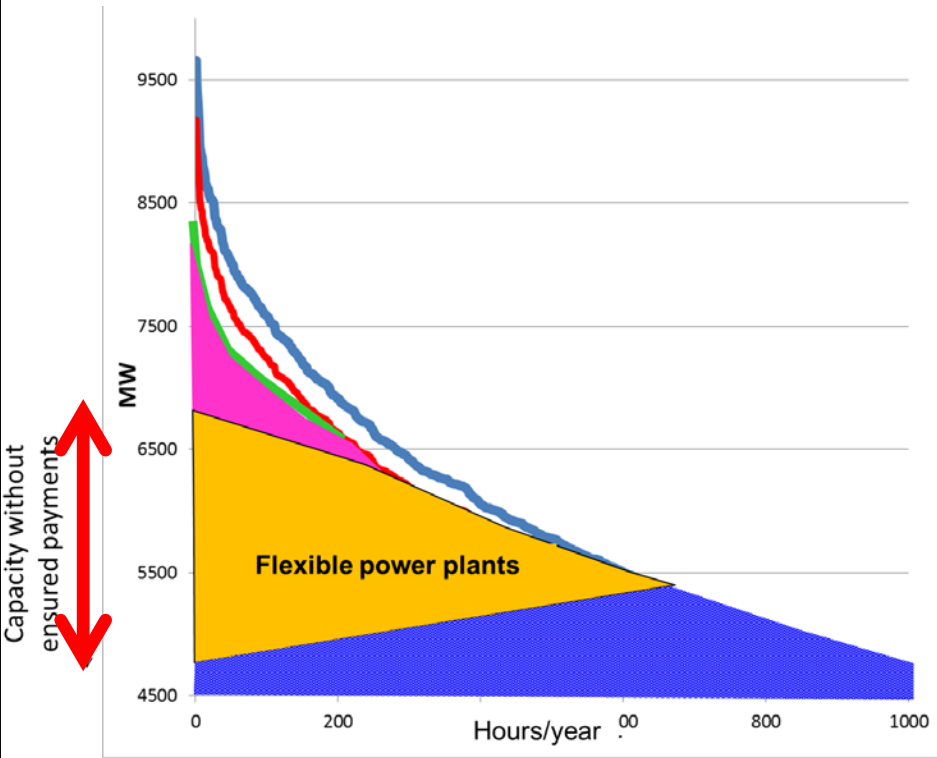
**strive to retain system resource adequacy by correct price signals**

# 5 Flexible coverage of residual load

Capacity without  
ensured payments



# Comparison



## Europe:

- No reliability regarding construction times.
- With respect to economics nuclear has NEVER in history in Western countries fulfilled its promises
- Actual investment costs were always higher than costs announced
- Are China & Korea different ?

- It is **impossible** to find any sound **economic** argument in Europe in favour of nuclear
- Currently, in Europe **nuclear** is the **most expensive option** to generate electricity
- **Military** reason No. 1 world-wide?
- If not, **what** is the reason?

The (last) and final chapter: The  
Economics of Decommissioning ...  
→ Discounting to what magnitude?