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European University Institute

# Anticipation for Efficient Electricity Transmission Network Investments

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Conference Belrin 9th October 2010

# Outline



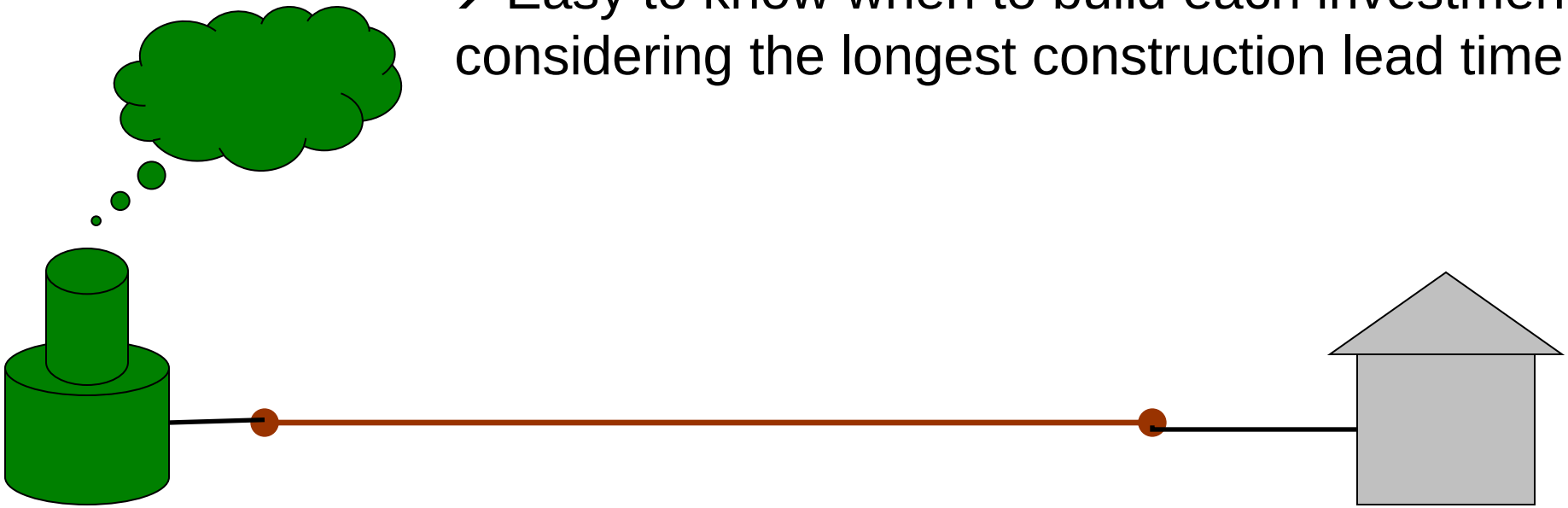
- Motivation
- Problem
- Model
- Illustration
- Conclusion

# Coordinated gen° and trans° investments by an integrated utility



Integrated Utility

→ Easy to know when to build each investment considering the longest construction lead time

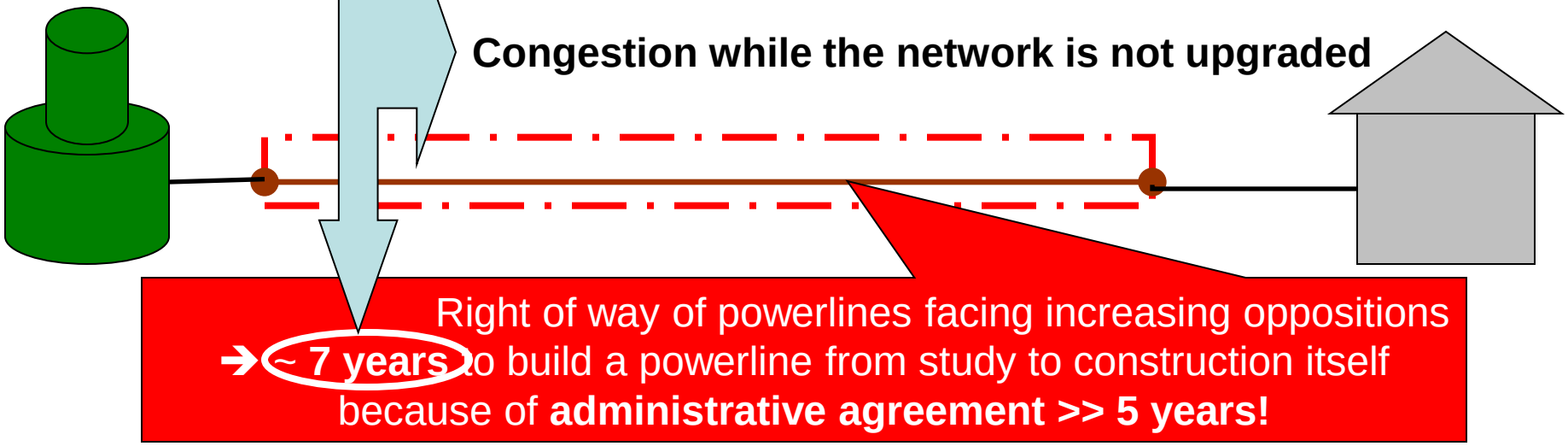


# Unbundling and coordination need

| Generation technology | Time to build (year) | Notional size (MW) |
|---|---|---|
| *CCGT* | 2 | 800 |
| *Wind onshore* | 2 | 25 |
| *offshore* | 2 | 100 |
| *Coal* | -5 | 150-1600 |
| Nuclear | 7 | 1600 |

Liberalised power system

>> Prompts investors to choose generation technologies with short construction lead time




Right of way of powerlines facing increasing oppositions

➔ **~ 7 years** to build a powerline from study to construction itself because of **administrative agreement >> 5 years!**

# Two possible behaviors for the TSO



- Reactive behavior
  - Wait connection request to study opportunity for transmission investments
- Proactive behavior
  - Anticipate connection request in areas with exploitable energy sources
    - Gas
    - Wind
  - Administrative procedures are already agreed when generators request for connection

# Advantages & drawbacks of the two possible behaviors



- Reactive behavior

  ➔ Excessive congestion if CCGT or wind power involved while network is upgraded

- Proactive behavior
  - No excessive congestion
  - But **proactive behavior is costly** because, if generation does not come, the TSO did
    - the study to upgrade the network
    - And the procedures to obtain the administrative agreement to build the line

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# Problem



- What is the efficiency of anticipating generation connection for the TSO in terms of minimization of the network cost?
  - No anticipation creates congestion for quite long period while network must be upgraded
  - But anticipation is costly if the anticipated generators do not eventually come

➔ We must arbitrate between these two costs

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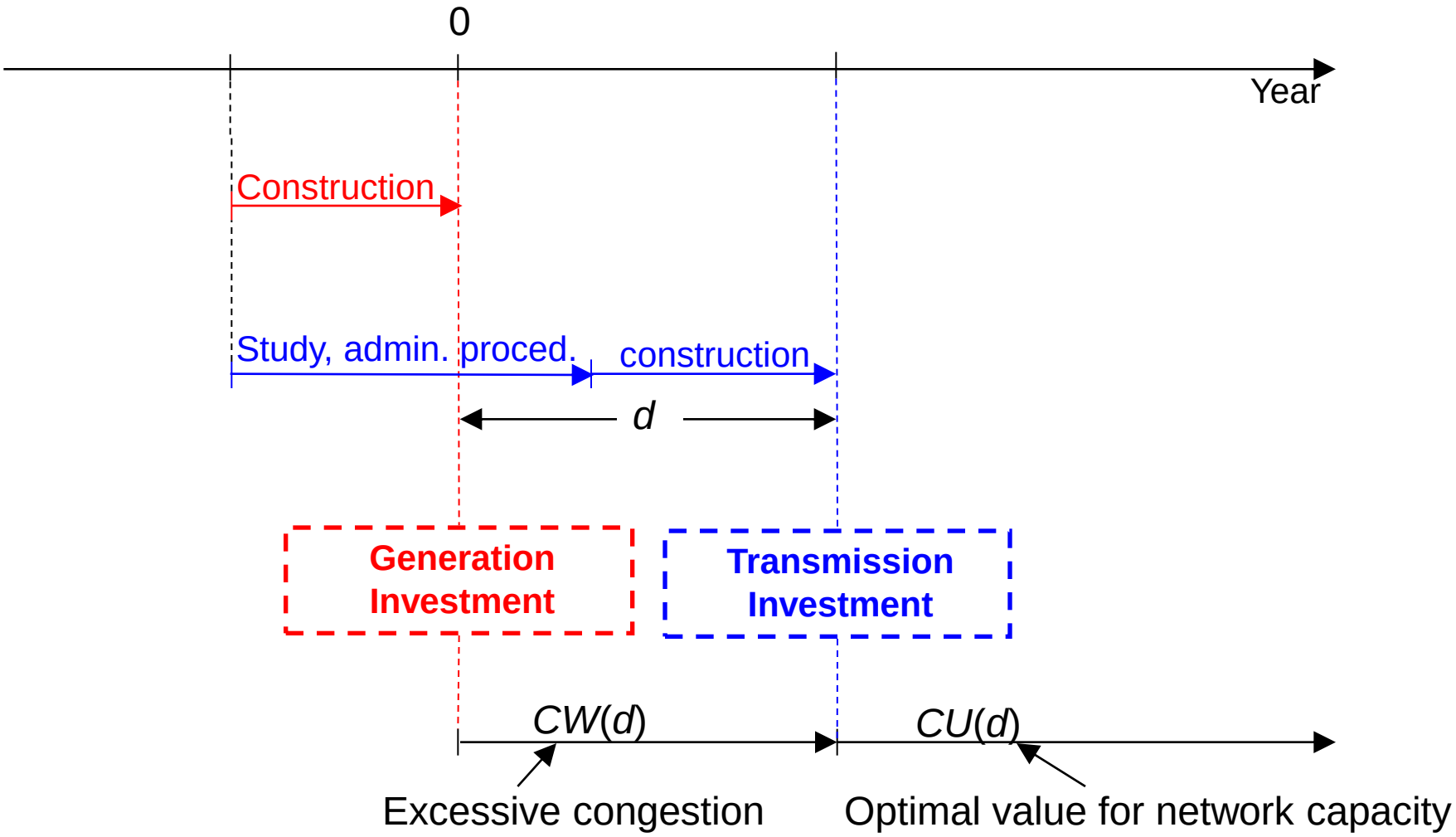
# Sequence of investments with a reactive TSO





# Costs faced by a reactive TSO



Congestion cost **w**ithout and after the network being **u**pgraded

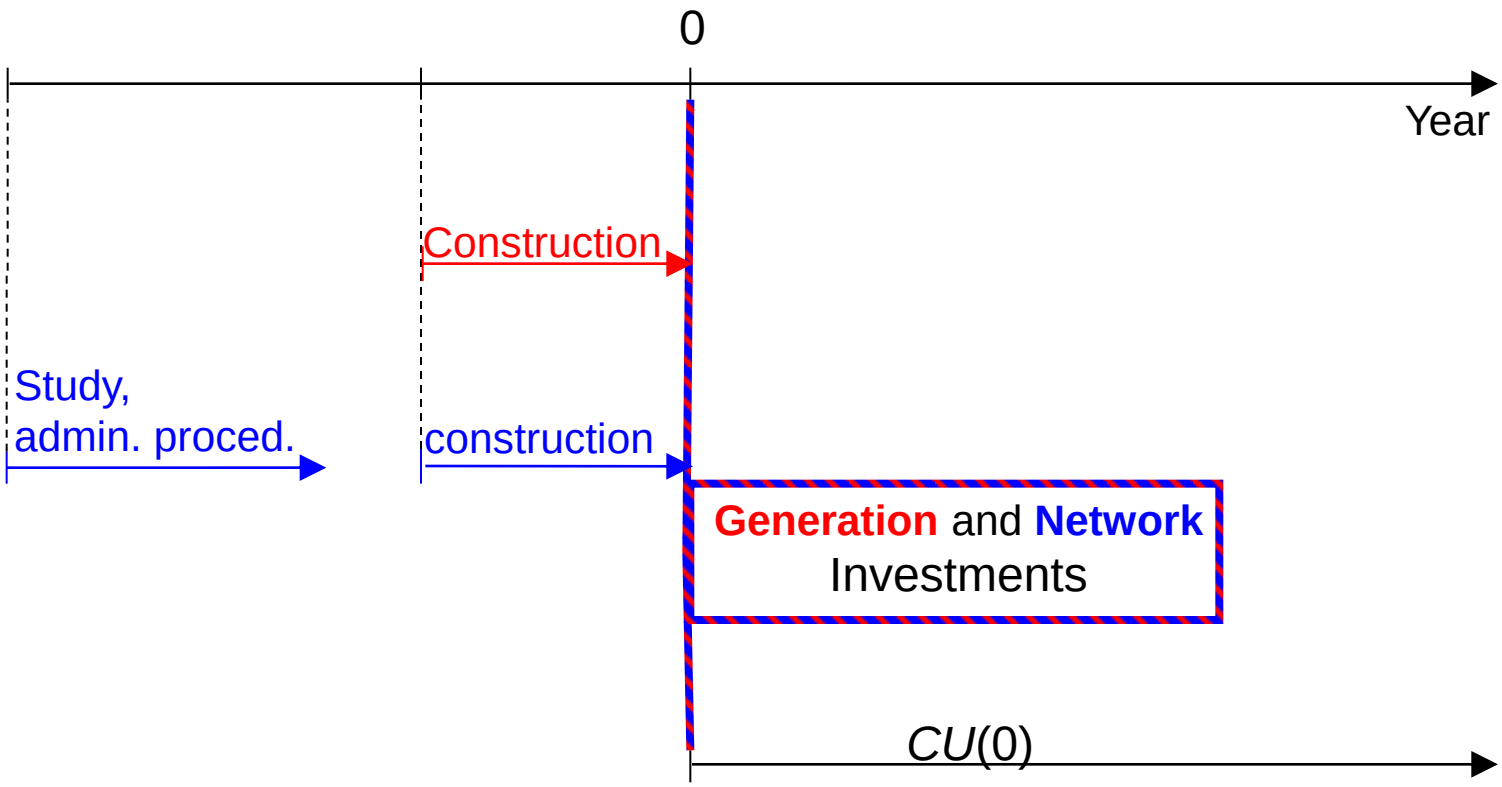
| TSO \ Generator | invests<br>Probability $p$ | does not invest<br>Probability $1\text{-}p$ | Expected social cost |
|---|---|---|---|
| *waits for connection of power plant before studying and upgrading* | $CW(d) + CU(d) + I/(1+a)^d$ | $0 + 0$ | $E\left[C_{reactive\,TSO}(p)\right] = p\left[CW(d) + CU(d) + I/(1+a)^d\right]$ |

Transmission investment cost

No congestion & no network investment

# Sequence of investments with a proactive TSO





# Costs faced by a proactive TSO



Congestion cost with **u**pgrade as soon as the generator connects

| Generator / *TSO* | invests Probability $p$ | does not invest Probability $1\text{-}p$ | Expected social cost |
|---|---|---|---|
| *waits for connection of power plant before studying and upgrading* | $I + CU(0)$ | $\alpha I + 0$ | $E\left[C_{proactiveTSO}(p)\right] = p\left[I + CR(0)\right] + (1-p)\alpha I$ |

Transmission investment cost

No congestion cost

Anticipation cost
= network study + admin proced.

# Condition for a proactive TSO to be efficient



- When is proactive as efficient as reactive?

$$\Leftrightarrow p_{\lim} = \left[\frac{\alpha}{(1+a)^{-d} + \alpha - 1 + \left[CW(d) + CU(d) - CW(0)\right]/I}\right]$$

$p < p_{lim} \Leftrightarrow$ reactive TSO > proactive TSO

$p > p_{lim} \Leftrightarrow$ proactive TSO > reactive TSO

The anticipation strategy is all the more efficient that $p_{lim}$ is small

For a given $\alpha$, $p_{lim}$ as function of $d$

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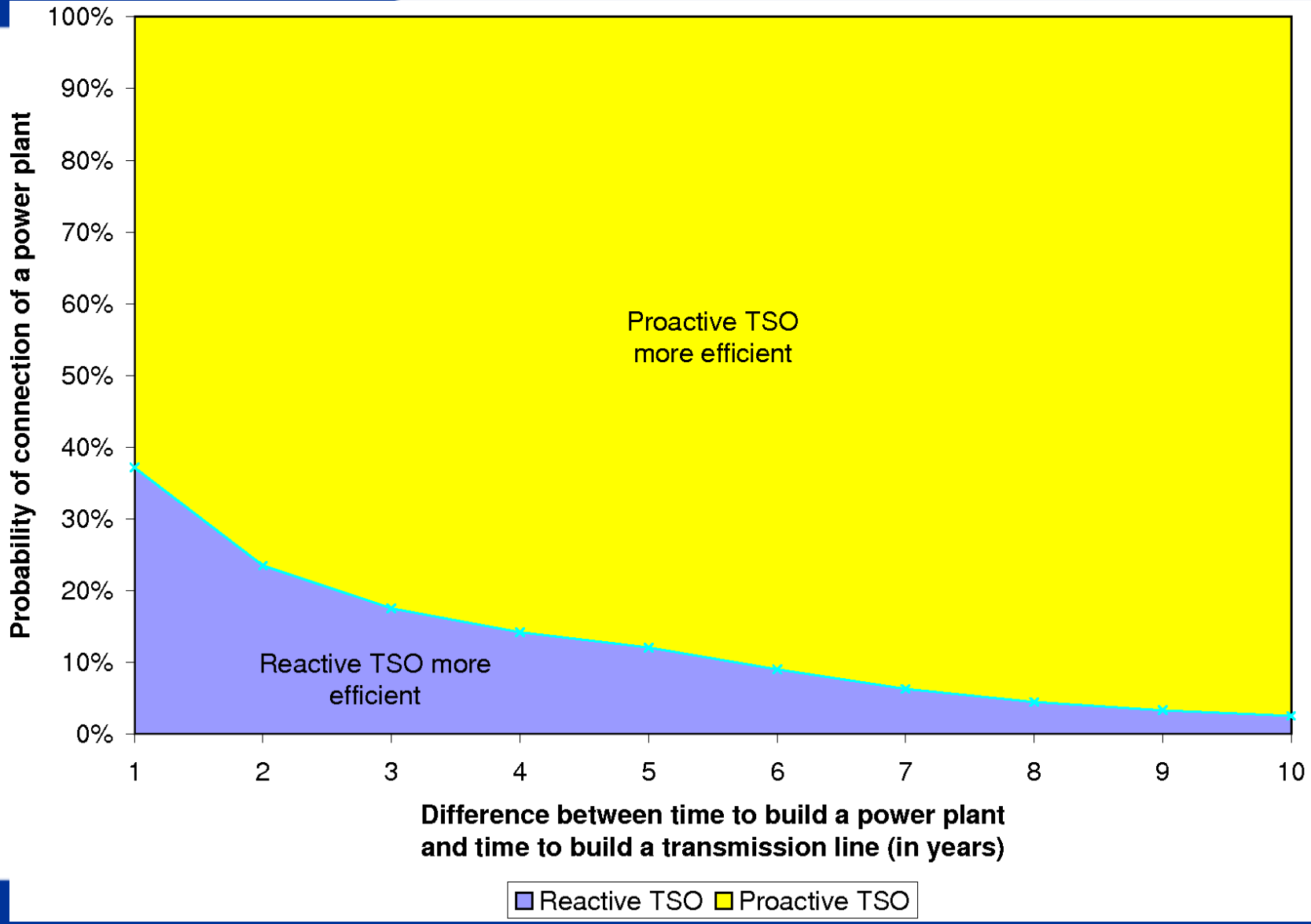
# “Probability limit” and condition for a proactive TSO





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# Conclusion



- A model to evaluate the efficiency of anticipating of power plants to minimize the cost of the network
- Illustration on a simple realistic example with CCGT
  - Efficient to anticipate the connection of power plants for the TSO
  - Planning in advance network reinforcement
  - Reduce congestion cost

# Future researches



- Variation of the cost of anticipating
- Duplicate this study for wind farm
- Interaction with regulatory actions
- Use real option methods

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Thank you for your attention

Questions ? Comments ?

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