

2023 IEEE PES ISGT-Europe

October 23rd-26th, 2023, Grenoble, France

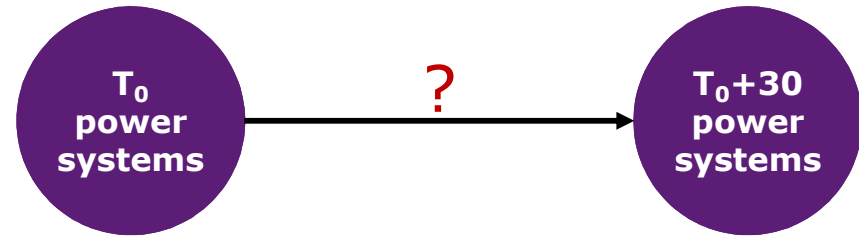
Perspectives on distribution network planning practices in the context of a high penetration of distributed energy resources

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▶ Long term planning



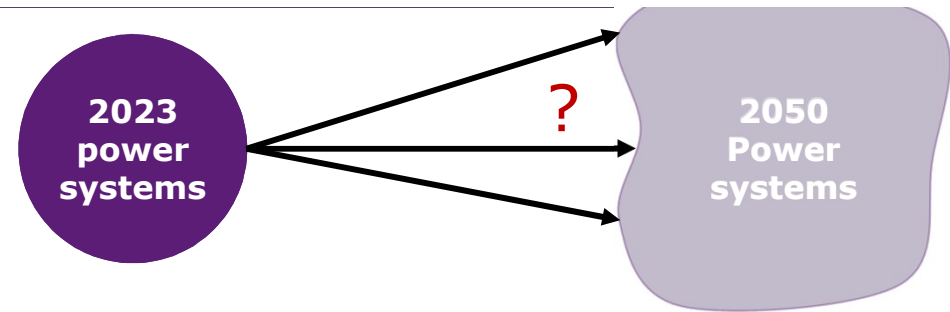
- ▶ To imagine/predict the evolution of the distribution systems
- ▶ Assumptions of loads and/or productions evolution (next decades)
- ▶ Trade-off between two criteria:
 - Costs: CAPEX and OPEX
 - Reliability: SAIDI, SAIFI, ENS



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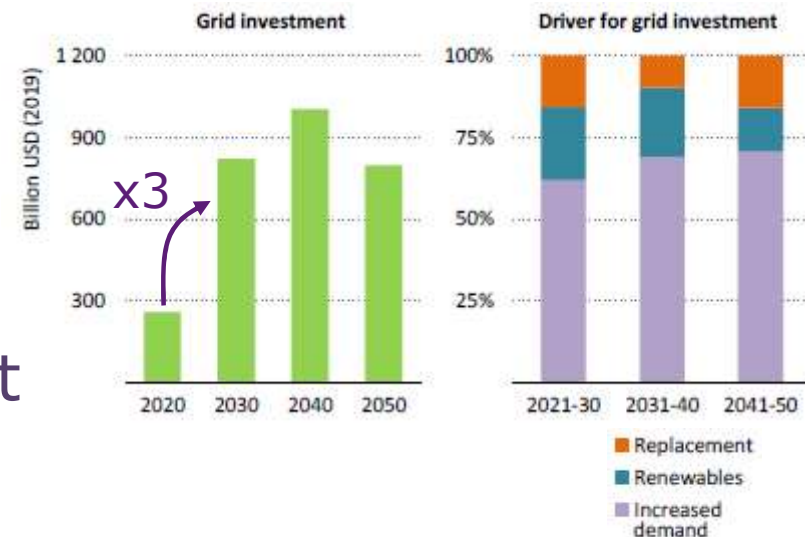
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► What is changing?



- Increase of photovoltaic and wind generation
- Increase of electricity consumption
 - industry decarbonization
 - electric vehicles
- Load profile shape
 - Local energy communities
 - Sobriety
- Increase of territory contrast
- Increase of uncertainties

Global investment in electricity networks
Net Zero by 2050, IEA



▶ **Some search questions around long term planning**

- ▶ **Traditional AC systems** still the best options?
- ▶ **Artificial intelligence** : a **buzz word** or a **real aid**
- ▶ **Traditional cost benefit analysis** still appropriate for decisions-making?
- ▶ **Integrated versus silo based planning?**
synergies between power systems and the other **energy sectors** and final **end-users**?



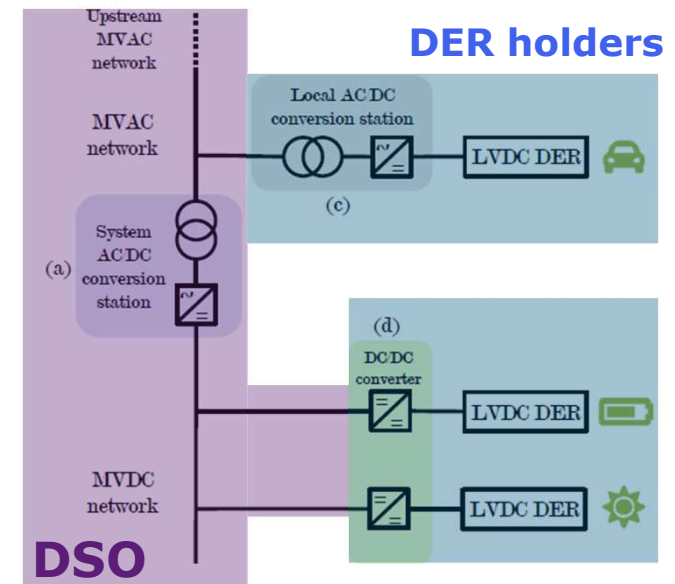
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Traditional AC systems still the best options?

Interest of AC/DC structure depends on:

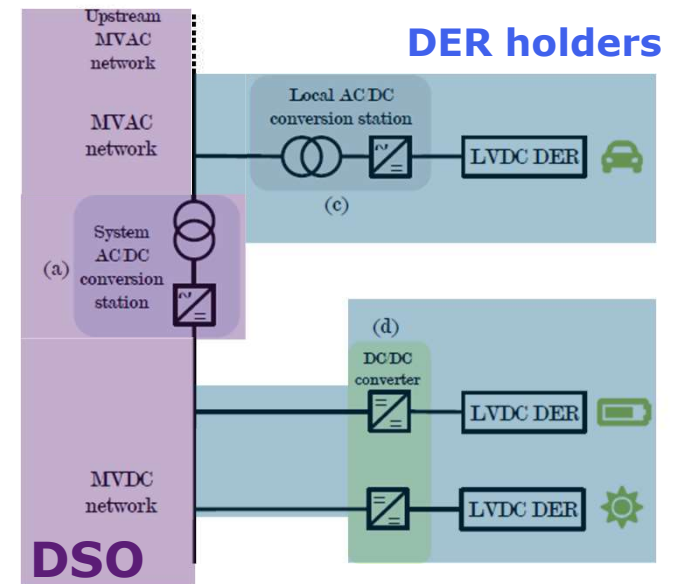
- Amount of DC resources in the network
- State of the network
 - Weak or strong
 - Rural or urban
- Policies and cost sharing model
 - Shallow



Traditional AC systems still the best options?

Interest of AC/DC structure depends on:

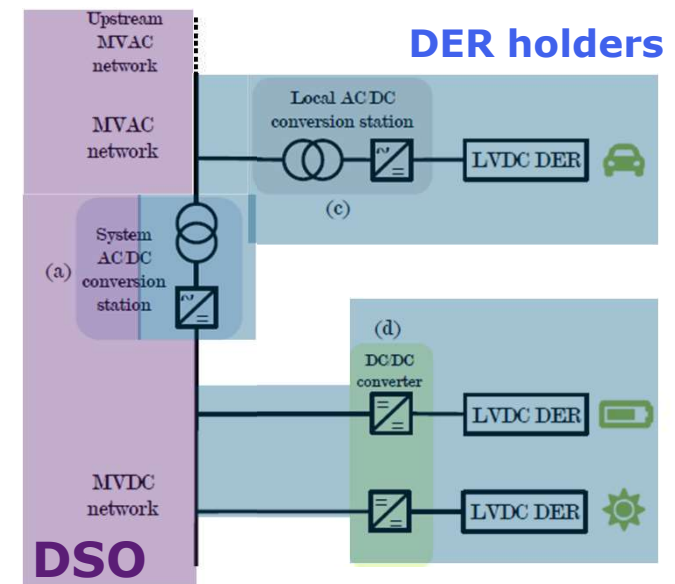
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Traditional AC systems still the best options?

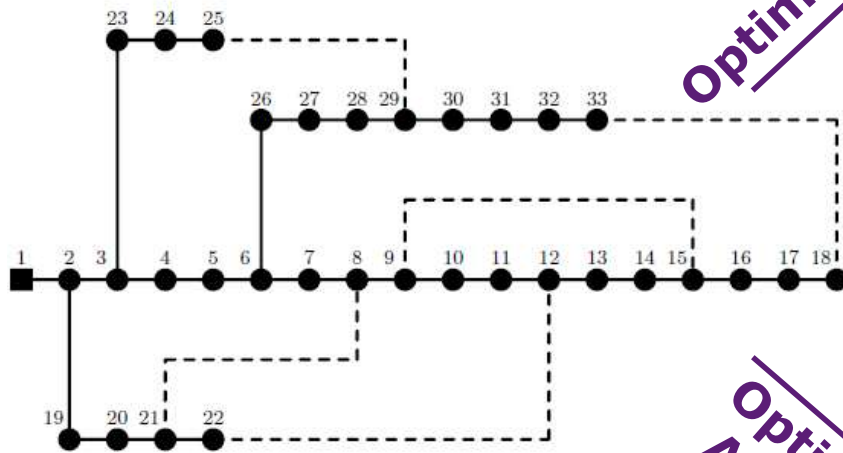
Interest of AC/DC structure depends on:

- Amount of DC resources in the network
- State of the network
 - Weak or strong
 - Rural or urban
- Policies and cost sharing model
 - Shallow
 - Hybrid
 - Deep
- Global costs optimization subjected to constraints



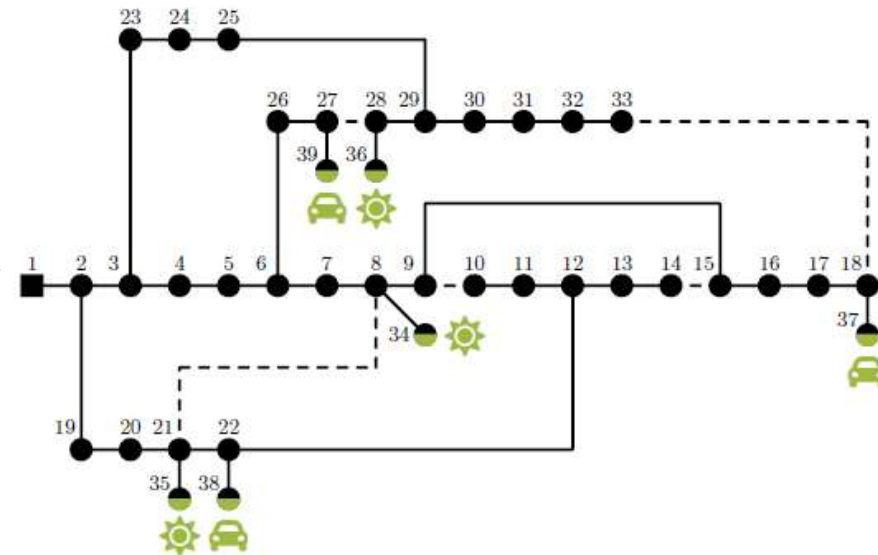
Traditional AC systems still the best options?

Example on the IEEE 33 buses

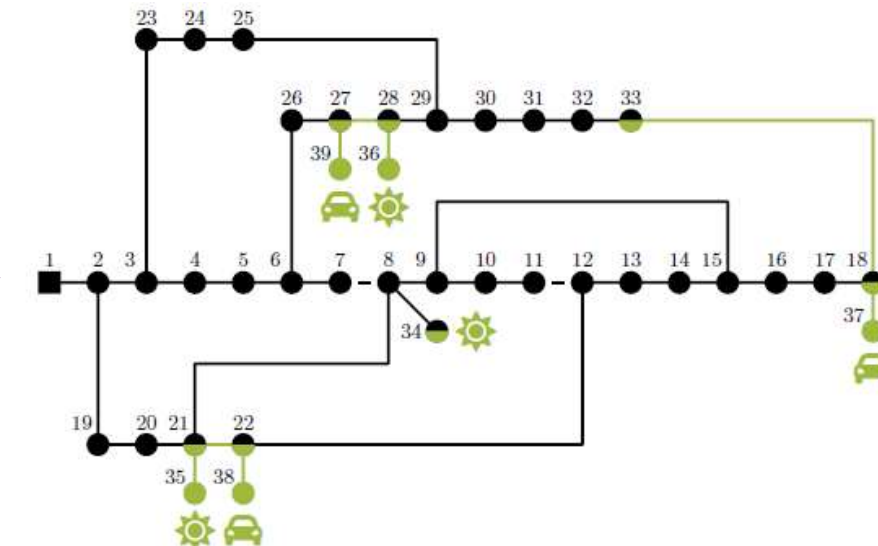


Initial network

Optimal AC



Optimal AC/DC

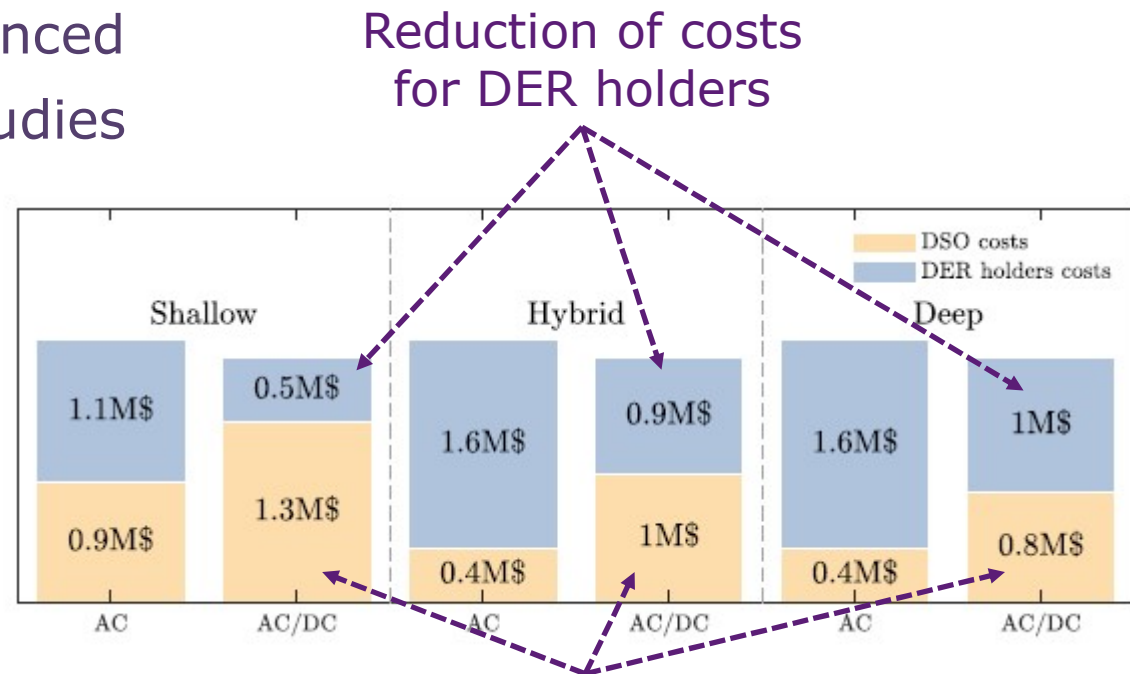


- HV/MV AC substation
- AC node
- DC node
- AC/DC node

Traditional AC systems still the best options?

Preliminary results

- Reduction of society costs
- Cost sharing unbalanced
- Sensitive to case studies



On-going publication, PhD Heitor Farias de Barros

DSO costs can significantly increase

Artificial intelligence : a buzz word or a real aid

Assessment of the diversity factor in LV

$$\text{Diversity factor} = \frac{\sum_{i=1}^n P_{max}(i)}{P_{max}(substation)}$$

- $P_{max}(i)$: individual peak of customer i
- $P_{max}(substation)$: peak value at the MV/LV substation

–Input data

- P_{max} of more than 12000 LV customers during 1 year
- Customers meteorological data

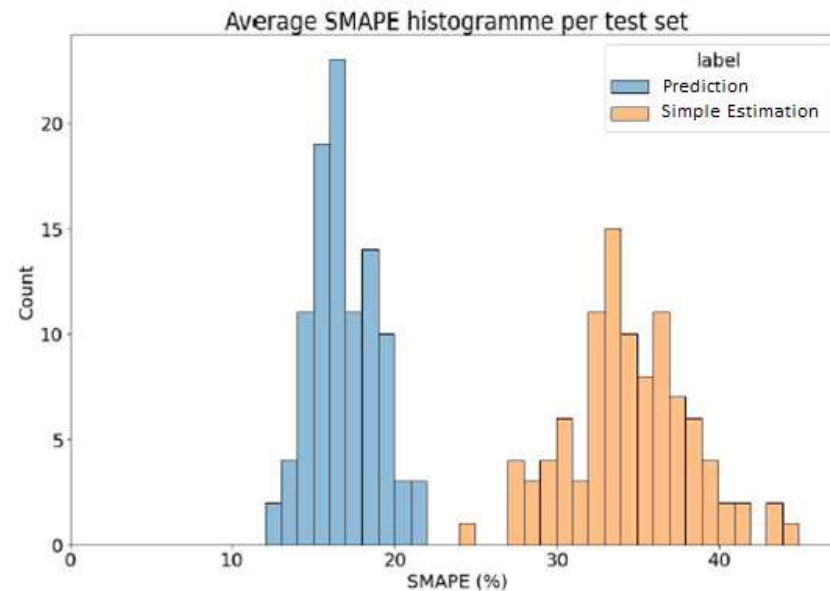
–Methods: supervised learning algorithms (random forest) & Shapley Additive Explanation (SHAP)

Artificial intelligence : a buzz word or a real aid

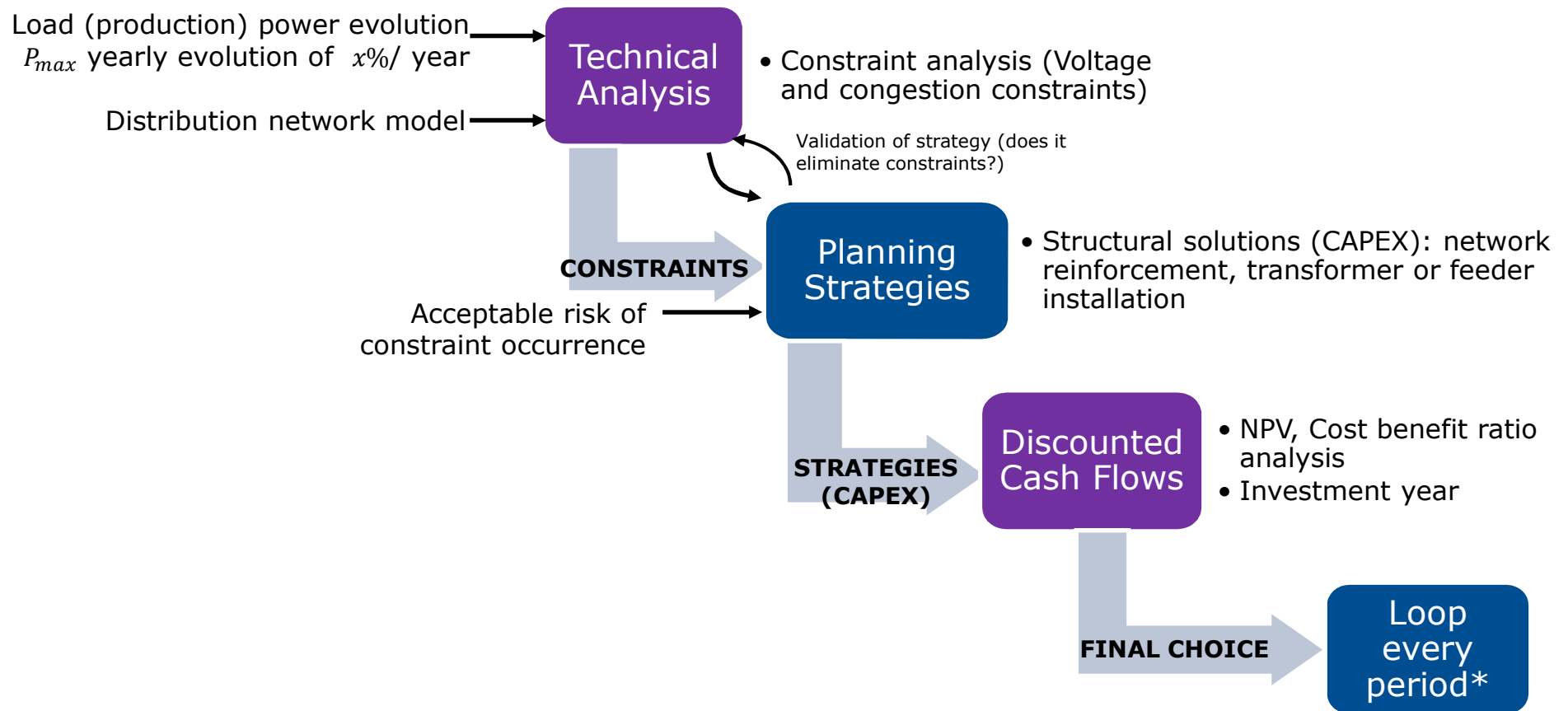
Results

– **Improvement of the results by 50% in comparison with the standard NFC 14-100**

- 100 training sets of 18 MV/LV substations
-

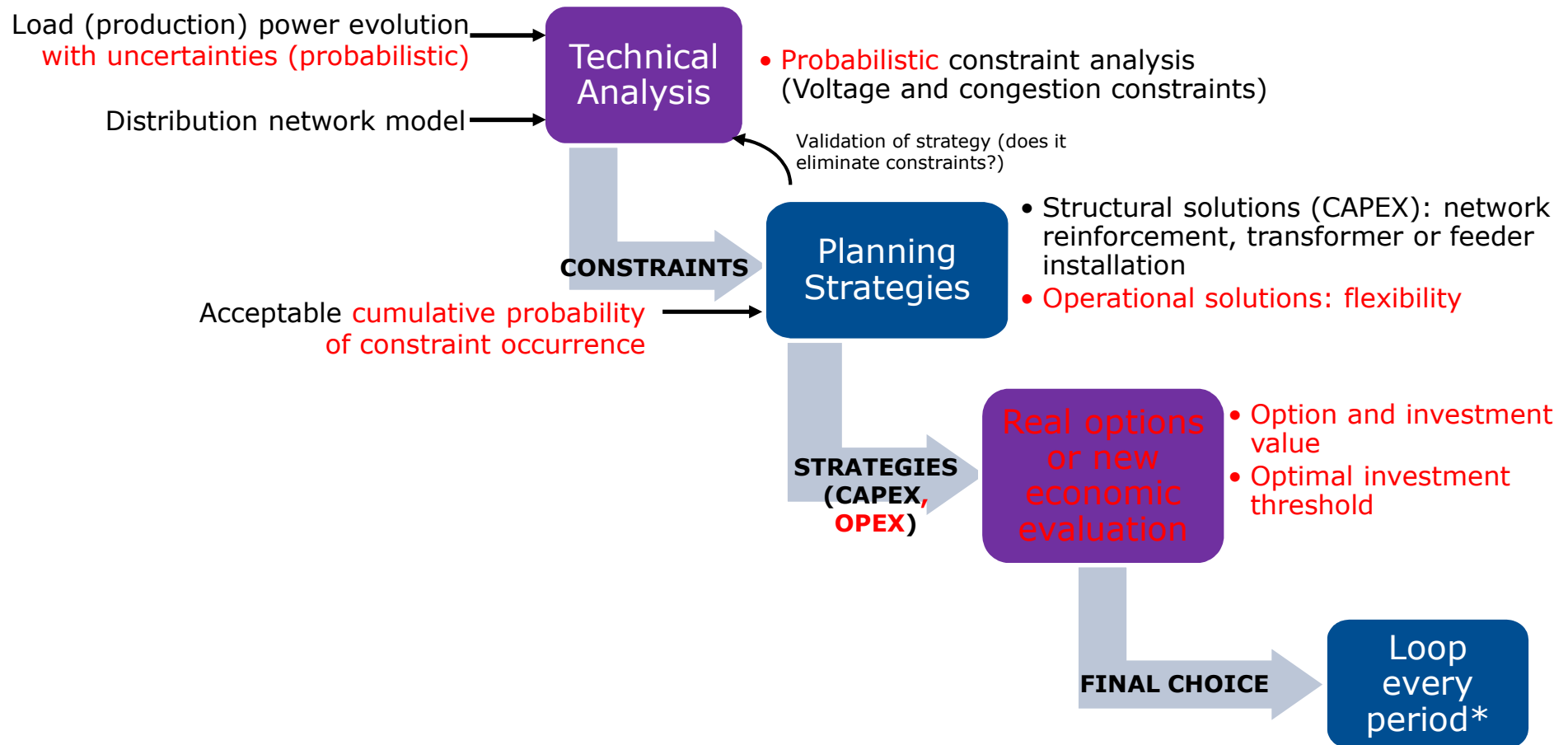


Traditional cost benefit analysis (CBA) still appropriate for decisions-making?



* Period duration is left to the discretion of the DSO

New cost benefit analysis (CBA) still appropriate for decisions-making?



* Period duration is left to the discretion of the DSO

▶ **Integrated versus silo based planning?**

▶ **Multi-energy planning**

- **ENTSO-E Roadmap for a multi-sectorial Planning Support**
- **Key questions**
 - **Services mapping**
 - **Modelling scale in terms of space and time**
 - **Data sharing**

▶ **Integrated versus silo based planning?**

▶ **Multi-players planning**

- **With/without flexibility market?**
- **How to involve the end-user in techno-oriented methods?**
- **Indicators definition**
 - **Risk**
 - **Acceptability**
 - **Environmental**
 - **Social**
 - **Resiliency -> “n-x” conditions to be defined?**
- **Bottom-up planning versus Top-down planning**

▶ **Some take away messages for discussion**

- ▶ **A lot of open questions regarding the evolution of distribution network planning methods in a context of:**
 - Energy transition
 - Social transition
- ▶ **Hypothesis, key performance indicators, technical choices, computation methods, etc.**
- ▶ **Regulation**