Considerations on nuclear projects organization and construction cost

WPNE Workshop on Project and Logistics Management in Nuclear New Build

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- **Contractual and industrial organization**
- **Reducing construction costs**
  - The value of experience
  - Standardization

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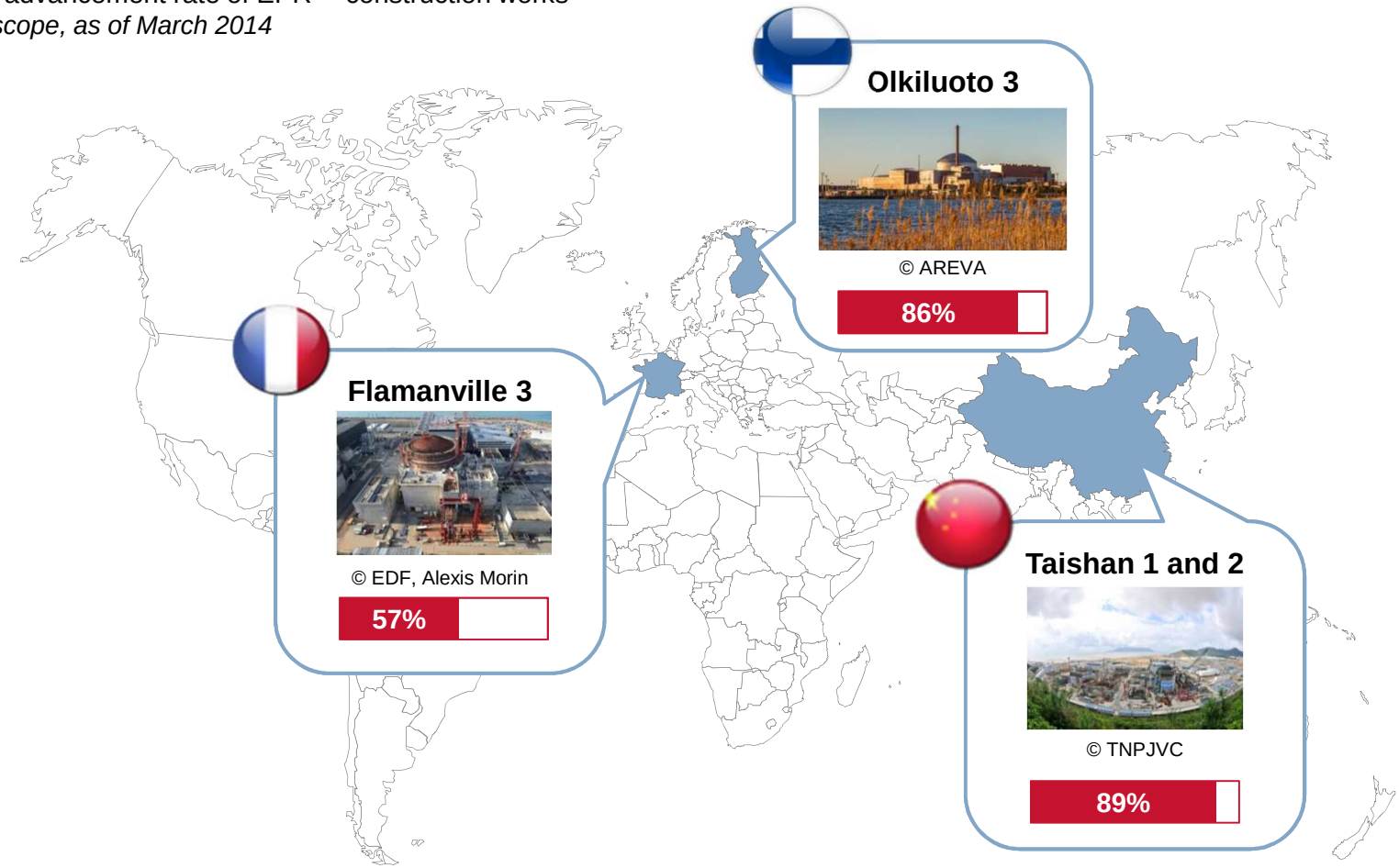
With four EPR™ reactors under construction in three countries, AREVA benefits from significant lessons learnt

Physical advancement rate of EPR™ construction works
AREVA scope, as of March 2014



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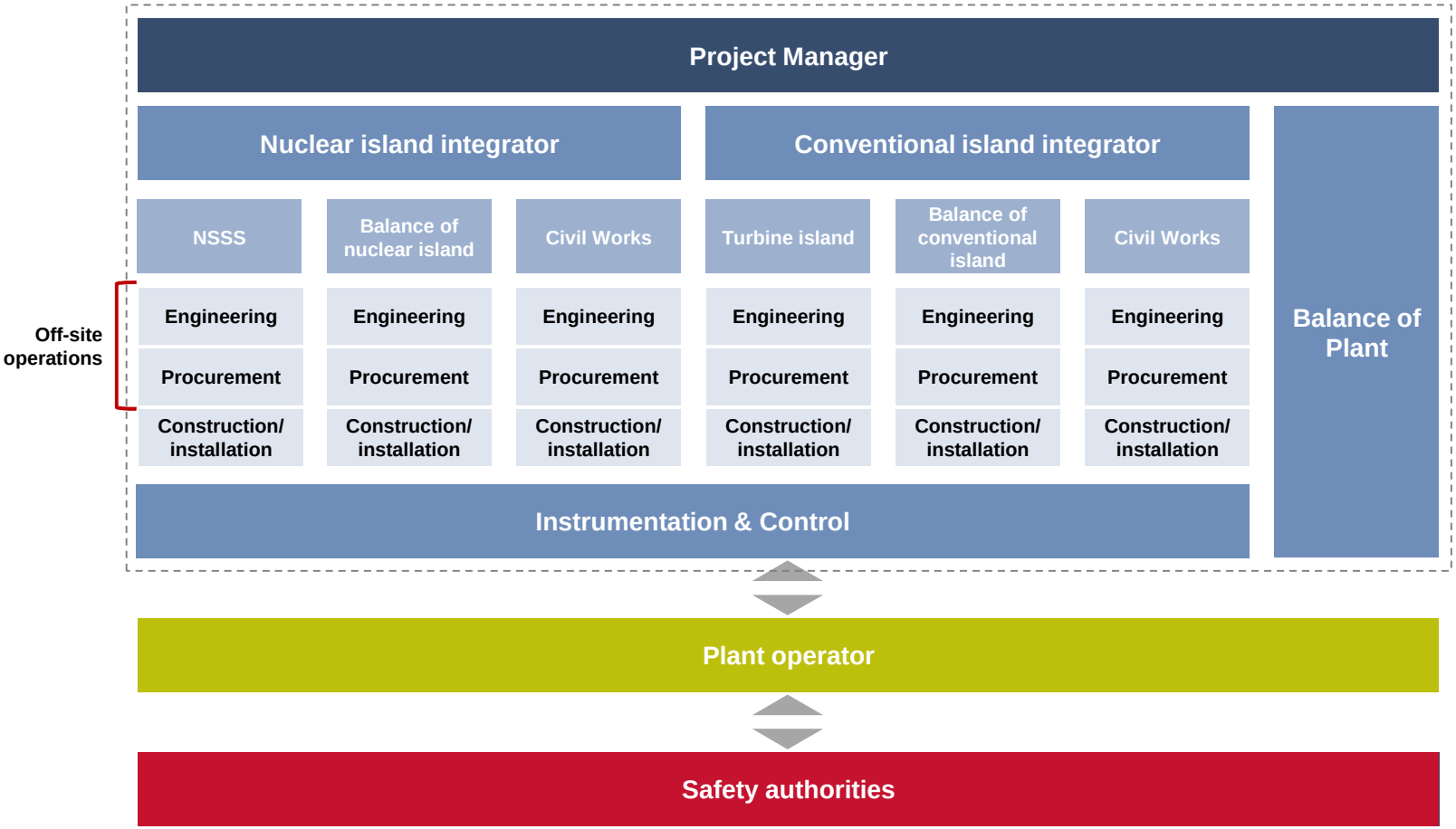
Nuclear New builds are complex projects due to the level of technology and the wide range of stakeholders they involve



The contractual framework must clearly define the responsibilities of each stakeholder

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New Builds' contractual organization mostly depends on the customer

The choice of a given organization model firstly depends on the customer's maturity regarding nuclear

- A utility already operating a fleet of nuclear reactor will very likely have the necessary project management and system integration skills
  - The contract organization will then largely involve its own workforce
  - EPC packages for each major equipment will be awarded to contractors through independent call for bids

For those not already mastering nuclear project management, another parameter is the customer's will to develop its skills in the nuclear field

- Utilities with no intent to build a fleet try to lower their risks through EPC turnkey contracts
- For utilities intending to develop nuclear fleets:
  - Nuclear programs are often part of a country's industrial policy, implying the development of a local supplier base
  - In any case, the utility will try to lower the cost of its program by bringing competencies in-house
- As such, the contractor is required to work with local partners and suppliers with a view to transfer skills at all levels:
  - Manufacturing
  - Engineering
  - Project management
- Requirements on contractual and industrial organization may vary

AREVA adapts its offers to the customer's choice and may advise during the early stage of a nuclear program on the most relevant industrial organization in terms of risk-sharing and performance

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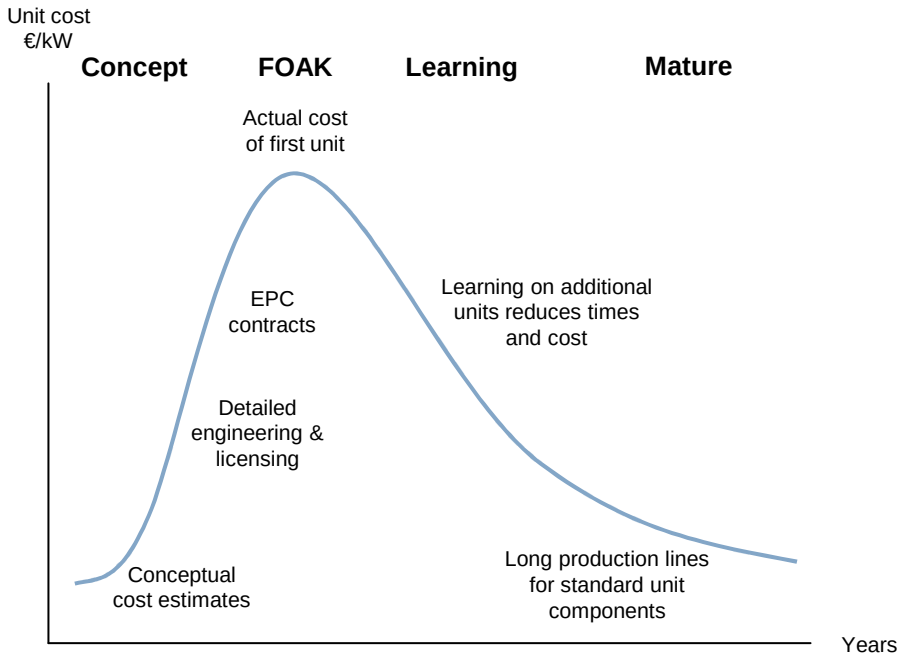
The history of the French nuclear fleet demonstrates that the learning effect plays a key-role in the reduction of construction cost

Experience, economies of scale or learning-by-doing all play a role in reducing nuclear construction costs

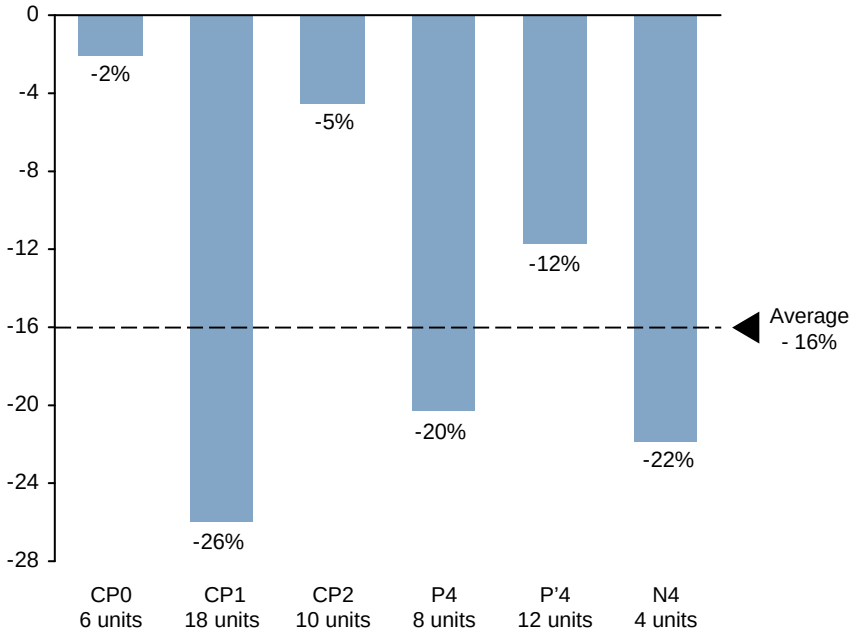
Nuclear projects learning curve



Source : Edward Kee, NERA, "Future of Nuclear Energy", GW Panel: Aftermath of Fukushima Dai-ichi Accident, March 2012

Construction cost reduction of up to -26% was achieved during the French civil nuclear program

Variation of construction costs* between the first and last unit of each technological series within the French nuclear fleet
In %, based on figures expressed in $€_{2010}$



* Excluding engineering and pre-operating charges. By date from first concrete.
Source : AREVA analysis based on "The Costs of the Nuclear Power Sector" , Cour des Comptes, 2012

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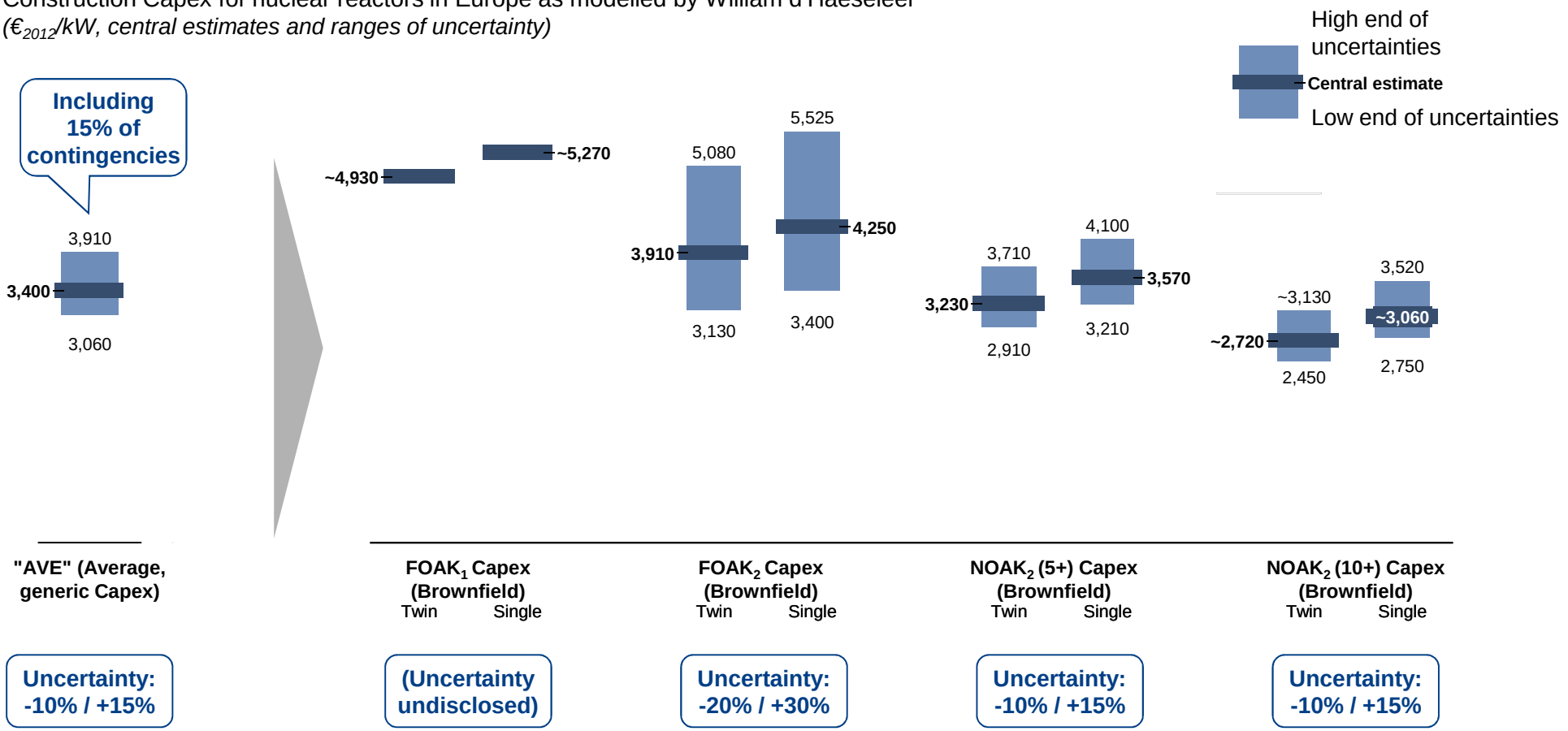
Based on a study issued by William d'Haeseleer, construction cost decrease by ~35% between a FOAK and a 5th twin-unit

Construction Capex for nuclear reactors in Europe as modelled by William d'Haeseleer
(€2012/kW, central estimates and ranges of uncertainty)



As some Capex values were not explicitly written in the report, AREVA calculated them from W. d'Haeseleer's assumptions, hence the "~" symbol
Source: William d'Haeseleer, 2013 – "Synthesis on the Economics of Nuclear Energy" (public report to the European Commission ENEF)

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EPR™ Standard allows guaranteeing high-performance through improved reliability, risk mitigation and cost optimization

EPR Standard is a reference that aims at easing series production

- **Gather the best solutions based on previous projects' returns of experience, in order to define the best technical solution enabling to cut cost and lead-time**
- EPR standard provides:
  - Certainty and risk-reduction on new projects
  - Consistency to AREVA's solutions
  - Supply-chain effectiveness
  - Engineering studies pooling
  - Facilitated REX exchanges between operators
- Overall, standardization allows productivity gains to the customer's benefit

EPR Design can be adapted to the local constraints or requirements

Country	Constraint	Impact
China	Wet temperatures	Ventilation and cooling system design
Finland	Regulatory requirements	Containment venting system
Middle-East	Sandstorms	Additional filters to air-intakes
US	Safety requirements	Cooling towers compulsory even on coastal sites
US	National standards	60 Hertz grid frequency (50 in Europe)

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Thank you for your attention

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