# Drivers for a NPP business case in the Netherlands

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# Summary

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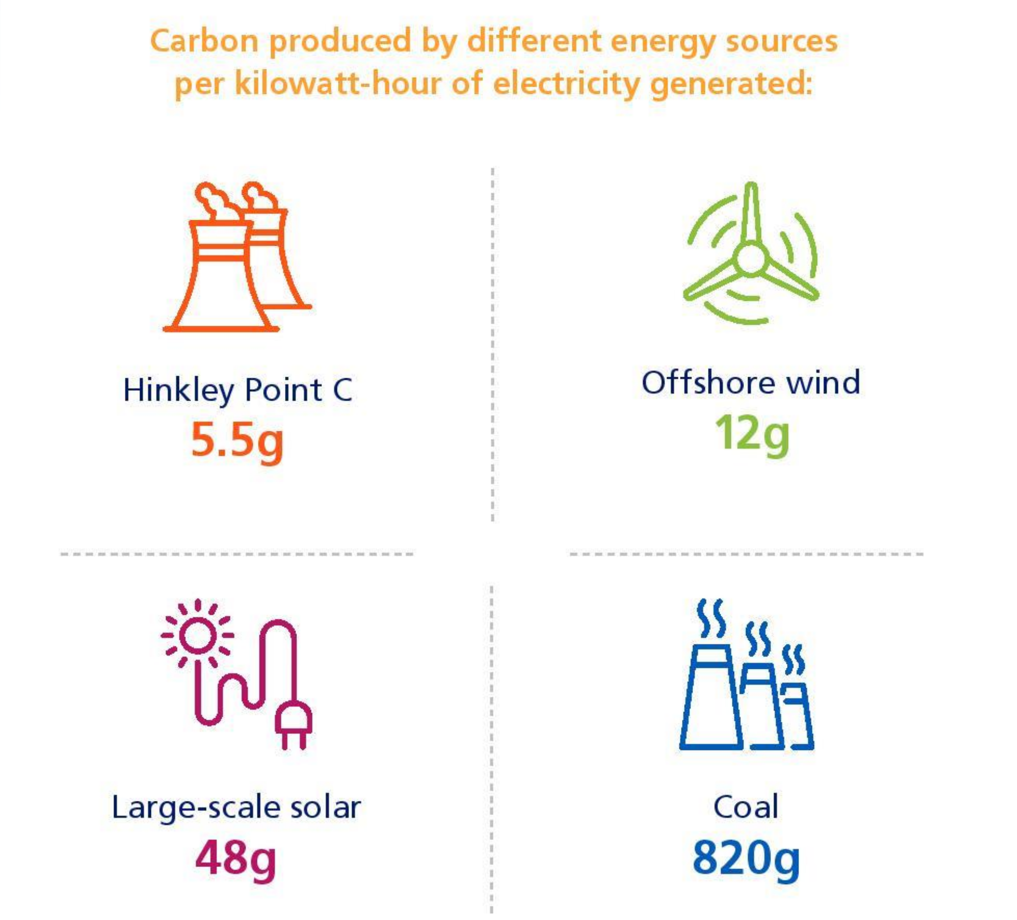
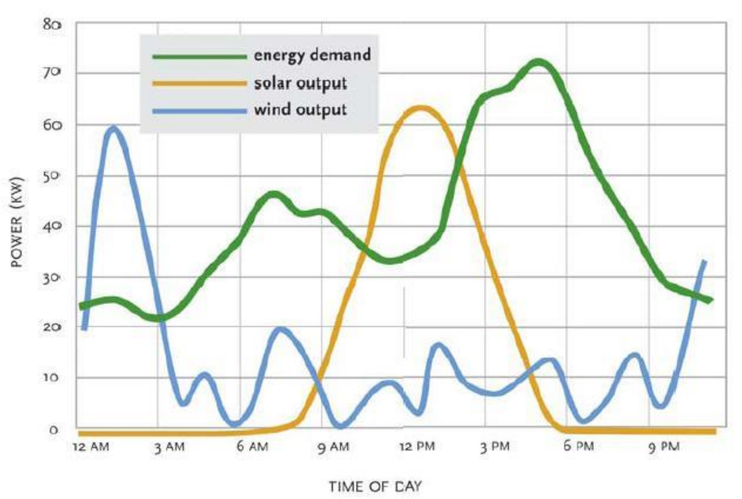
# About me

- Over 35 years experience in the Nuclear business
- Studied Applied Physics at the Technical University of Delft (NL)
- Specialised in Thermo-hydraulics, Reactor Physics, Deterministic Safety Assessments and PSA.
- Worked as Expert, Project Manager, Department Manager, NPP Plant Manager and Senior Consultant (EPZ, RWE, Independent)
- Involved in the development of NNB projects, involved in Business Case development :
  - The Netherlands (2X)
  - UK
  - Rumania
  - UAE
  - KSA

# Why new nuclear power in the Netherlands?
# CO2, Space and Reliability




| Dutch primary energy in 2050 | Regional | National | European | International |
|---|---|---|---|---|
| Total demand, including int transport | 2185 PJ | 2658 PJ | 3725 PJ | 3918 |
| Maximal sustainable production | 1775 PJ | 2132 PJ | 2698 PJ | 2065 |
| Shortage in space | 19% | 20% | 28% | 48% |



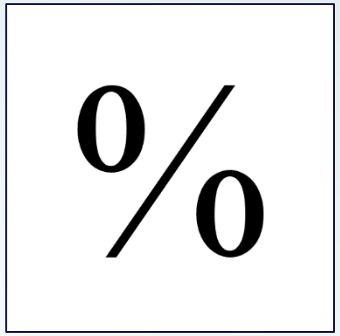

Wind and solar power is depending on weather conditions, introducing grid unbalance. Expensive long term storage facilities will be required.
Nuclear is a stable energy source, independent of the weather.

# Major Cost Driver of New Nuclear Power

## Investment-costs

Overnight Capital Costs
Construction delays:

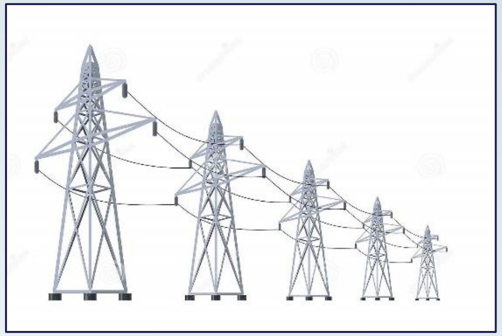
- Rework costs
- Extra Overhead
- Design changes



## Costs of Capital

Interest During Construction (IDC)
Interest During Operation (IDO)

WACC(IDC) < WACC (IDO)



## System-costs

General system costs
Specific system costs, (differ between sources of generation)

# Best way to compare sources of electricity generation: VA-LCOE

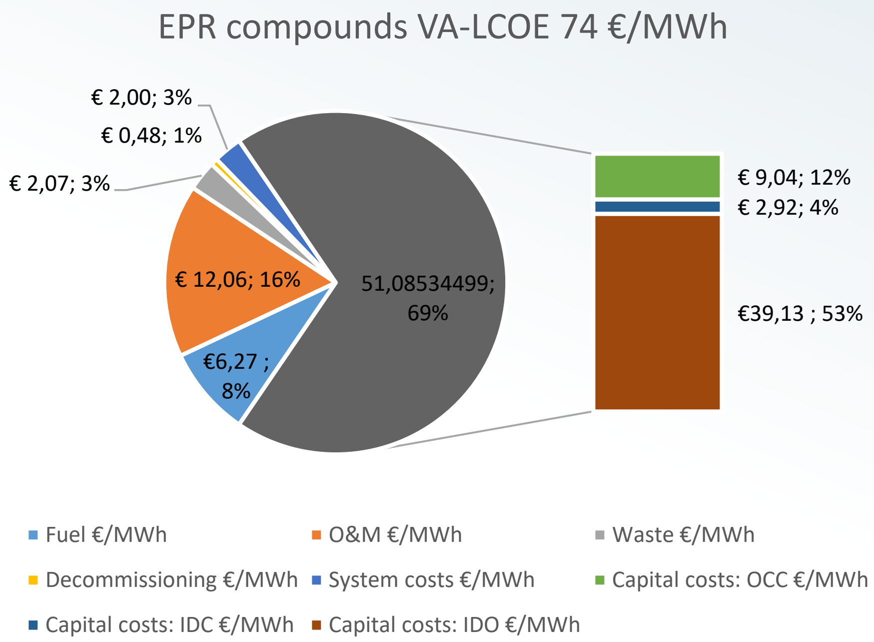
Levelized cost of electricity (LCOE): defined as the price at which the generated electricity should be sold for the system to break even at the end of its lifetime (€/MW)(present value calc)

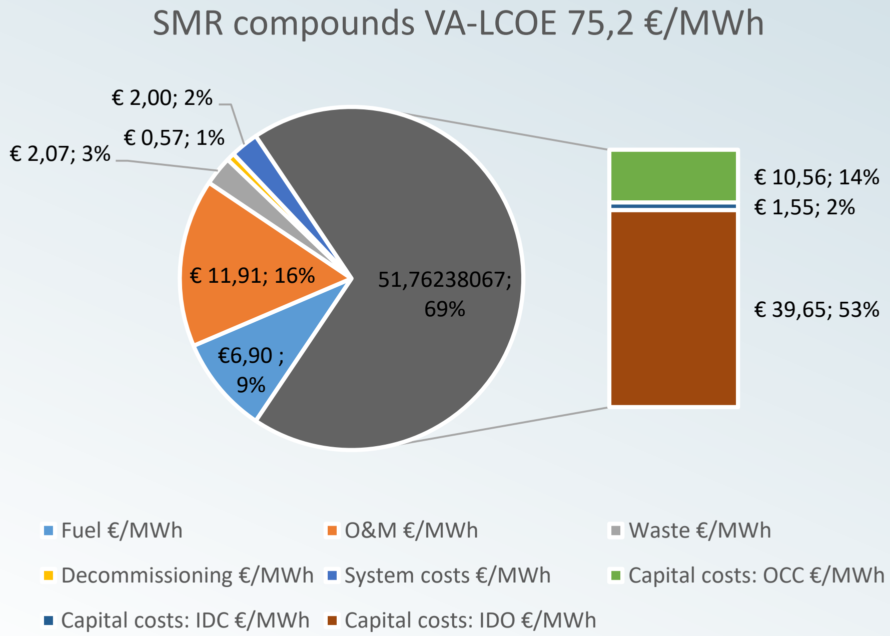
Value Adjusted levelized costs of electricity (VA-LCOE): according to the IEA defined as the LCOE, adjusted for the source-specific systemcosts (€/MW)

The following figures assume the same WACC during and the construction and operation phase. This is normal scenario study practise. In reality WACC(IDC) > WACC(IDO)

WACC: company internal discount rate, used in Business Case calculations

# Two examples Nuclear VA-LCOE (year 2040, value €: 2018)

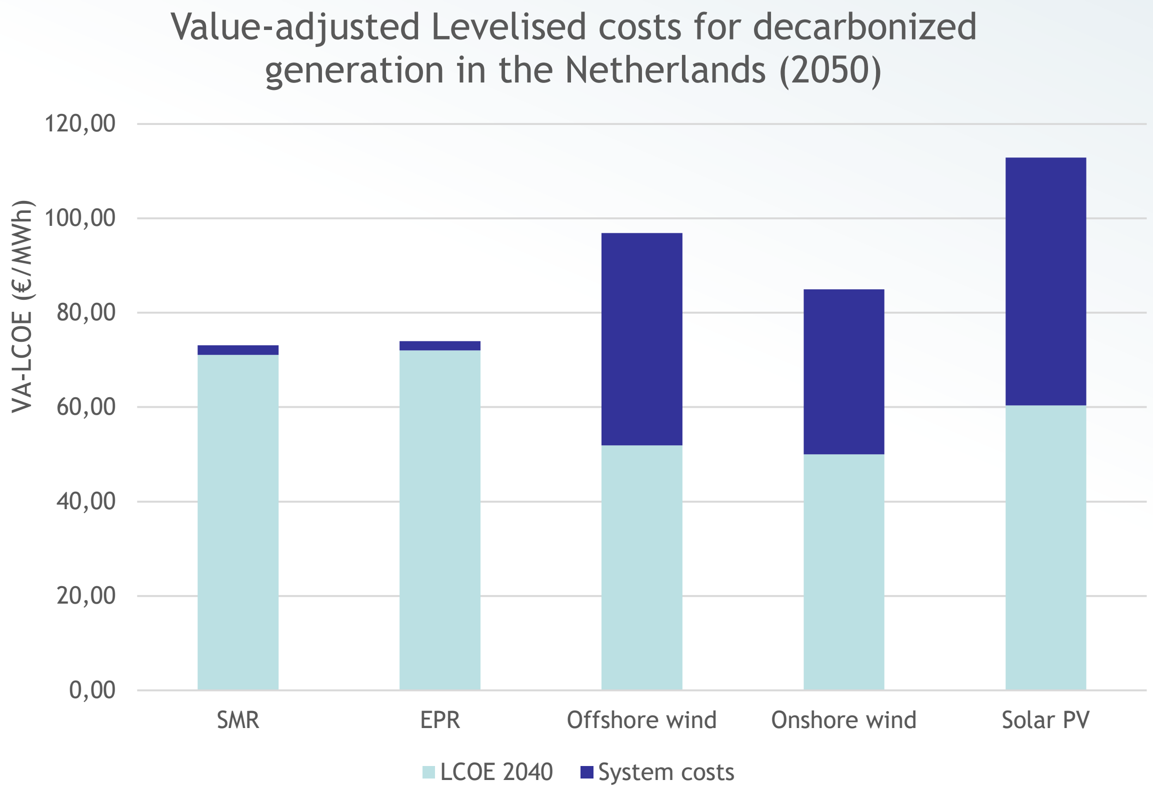


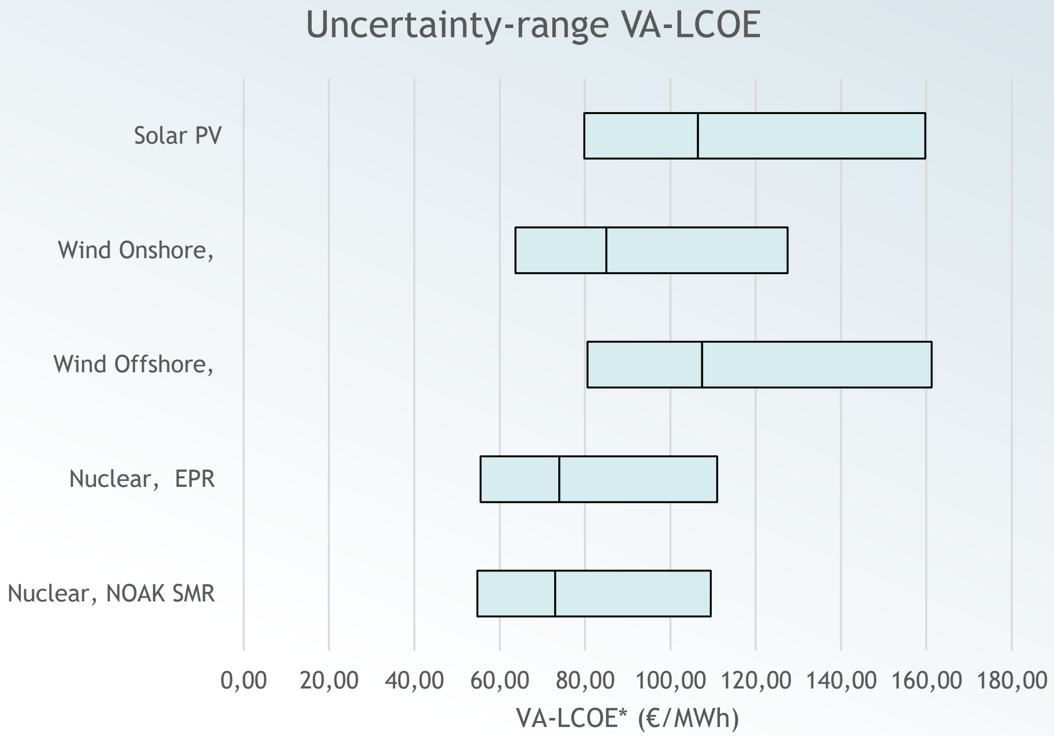




| Assumptions | EPR | SMR |
|---|---|---|
| Development/Power | NOAK/1630 MW | NOAK/200 MW |
| Utilisation factor | 100% | 100% |
| Lifetime | 60 years | 60 years |
| OCC | 7.335 BEuro | 1.0 BEuro |
| WACC | 7% | 7% |

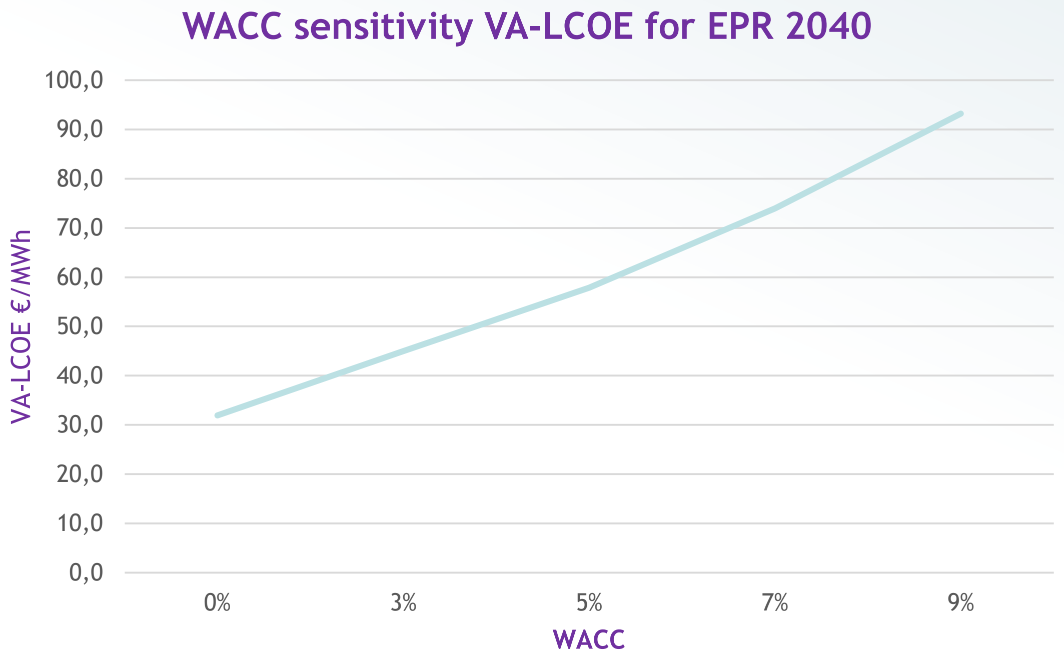
# Nuclear compared with other low-CO2 sources (2040)

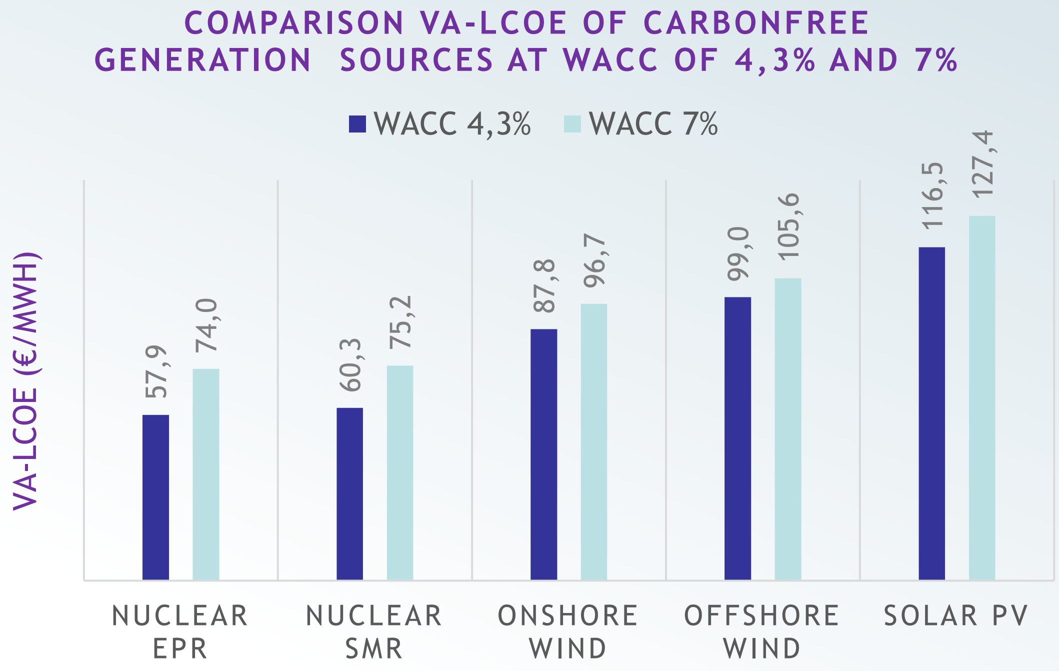
Assumed Nuclear WACC: 7% and VRE's: 4,3%



# When a new nuclear could be erected under the same financial provisions as VRE's…



# Conclusion

1. Taking into account system costs, nuclear energy is competitive with Variable Renewable Energy
2. In order of importance, the major cost drivers for new nuclear are:
   - WACC, depending on state support and guarantees
   - System costs, low for nuclear and neglected for VRE’s
   - Construction time, mostly because the increase of Interest During Construction (IDC)
3. The advantage of nuclear energy for the production of hydrogen is the continuous availability of electricity. Unlike Variable Renewable Energy sources, Nuclear Energy is a continuously available and controllable electricity source, resulting in a stable and reliable grid
4. After the Commercial Operation Date (COD), the project risks fall down dramatically, resulting in a lower WACC. This is not shown in the analyses.