Towards nuclear energy in Vietnam

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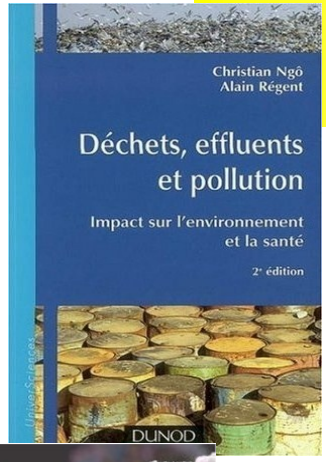

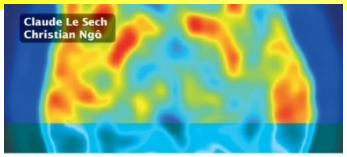

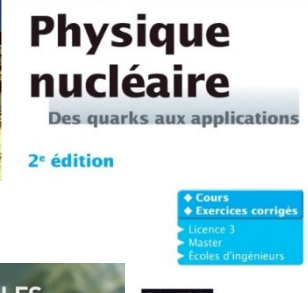

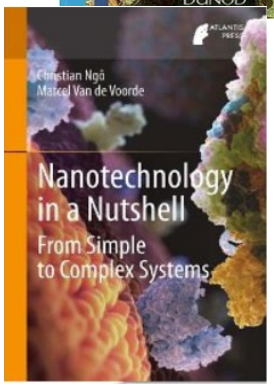

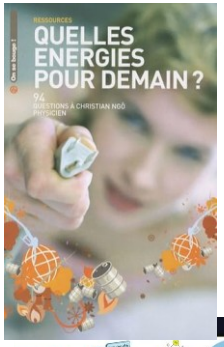

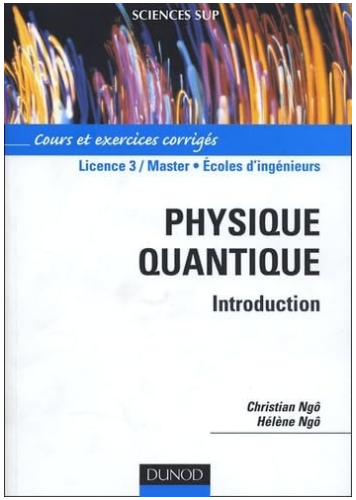

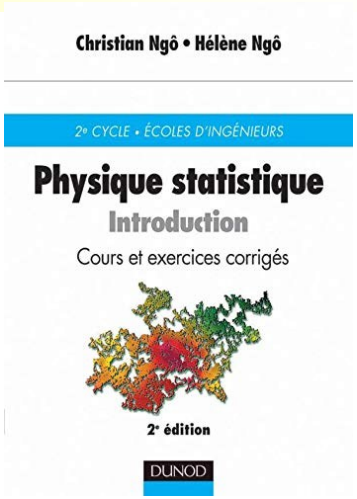

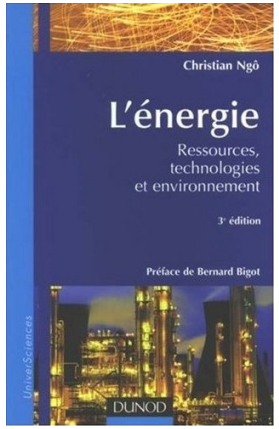

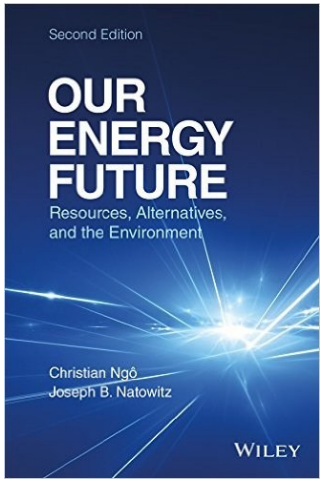

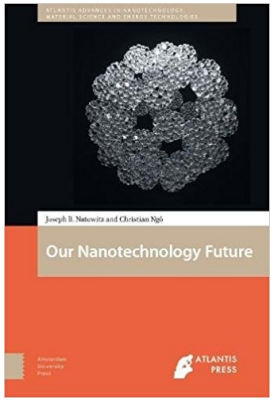

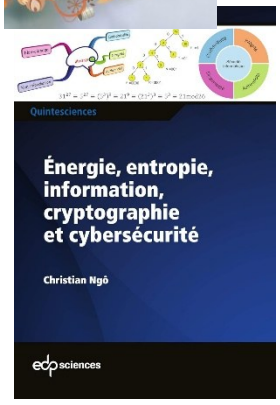

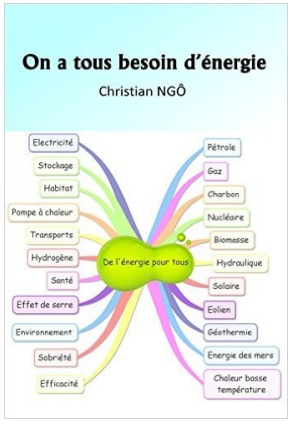

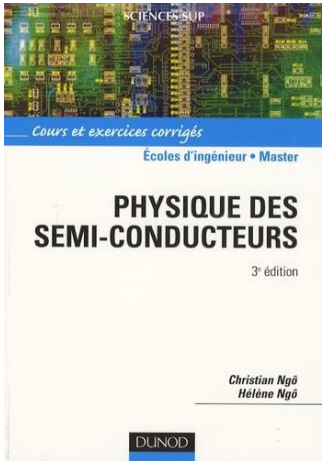

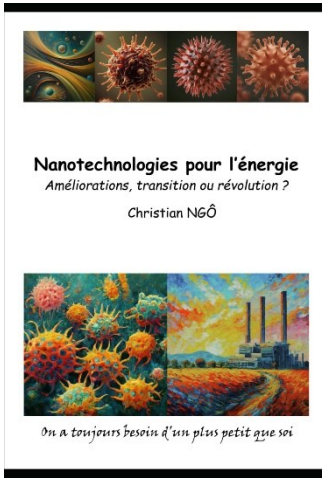

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Nuclear power generation: for abundant, cheap and continuous electricity production

Nuclear power generation

- Stable cost of electricity over time
  - If the price of natural uranium is multiplied by 10, the price of kWh increases by less than 40%. If the price of natural gas is multiplied by 10, the price of kWh is multiplied by 7 (700%).
- Underground nuclear reactors (accidents, dismantling)
  - At the end of life: remove the core which is hignly radioactive and encase de entire faciity in concrete
- Construction close to the seaside (cooling)
- Most common technology: PWR (300 PWR over 447 worldwide) About 14600 reactor-years of cumulative operation experience
  - As 2 kWh of heat are produced for 1 kWh of electricity generated, part of the heat can also be used

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Which research should be carried out in case of a turnkey nuclear reactor

In the case of a turnkey reactor, most of the engineering, licensing, and construction is provided by the vendor. However, developing domestic research and expertise is essential for safe, independent, and sustainable operation over the plant's lifetime.

- Vietnam should build independent safety expertise, waste and decommissioning research, fuel cycle studies, human resource development
- Vietnam should develop expertise, by making research on different subjects, for supporting the independent control authorities
- Vietnam should be invested in radiation protection (methods, detectors, measurements)
- Vietnam should also prepare for long-term energy strategy and technology evolution.

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Which research should be carried out in case of a turnkey nuclear reactor

Some interesting areas of research that should be launched in the more or less short term

- Research areas
  - Long term (> 15 years)
    - Waste management
    - Reactor lifespan extension
    - Fuel cycle
    - New reactor technologies
    - Decommissioning strategy
  - Short term (0-5 years)
    - Regulatory setup
    - Workforce training
    - Radiation detection and measurement
    - Engineering
    - Safety assessments
    - Measurements
    - environmental impact research
    - Socioeconomic impact studies
    - Risk communication
    - Radiation protection
  - Medium term (5-15 years)
    - Life management
    - Fuel cycle studies
    - Domestic manufacturing
    - Cybersecurity
    - Supply chain resilience
    - Grid optimization
    - Energy economics
    - Specific waste solutions

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Human ressources training

The human ressource training should be continuous, competency-based and safety-driven

Human ressources training

Knowledge transfer
- Mentoring
- Apprenticeship
- Succession planning
- International ccoperation
- Digital Tools & e-learning

Safety culture & human factors
- Safety first
- Human performance tools
- Anticipating human errors

The nuclear industry installing the turnkey reactor will specifically train the operators and personnel needed to operate the reactor. This point will therefore not be detailed.

1. Work under quality assurance
2. Develop certification for teaching renewal of qualifications

Initial training and qualification
- Universities & technical institutes
- Initial training (nuclear fundamentals, radiation protection, safety culture
- Licensing & certification

Continuous training and requalification
- On-the-job training
- Refresher courses
- Requalification exams
- Cross-training

Training objectives:
1. Technical competence
2. Regulatory compliance
3. Competency-based approach
4. Lifelong learning
3. Mitigate risks
4. Anticipate workforce aging

Simulation & practice
- Full-scope simulators
- Emergency drills
- Scenario based learning

Radiation protection

Protection of people, workers, and the environment from the harmful effects of exposure to ionizing radiation.

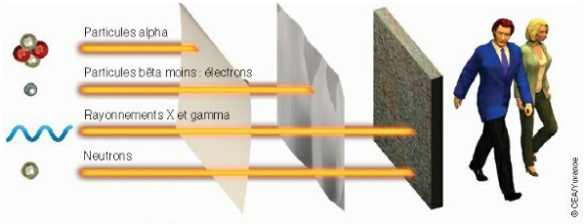
Any person working (even occasionally) in a nuclear installation must have training in radiation protection validated by an examination and valid for a defined period.

Key principles

- Justification
- Limitation
- Optimization (ALARA= As Low as Reasonably Achievable

Protective measures

- Limiting time
- Limiting distance
- Using shielding



Nuclear safety management

Definition

Technical and organizational actions to prevent nuclear accidents and minimize their consequences

Principles

Key principle

Defense in depth: Multiple physical and organizational barriers

Key principle

Safety culture: Commitment to safety at all organizational levels

Key principle

Compliance with national and international regulation

Key principle

Continuous assessment and improvement: Use what is learned from feedback and benchmarking

Objectives

Protect workers, the public and the environnment

Nuclear safety management

Key elements

Leadership and safety culture

1. Clear responsabilities and accountability
2. Strong safety culture at all organizational levels

Emergency and preparedness

1. Development and regular testing of emergency response plans
2. Periodic training and drills for staff and first responders.
3. Coordination with authorities

Risk assessment and prevention

1. Identification and analysis of hazards
2. Implementation of safety barriers and controls

Training and competences

1. Regular training and drills
2. Certification programs

Nuclear safety management

International oversight

Regulatory bodies

1. IAEA
2. National regulatory authorities (independent from the operator)

Safety standards and guidelines

1. Use of IAEA safety fundamentals and guides
2. Regular safety reviews and peer assessments

Continuous improvement

1. Incident reporting and feedback mechanisms
2. Benchmarking and share of best practices worldwide

Be careful not to apply more than is required for a good safety

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While developing nuclear energy, keep in mind the two following basic principles

- Have common sense
- Choose a simple solution rather than an equivalent complicated one

Thank you for having the patience to listen to me.

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