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An overview of strategic utilization plan for the Moroccan nuclear research reactor over the period of 2010-2015

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Outline

- Presentation of CNESTEN and CENM
- Vision, Objective of the strategic plan
- Main segments
- Education & Training
- Radio-isotope production

CNESTEN

- The National Centre for Nuclear Energy, Science and Technology (CNESTEN)
- Moroccan state-owned company, created on 1986, under Ministry of Energy and Mines
- Missions :
  - Support to the development of a nuclear power program
  - Promotion of nuclear techniques
  - Technical support to the State in safety and security
  - Radioactive waste management
  - Research, Education and Training

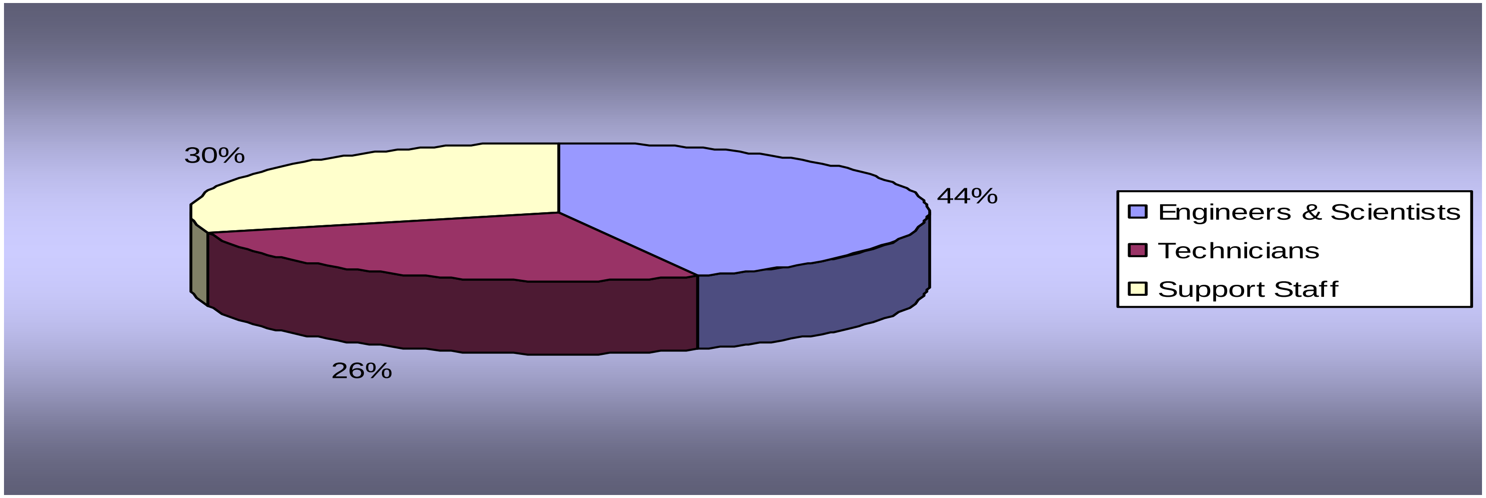
The Maamora Nuclear Center (CENM)

- 2 MW Research Reactor (Triga Mark II)
  - NAA
  - Radioisotope production
  - Research in solid physics
  - Education and Training
- Radioisotope Production Laboratories
- Industrial applications (NDT training and certification, tracers and gauges)
- Radioactive waste treatment and interim storage facility

Maamora Nuclear Center

CNESTEN : Human Resources

Workforce : 250



Training :

Beneficiaries : 120 Operation Staff

Duration : 6-7 months per person

Period : Design, Implementation, Operations

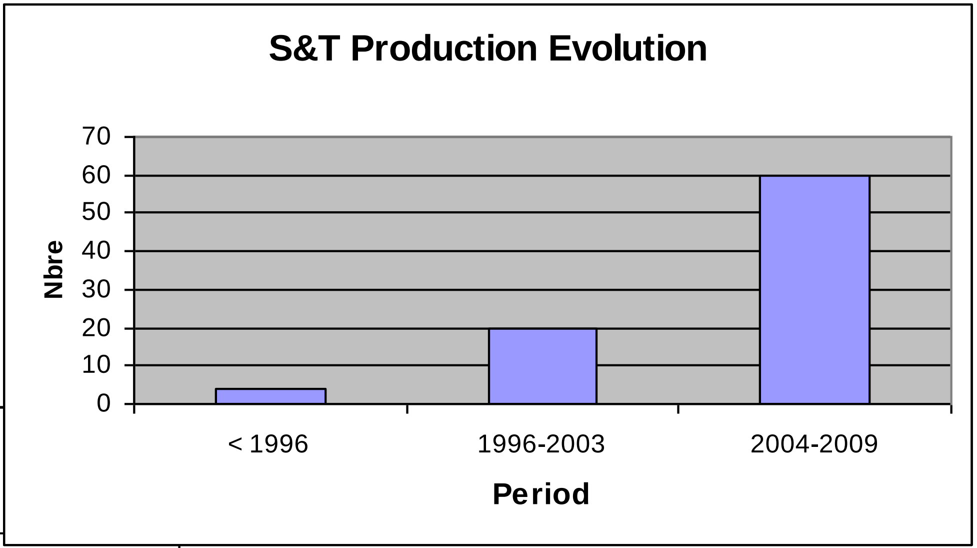
CNESTEN : (AFRA) Sustainability

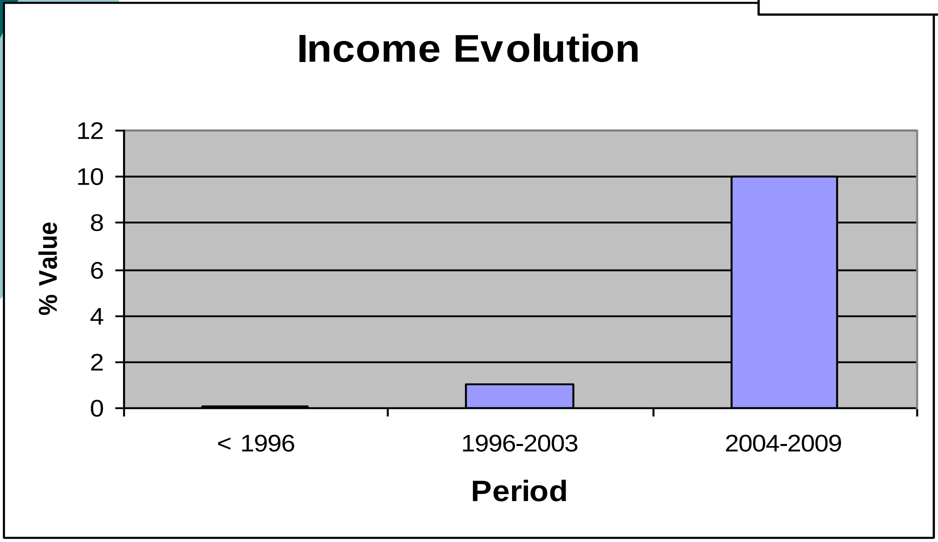
- Facilities and equipment are of state of art **(average to good)** : *maintenance is a major sustainability component*
- Income generation **(average to good)** :*30% of operation budget excluding salaries*
- Legal framework **(average to good)** in the light of the new law to be issued related the Nuclear Authority
- Human resources **(average)** : about 30 experts in various fields, but great difficulties to retain them
- Institutional dimension (IS, Reporting System, Coordination) **(weak to average)**

Output Evolution

25% annual growth for :

- National & international expertise
- RI in medical sector





E&T Training activities :

IAEA RTC - PGEC since 2001

National NDT Center

23 000 days of E&T per year

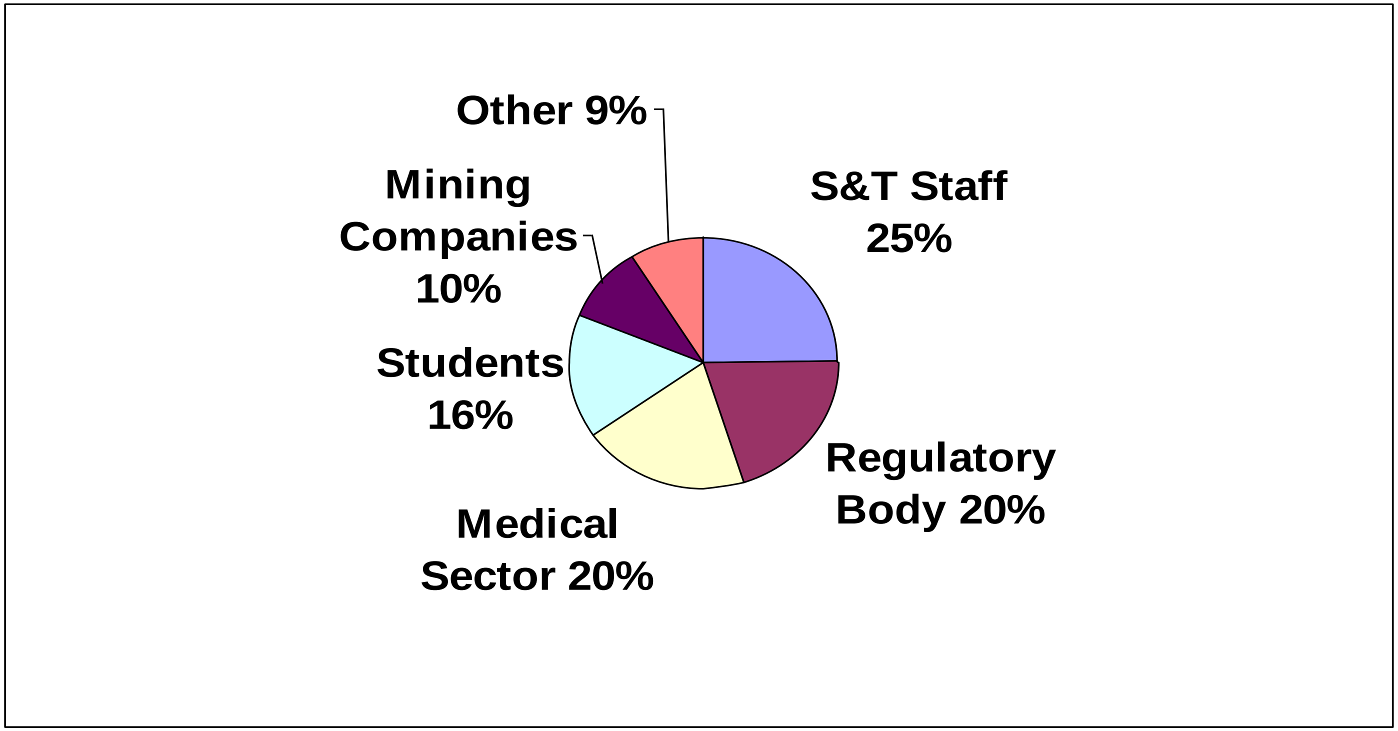
RP, NDT, PP, Emergency, NP, …

1 000 participants (20% foreigners) /year

2 000 visitors (students, NGO, …) /year

Education & Training : PGEC

- 137 Professionals from 19 African French speaking countries
- Education/Training Program Development



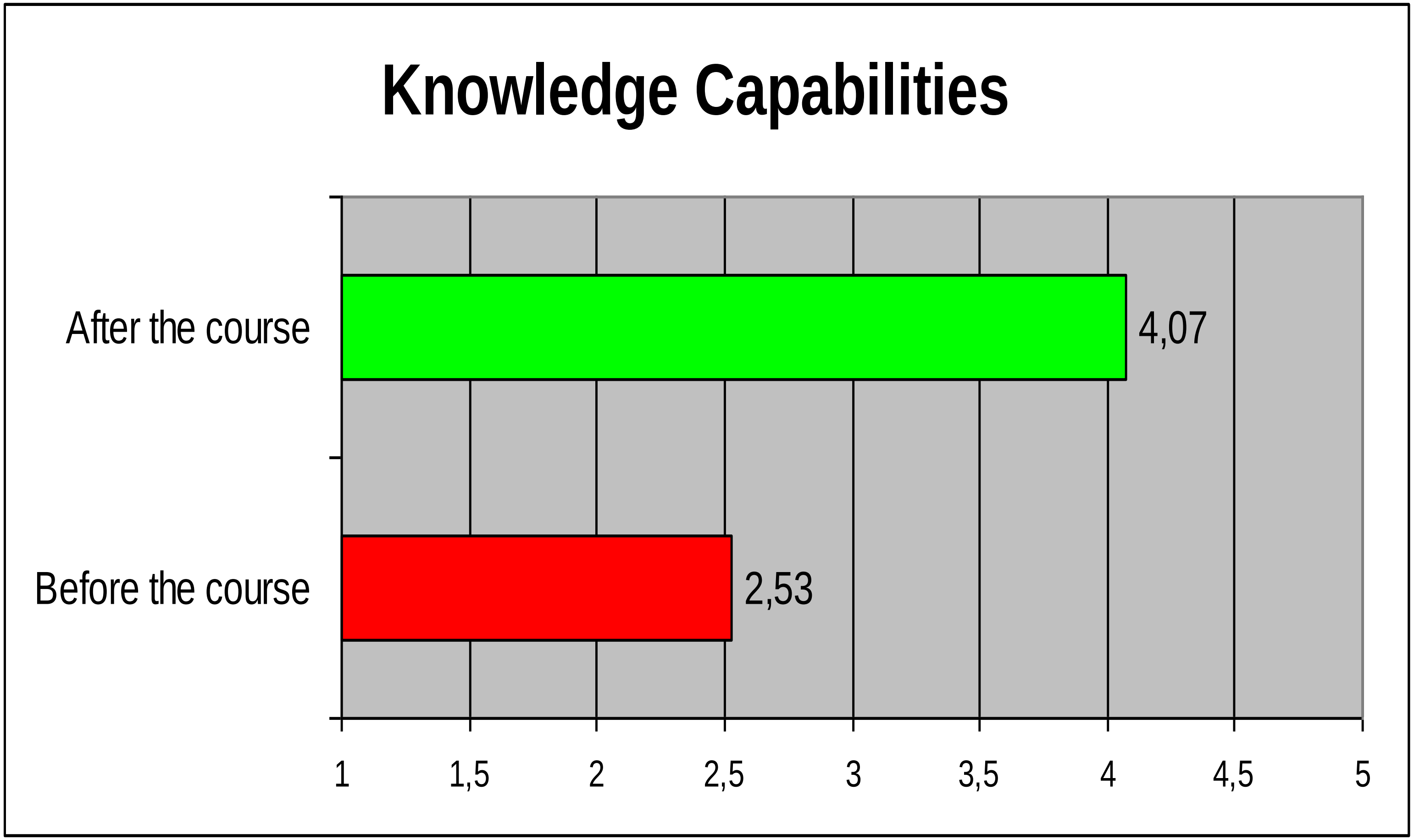
Education & Training : PGEC Modules

Module	Title	Duration (week)
I	Review of fundamentals	2
II	Quantities & Measurements	2
III	Biological effects of Ionizing Radiation	1
IV	Principles of radiation protection and Regulatory control	2
V	Assessment of external and internal exposure	2
VI	Protection against occupational exposure	4
VII	Medical exposure	1,5
VIII	Public exposure	2
IX	Accidental exposure	2
X	Training the trainers	1
XI	Project assignement	
	Global Evaluation	1,5
Total		**21**

Education & Training : PGEC Content

- 242 sessions of lectures
- 86 sessions of exercises
- 62 sessions of practical exercises
- 27 Tutorised sessions
- 41 Sessions of Examination, 1 Final Exam
- 11 Technical Visits
- 30 Sessions Project Assessment
  - 60 Lecturers : CNESTEN (70%)
    Universities (10%)
    Industrial facilities (10%),
    IAEA - France (10%)

Education & Training : PGEC



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Cancer Research

Role of H_2O_2 in *RET/PTC1* Chromosomal Rearrangement Produced by Ionizing Radiation in Human Thyroid Cells

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Abstract

During childhood, the thyroid gland is one of the most sensitive organs to the carcinogenetic effects of ionizing radiation that may lead to papillary thyroid carcinoma (PTC) associated with *RET/PTC* oncogene rearrangement. Exposure to ionizing radiation induces a transient "oxidative burst" through radiolysis of water, which can cause DNA damage and mediates part of the radiation effects. H_2O_2 is a potent DNA-damaging agent that induces DNA double-strand breaks, and consequently, chromosomal aberrations. Irradiation by 5 Gy X-ray increased extracellular H_2O_2. Therefore, we investigated the implication of H_2O_2 in the generation of *RET/PTC1* rearrangement after X-ray exposure. We developed a highly specific and sensitive nested reverse transcription-PCR method. By using the human thyroid cell line HThori-3, previously found to produce *RET/PTC1* after γ-irradiation, we showed that H_2O_2, generated during a 5 Gy X-ray irradiation, causes DNA double-strand breaks and contributes to *RET/PTC1* formation. Pretreatment of cells with catalase, a scavenger of H_2O_2, significantly decreased *RET/PTC1* rearrangement formation. Finally, *RET/PTC* chromosomal rearrangement was detected in HThori-3.1 cells after exposure of cells to H_2O_2 (25 μmol/L), at a dose that did not affect the cell viability. This study shows for the first time that H_2O_2 is able to cause *RET/PTC1* rearrangement in thyroid cells and consequently highlights that oxidative stress could be responsible for the occurrence of *RET/PTC1* rearrangement found in thyroid lesions even in the absence of radiation exposure. *Cancer Res; 70(10); OF1–10. ©2010 AACR.*

Impact factor : 7,145

Introduction

Chromosomal rearrangements involving the *RET* gene (REarranged during Transfection) are highly prevalent in papillary thyroid carcinomas (PTC) occurring after childhood exposure either to environmental radiation after the Chernobyl accident or to medical external radiation (1–4). In the normal thyroid gland, *RET* which encodes the tyrosine kinase receptor for growth factors belonging to the glial-derived neurotrophilic factor family, is expressed only in parafollicular thyroid cells. The recombination of the intracellular kinase encoding domain of the *RET* gene with a heterologous gene expressed ubiquitously generates *RET/PTC* chimeric oncogene proteins that are expressed in follicular thyroid cells. These chimeric proteins are constitutively active (1, 2). *RET/PTC1*, which is the most frequent rearrangement, is the result of the fusion of *RET* and *CCDC6* genes from a paracentric inversion of the long arm of chromosome 10 with breakpoints in q11.2 and q21 [inv(10) (q11.2q21); ref. 5]. Despite the fact that *RET* and *CCDC6* genes are 30 mb apart, their high spatial proximity in interphase nuclei in normal thyroid cells was thought to promote their recombination (6, 7).

External radiation during childhood increases the risk of thyroid tumors, either benign or malignant (1–4, 8). More than 90% of these cancers are papillary, presenting a *RET/PTC* rearrangement in 70% of cases. Several *in vitro* and *in vivo* studies have shown that exposure to ionizing radiation induces *RET/PTC* rearrangement. Thus, using a nested PCR assay, *RET/PTC1* transcripts were detected in a human undifferentiated thyroid carcinoma cell line (8505C) after exposure to 50 Gy of X-rays (9). *RET/PTC1* and *RET/PTC3* were detected in human thyroid tissues transplanted in severe combined immunodeficiency mice and submitted to X-ray irradiation (10). More recently, *RET/PTC* rearrangements were induced in immortalized human thyroid cells (HThori-3) after exposure to γ-radiation in a dose-dependent manner (11). These results strongly support the direct role of radiation exposure in *RET/PTC* generation.

Ionizing radiation exposure induces a transient "oxidative burst" through water radiolysis (12) that generates H_2O_2, and in turn, H_2O_2 could cause DNA damage and mediate part of

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Note: R. Ameziane-El-Hassani and M. Boufraqech contributed equally to this work.

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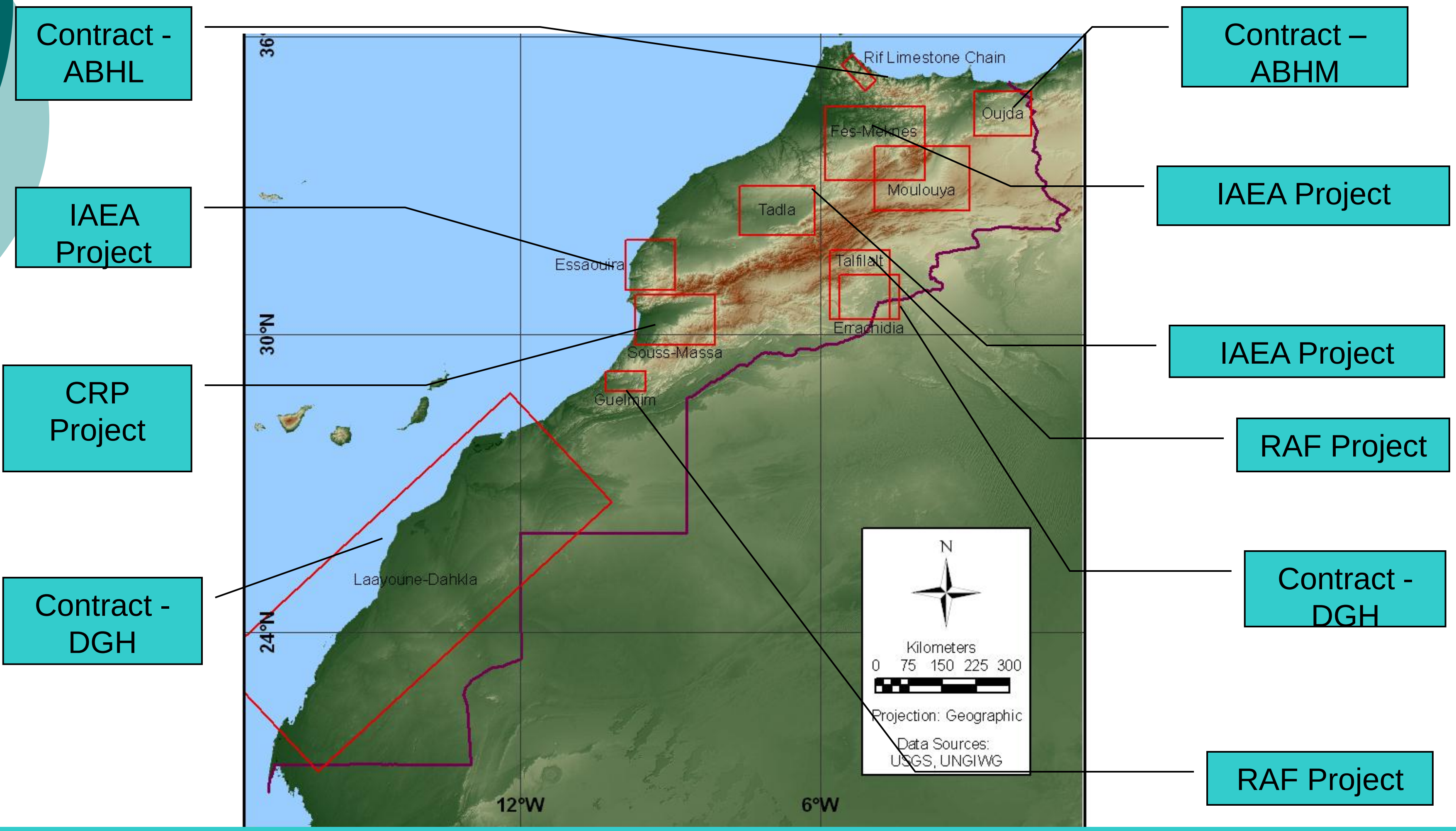
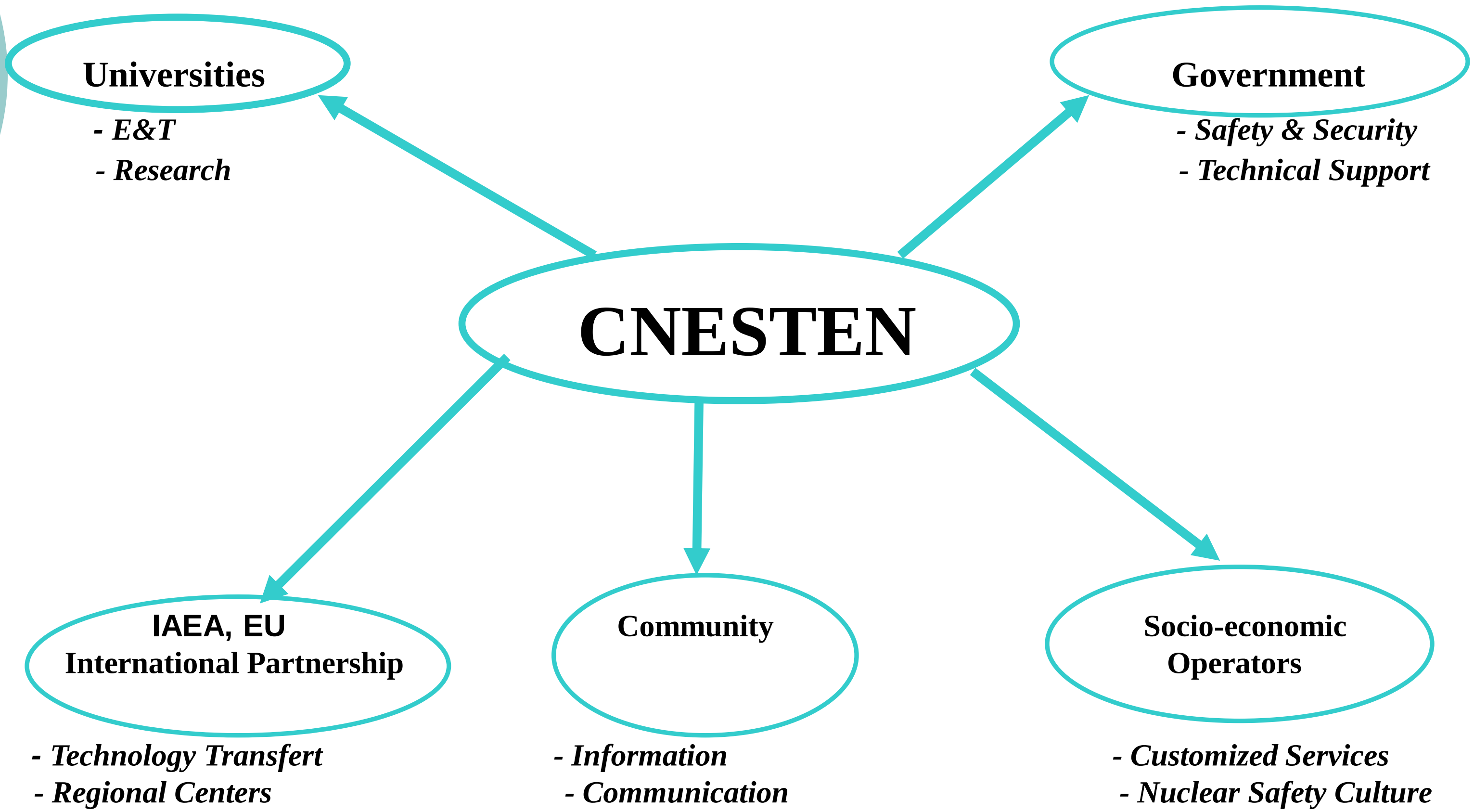
Research and study related to Isotopic Hydrology



Position in the Market Place



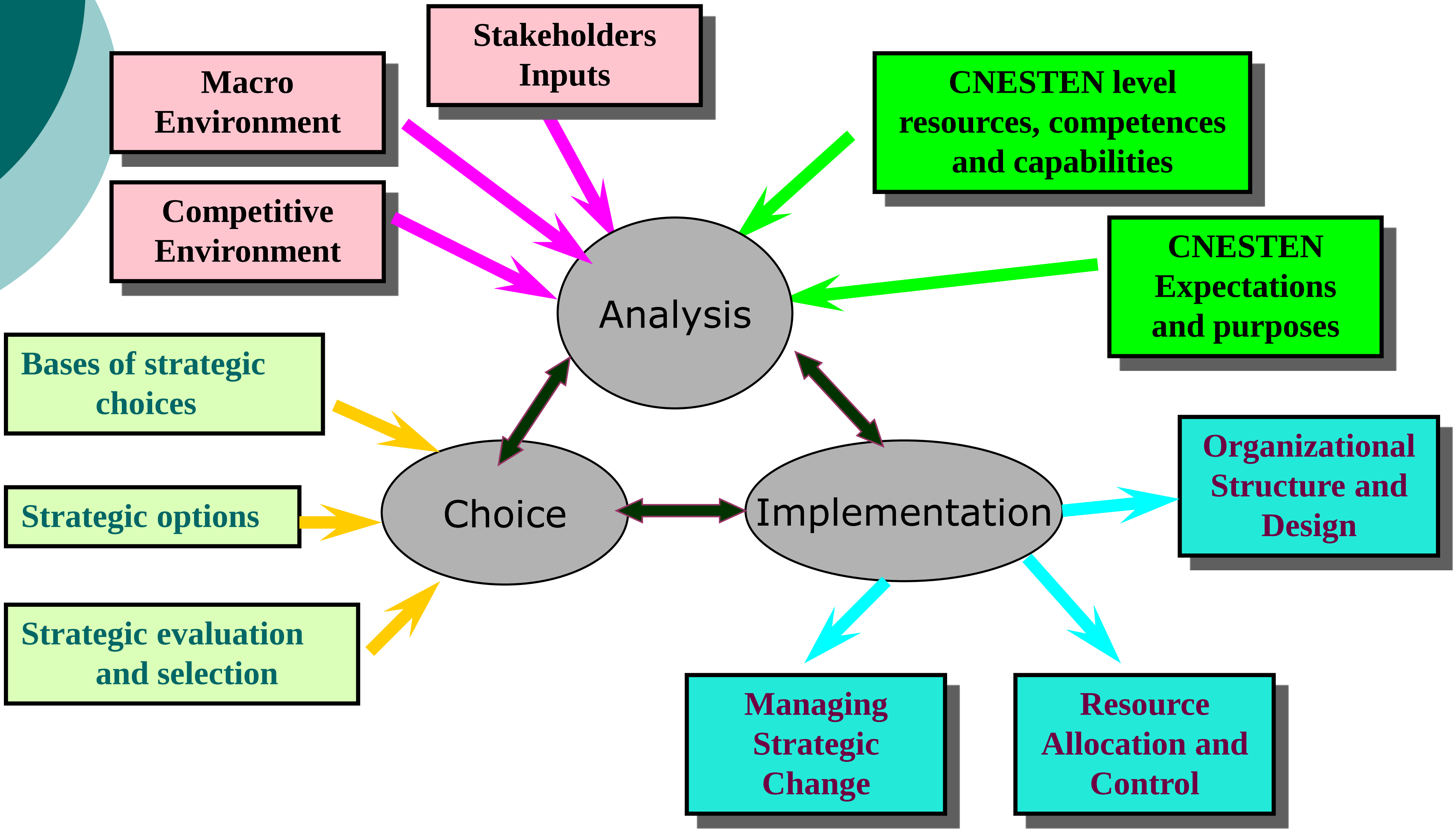
Vision of the Strategic Plan

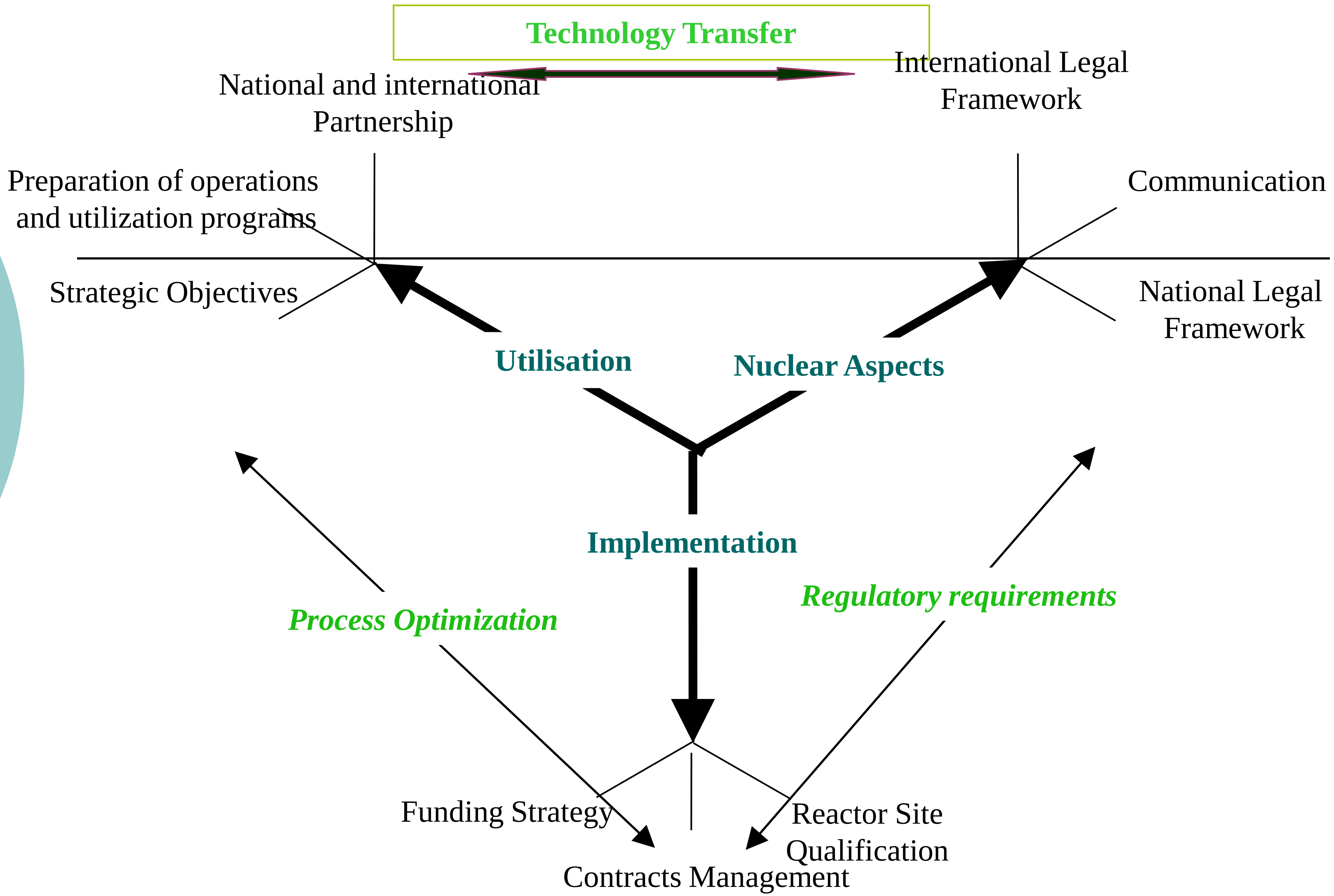
To develop and strengthen CNESTEN position in the market place by fully integrating both operational and logistical issues in being strategically led, market oriented, competitively focused, operationally efficient, revenue generating applications emphasized, and human resources driven

Main Objective

To efficiently and effectively meet existing and potential needs: research and development, education and training, and generally all related products and services, both at national and regional level, within a sustainable framework

Process of elaborating the Strategic Plan



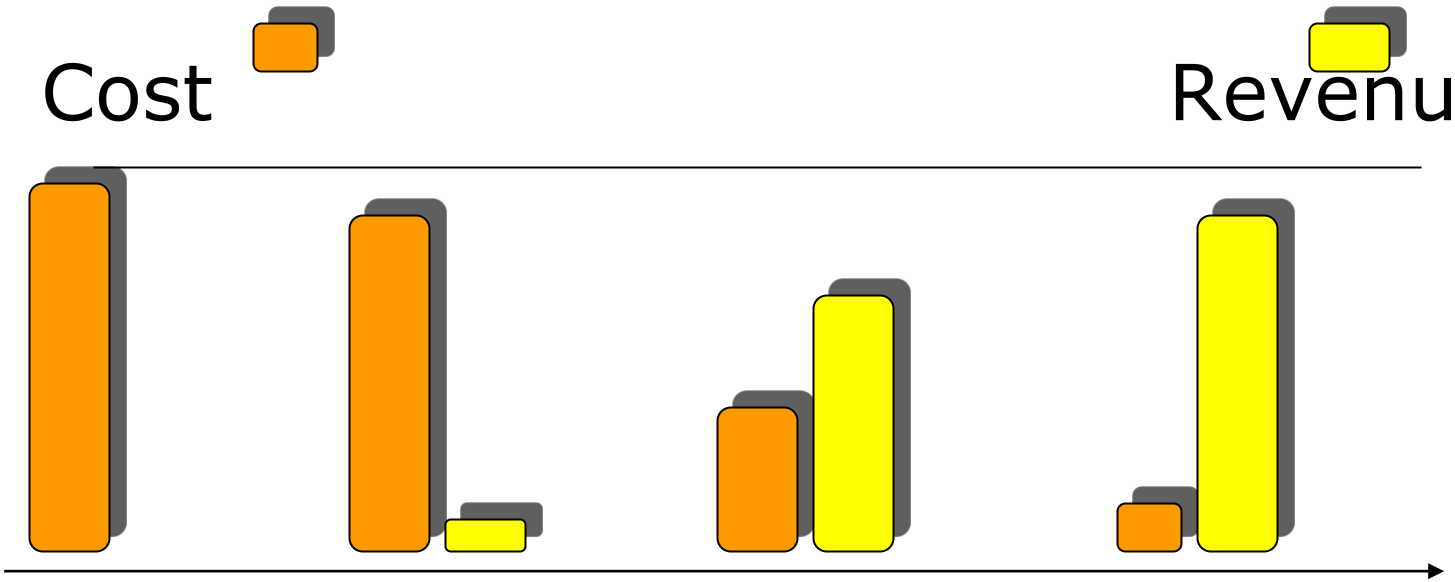

Technology Transfer
National and international Partnership
International Legal Framework
Preparation of operations and utilization programs
Communication
Strategic Objectives
National Legal Framework
Utilisation
Nuclear Aspects
Implementation
Process Optimization
Regulatory requirements
Funding Strategy
Reactor Site Qualification
Contracts Management

Projects Classification

- Objectives
  - Harmonisation, Visibility, Inter-Comparaison, Evaluation, Valorisation, etc.

- Criteria
  - Type of expected outputs/outcomes
  - Cost analysis and Fund raising

Projects Classification : Cost/Revenue



Type 1	Type 2	Type 3	Type 4
Infrastructure	R & D Public Services	Promotion Services	Commercial Services

Key segments

- **Education & Training**
- **Radio-isotope production for medical applications**
- **Neutron Activation Analysis for geochemistry, archeometry, environment**
- **Neutron Diffraction, Power Neutron Diffraction, Small Angle Neutron Scattering, for physics of condensed matter**
- **Neutro radiography**

Education & Training : Vision

- To become recognized as a Regional Nuclear Training Centre for its training competencies, state of the art of equipment and facilities, comprehensive curriculum activities, strategic location, and eagerness to meet and exceed participants and stakeholders’ expectations

Education & Training : Programs

- In House training
- Professional Education/Training for nuclear related activities
- Education/Training Program Development

In line with capacity building development for both nuclear energy and nuclear technology programs

Education & Training : EduTA

- Assessment of national needs and infrastructure
- Assessment of national strategy
- Legal framework
- Experts (60), Technicians (600), Operators (6000)

Education & Training : Business Model

Investment cost :

- Construction : Regular Budget
- Equipment : Cooperation Fund

Capacity splited into :

- E&T for universities and governmental agencies : ***regular budget & Cooperation fund***
- Promotional training, workshops,... : ***Cost sharing***
- Professional training : ***Commercial contracts***

Master Degree : BNL Model
Centers of Excellence : National and Regional levels

RI production : Key elements

- Particapting in building and developing the Market
- Sustainable growth : 25% per year
- Iodine 131 and Tc Generators (90% of the domestic market needs)
- Production of Iodine 131 expected this year through activation of TeO_2
- Production of Tc Generators by 2011 using Mo99 :

  (Phase 1 : importation) and

  (Phase 2 : neutron activation)

RI production : Key issues

- Safety issue in Te activation for producing I 131
- Technical feasability of Neutronic Activation for producing Mo 99

Conclusion

- Motivations of RR
- Greater national awarness of the importance of nuclear applications for socio-economic development
- Formation of a nuclear market which is becoming more visible at the national level
- 3 Pillars of RR Utilisation (End users, Governmt, Universities)
- Integrative business approach (E&T, RP services, Waste Management, Environmental impact studies, R&D, …)
- Cooperative relationship stronger with the international community in terms of E&T, R&D, exchange of experts, exchange of information

THANK YOU FOR YOUR ATTENTION !