
WORKSHOP ON
DESALINATION ECONOMIC EVALUATION

30 April - 4 May 2001

Miramare - Trieste, Italy

in cooperation with

The International Atomic Energy Agency (IAEA)

and

the Kuwait Foundation for the Advancement of Sciences (KFAS)

Desalination Economic Evaluation
Programme (DEEP)

Peter J. Gowin
International Atomic Energy Agency
Vienna, Austria



Desalination Economic Evaluation Programme (*DEEP*)

P.J. Gowin
International Atomic Energy Agency

International Atomic Energy Agency

- Independent Organization within the UN system
 - Safety
 - Safeguards
 - Technology
- Division of Nuclear Power: **Seawater Desalination**

History of *DEEP*

- Several studies on nuclear desalination 1964 - 1967
- Renewed interest in nuclear desalination by Member States expressed at General Conference 1989
- New studies and Technical Documents
- Development of CDEE (Cogeneration and Desalination Economic Evaluation) spreadsheet

Scope of *DEEP*

- Present version of *DEEP*
- MED, MSF and RO
- Nuclear, Gas, Coal, Diesel, Combined Cycle
- Focus on plants bigger than 50,000 m³/d
- Available as Trial Version from IAEA

License Agreement

■ DEEP is available cost-free from the Agency

- Version 2.0
- CD-ROM
- Manual

■ License Agreement

- All DEEP studies to be reported to Agency
- Use of DEEP to be acknowledged
- DEEP Modifications are property of the Agency

Nuclear Power Options in *DEEP*

- Medium sized PWR, Westinghouse (AP-600)
- Medium sized PHWR, AECL (CANDU 3)
- Small PWR, Russian KLT-40
- Nucl. gas turbine reactor, General Atomics (GT-MHR)
- Nuclear heat only reactor, Chinese HR-200

Fossil Power Options in *DEEP*

- Superheated steam boiler for coal, cogeneration
- SSB for oil or gas, cogeneration
- Open cycle gas turbine, cogeneration
- Combined cycle gas turbine, cogeneration
- Diesel, power plant
- Boiler (steam or hot water), heat-only plant

2001

IAEA

7

Desalination Options in *DEEP*

- Multi-effect distillation
- Multi-stage flash
- Reverse osmosis (spiral wound)
- Reverse osmosis (hollow fibre)
- All hybrid combinations of the above

2001

IAEA

8

Calculation Routine of *DEEP*

- Input of capacity etc., input of technical parameters or default
- Power plant performance
- Power plant modification: heat extraction
- Desalination plant performance
- Power and desalination plant cost
- Economic evaluation: water and power cost
- Graphic output

2001

IAEA

9

Cost Allocation

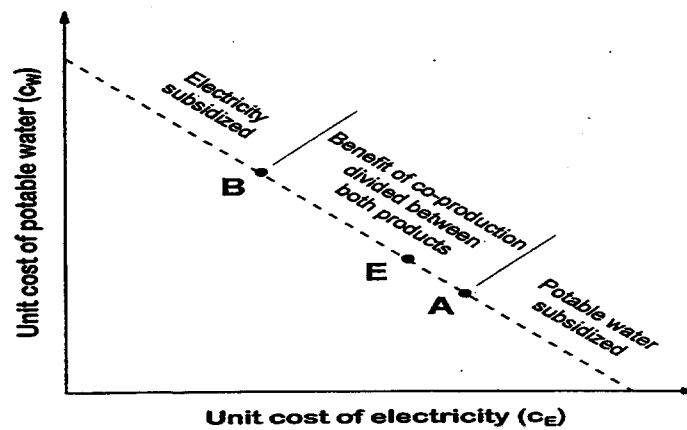
- Known:
 - Total Plant Investment to a certain extent assigned to each plant
 - Water production
 - Power production
- To be determined:
 - Water cost
 - Power cost

2001

IAEA

10

Cost allocation methods



2001

IAEA

11

Cost Allocation Methods

Prorating Methods

Allocation according to given criteria

- Proportional Method
 - two single purpose plants
- Exergy Method
 - IAEA development
- Energy Method
- Other criteria

Credit Methods

One assumed, other obtained

- Power Credit Method
 - DEEP
- Water Credit Method
- Market Bases Methods

2001

IAEA

12

Power Credit Method

- Used in **DEEP**
- The electricity cost is set to be the cost obtained from a single purpose power plant
- This is a high cost, because the additional benefit of co-production goes entirely to the water plant
- Result: lowest possible water costs
- In the graph: point A

2001

IAEA

13

Power Credit Method and **DEEP**

- **DEEP**
water cost is obtained by charging to water all water plant investments plus [lost electricity times electricity price (as for single purpose plant, known in DEEP)] and divide by water production
- According to graph
water cost is obtained by deducing from the total investment [electricity production times electricity price (as for single purpose plant, known in DEEP)] and divide by water production. Straightforward as explained for the PCM: determine electricity cost and obtain water cost by deducing from total).

2001

IAEA

14

Purpose and Validation of *DEEP*

Validated by international experts in April 1998:
DEEP is to be used for

- *"side by side comparisons of a large number of plant alternatives on a consistent basis"*
- *quick identification of lowest cost options for given requirements (capacity, site, economic assumptions)*
- *approximate cost of desalinated water as a function of input parameters (capacity, site, economic assumptions)"*

User-Friendliness of *DEEP*

(1 OF 4)

- Project April 98 - mid 1999
- Objectives Achieved
- Sheets, Formatting and Layout
 - new structure for easy operation
 - including explanations
 - pointing the user to important values

User-Friendliness of *DEEP*

(2 OF 4)

- Database System for the cases
 - DEEP comes with a “reference casebase” (12 cases)
 - user performs calculations and stores the thus created new “case” in a “casebase”
- “Summary Report” and “Full Report” will be created for each case
 - formatted reports suitable for printout

User-Friendliness of *DEEP*

(3 OF 4)

- “Comparative Presentation” for five selected cases
 - formatted for presentation
 - automatic comparisons
 - graphics output
- compensates for the lost comparative aspect in the casebase system

User-Friendliness of *DEEP*

(4 OF 4)

■ “Open System”

- creation of new cases for new technologies, such as vertical MED
- review by the Agency (CT, AGM), or as part of the peer review system
- if new case is approved, incorporation in the IAEA reference casebase

2001

IAEA

19

Studies using *DEEP*

(1 OF 2)

- Used in several independent international studies
- All Studies are collected and made available to every user
- Working Material Series

2001

IAEA

20

Co-ordinated Research Project 1 (1 of 2)

■ “Optimisation of the Coupling of Nuclear Reactors with Desalination Systems”

- Nuclear reactor designs
- Optimization of thermal coupling of NSSS
- Performance improvement of desalination systems
- Advance desalination technologies

■ Objective

- Increase the competitiveness by technological optimisation

2001

IAEA

21

Co-ordinated Research Project 2

■ “Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies”

- to start in 2001 for 5 years
- application of DEEP and other tools
- case studies

■ Objective

- deepen the understanding of the economics of nuclear desalination
- complement the generic TecDoc on Economics

2001

IAEA

22