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International Atomic Energy Agency

Atoms for Peace and Development

IAEA Role, Tools & Activities on Non-Electric Applications and Cogeneration Using Nuclear Energy

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Contents

- ❑ IAEA and its Role
- ❑ IAEA Meetings & Activities (2017-2018)
- ❑ Tools & Toolkits
- ❑ Recent & Upcoming Publications
- ❑ Questions & Discussion!

Activities of IAEA Project on Non-Electric Applications

IAEA Project on Non-Electric Applications

Events

Technical Meetings
Research Coordination Meetings
Training Workshops
Consultants Meetings
Conferences

Tools & Toolkits

HEEP
DEEP
DE-TOP
WAMP
Hydrogen Toolkit
Desalination Toolkit

Publications

Technical Documents
Nuclear Energy Series Documents
Meeting Reports
Peer-Reviewed Journal Publications
Conference Papers



IAEA

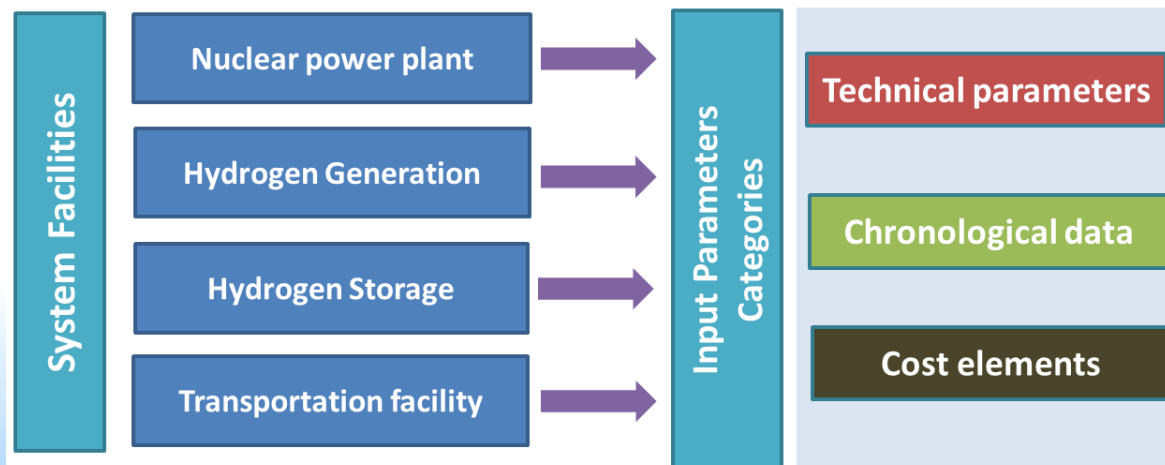
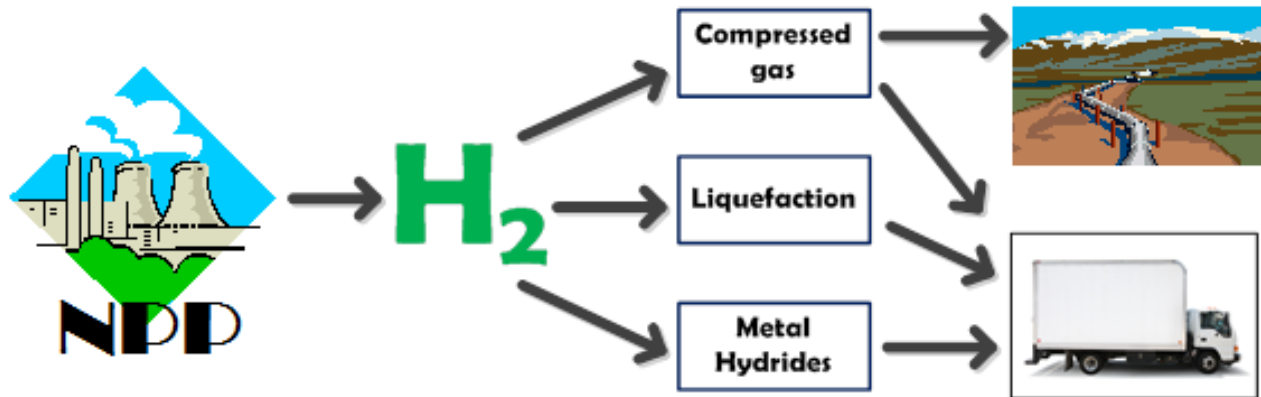
International Atomic Energy Agency

Atoms for Peace and Development

IAEA Tools & Toolkits

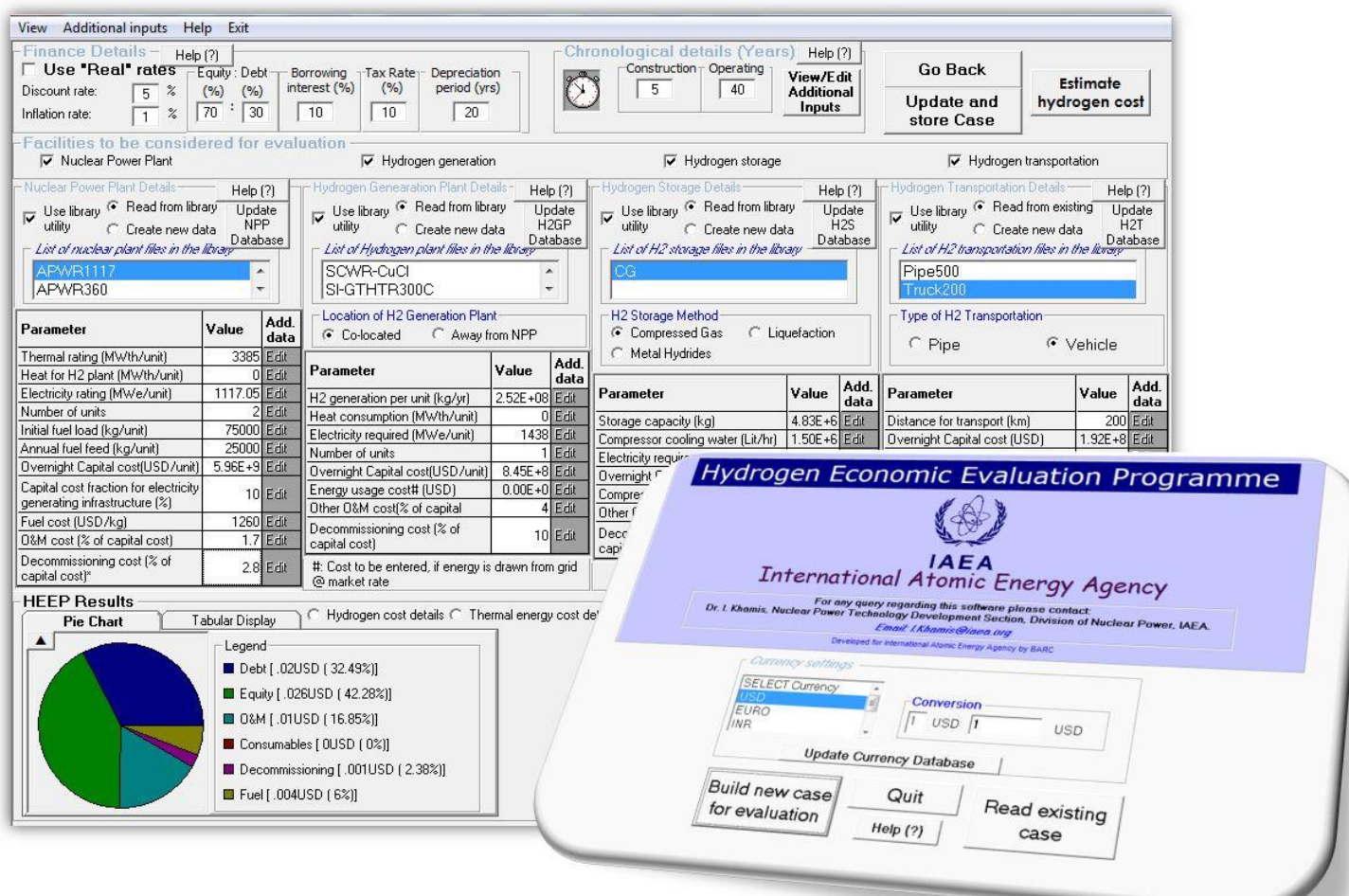
IAEA Tool on Nuclear Hydrogen Production

HEEP Hydrogen Economic Evaluation Programme



HEEP

Evaluates the economics of the most promising processes for hydrogen production



The screenshot displays the HEEP (Hydrogen Economic Evaluation Programme) software interface. The main window is divided into several sections for inputting data and viewing results.

Finance Details: Includes fields for Discount rate (5%), Inflation rate (1%), Equity (70%), Debt (30%), Borrowing interest (10%), Tax Rate (10%), and Depreciation period (20 years).

Chronological details (Years): Includes Construction (5 years) and Operating (40 years) periods.

Facilities to be considered for evaluation: Checkboxes for Nuclear Power Plant, Hydrogen generation, Hydrogen storage, and Hydrogen transportation.

Plant Details:

- Nuclear Power Plant Details:** Lists nuclear plant files (e.g., APWR1117, APWR360).
- Hydrogen Generation Plant Details:** Lists hydrogen plant files (e.g., SCWR-CuCl, SI-GTHTR300C).
- Hydrogen Storage Details:** Lists storage files (e.g., CG) and H2 storage methods (Compressed Gas, Liquefaction, Metal Hydrides).
- Hydrogen Transportation Details:** Lists transportation files (e.g., Pipe500, Truck200) and types of H2 transportation (Pipe, Vehicle).

Parameter Tables:

Parameter	Value	Add. data
Thermal rating (MWth/unit)	3385	Edit
Heat for H2 plant (MWth/unit)	0	Edit
Electricity rating (MWth/unit)	1117.05	Edit
Number of units	2	Edit
Initial fuel load (kg/unit)	75000	Edit
Annual fuel feed (kg/unit)	25000	Edit
Overnight Capital cost (USD/unit)	5.96E+9	Edit
Capital cost fraction for electricity generating infrastructure (%)	10	Edit
Fuel cost (USD/kg)	1260	Edit
O&M cost (% of capital cost)	1.7	Edit
Decommissioning cost (% of capital cost)*	2.8	Edit

Parameter	Value	Add. data
H2 generation per unit (kg/yr)	2.52E+08	Edit
Heat consumption (MWth/unit)	0	Edit
Electricity required (MWth/unit)	1438	Edit
Number of units	1	Edit
Overnight Capital cost (USD/unit)	8.45E+8	Edit
Energy usage cost (USD)	0.00E+0	Edit
Other O&M cost (% of capital)	4	Edit
Decommissioning cost (% of capital cost)	10	Edit

Parameter	Value	Add. data
Storage capacity (kg)	4.83E+6	Edit
Compressor cooling water (Lit/hr)	1.50E+6	Edit
Electricity required		
Overnight Capital cost		
Compressor		
Other		
Decommissioning		

Parameter	Value	Add. data
Distance for transport (km)	200	Edit
Overnight Capital cost (USD)	1.92E+8	Edit

HEEP Results: Includes a Pie Chart and Tabular Display. The Pie Chart shows the breakdown of costs:

- Debt [.02USD (32.43%)]
- Equity [.026USD (42.28%)]
- O&M [.01USD (16.85%)]
- Consumables [0USD (0%)]
- Decommissioning [.001USD (2.38%)]
- Fuel [.004USD (6%)]

Hydrogen Economic Evaluation Programme
IAEA International Atomic Energy Agency
 For any query regarding this software please contact:
 Dr. I. Khamis, Nuclear Power Technology Development Section, Division of Nuclear Power, IAEA.
 Email: I.Khamis@iaea.org
 Developed for International Atomic Energy Agency by BARC

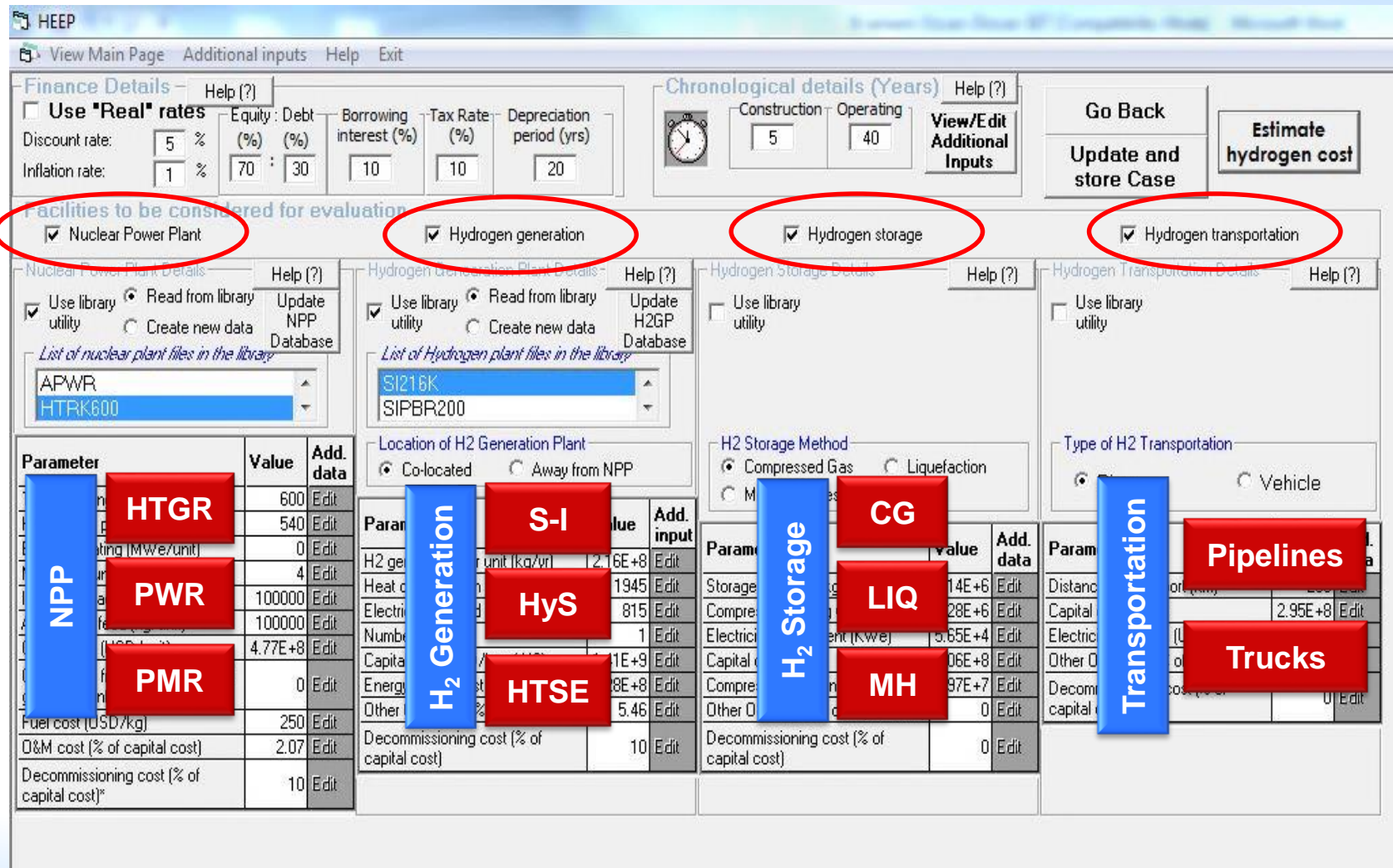
Currency settings:

- SELECT Currency: USD, EURO, INR
- Conversion: 1 USD = 1 USD
- Update Currency Database

Buttons: Build new case for evaluation, Quit, Read existing case, Help (?)

Hydrogen Economic Evaluation Programme

HEEP Features



HEEP

View Main Page Additional inputs Help Exit

Finance Details Help (?)

☐ Use "Real" rates

Discount rate: 5 % Equity: Debt: Borrowing interest (%): Tax Rate: Depreciation period (yrs):

Inflation rate: 1 % 70 : 30 10 10 20

Chronological details (Years) Help (?)

Construction: 5 Operating: 40

View/Edit Additional Inputs

Go Back Update and store Case Estimate hydrogen cost

Facilities to be considered for evaluation

☒ Nuclear Power Plant ☒ Hydrogen generation ☒ Hydrogen storage ☒ Hydrogen transportation

Nuclear Power Plant Details Help (?)

☒ Use library utility ☐ Read from library ☐ Create new data Update NPP Database

List of nuclear plant files in the library

APWR HTRK600

Hydrogen Generation Plant Details Help (?)

☒ Use library utility ☐ Read from library ☐ Create new data Update H2GP Database

List of Hydrogen plant files in the library

SI216K SIPBR200

Location of H2 Generation Plant

☒ Co-located ☐ Away from NPP

Hydrogen Storage Details Help (?)

☐ Use library utility

H2 Storage Method

☒ Compressed Gas ☐ Liquefaction

Hydrogen Transportation Details Help (?)

☐ Use library utility

Type of H2 Transportation

☒ Vehicle ☐ Pipelines

NPP

Parameter	Value	Add. data
HTGR	600	Edit
PWR	540	Edit
PMR	0	Edit
Heat rate (MWe/unit)	4	Edit
Electricity production (MWe/unit)	100000	Edit
Capital cost (USD/kW)	100000	Edit
Decommissioning cost (% of capital cost)*	4.77E+8	Edit
Fuel cost (USD/kg)	0	Edit
O&M cost (% of capital cost)	2.07	Edit
Decommissioning cost (% of capital cost)*	10	Edit

H₂ Generation

Parameter	Value	Add. input
S-I	2.16E+8	Edit
HyS	1945	Edit
HTSE	815	Edit
H2 generation unit (kg/vr)	1	Edit
Heat rate (MWe/unit)	1E+9	Edit
Electricity production (MWe/unit)	8E+8	Edit
Capital cost (USD/kW)	5.46	Edit
Decommissioning cost (% of capital cost)	10	Edit

H₂ Storage

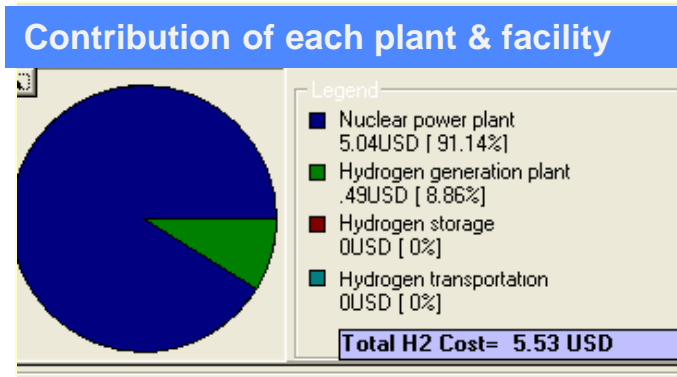
Parameter	Value	Add. data
CG	14E+6	Edit
LIQ	28E+6	Edit
MH	5.65E+4	Edit
Storage capacity (kg)	06E+8	Edit
Electricity production (MWe/unit)	97E+7	Edit
Capital cost (USD/kW)	0	Edit
Decommissioning cost (% of capital cost)	0	Edit

Transportation

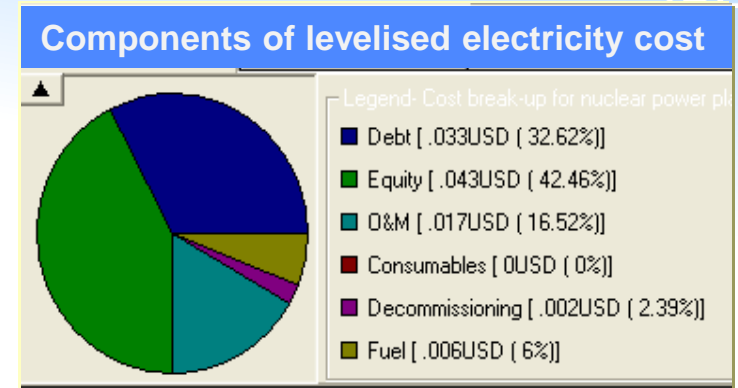
Parameter	Value	Add. data
Pipelines	2.95E+8	Edit
Trucks	0	Edit
Distance (km)	0	Edit
Capital cost (USD/kW)	0	Edit
Electricity production (MWe/unit)	0	Edit
Decommissioning cost (% of capital cost)	0	Edit

A captured image from main page of HEEP software

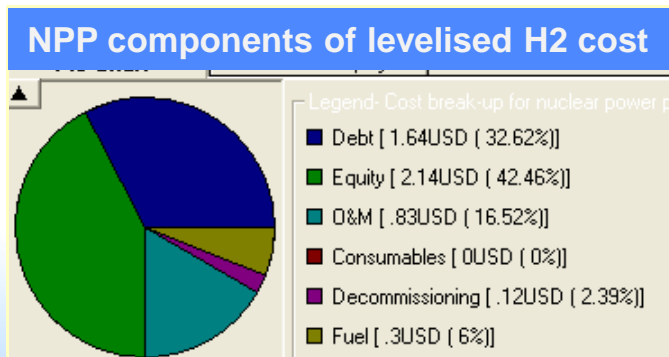
HEEP Results



Directly give contribution of each plant & facilities in total H2 cost.



Provides levelised cost of unit energy in the form of heat and/or electricity as an output.



Models the location of H2 generation plant with respect to the nuclear power plant and facilitate

Facilitates the study of effect of source of electricity/heat energy on the cost of hydrogen generation.

Hydrogen Economic Evaluation Programme

International Atomic Energy Agency

For any query regarding this software please contact:
Dr. I. Khamis, Nuclear Power Technology Development Section, Division of Nuclear Power, IAEA. (i.khamis@iaea.org)
Developed for International Atomic Energy Agency by BAKC

Table - 1: Finance details (using 'Nominal' rates)

Discount rate	5%
Inflation rate	1
Equity/Debt	70% : 30%
Borrowing interest	10%
Tax rate	10%

Table - 2: Time Period (years)

Construction	5
Operation	40

Table - 3: Nuclear Power Plant Details

Thermal rating (MWth/unit)	600
Heat for H2 plant (MWth/unit)	170
Electricity rating (MWe/unit)	203.99
Number of units	1
Initial fuel load (kg/unit)	7090
Annual fuel feed (kg/unit)	1773
Overnight Capital cost(USD/unit)	5.50E+8
Capital cost fraction for electricity generating infrastructure (%)	21
Fuel cost (USD/kg)	12962
O&M cost (% of capital cost)	3.98
Decommissioning cost (% of capital cost)*	0.52

Table - 4: Hydrogen Generation Plant Details

H2 generation per unit (kg/yr)	2.17E+07
Heat consumption (MWth/unit)	170
Electricity required (MWe/unit)	25.4
Number of units	1
Overnight Capital cost(USD/unit)	1.43E+8
Energy usage cost# (USD)	0.00E+0
Other O&M cost(% of capital cost)	4.26
Decommissioning cost (% of capital cost)	0

Table - 5: Hydrogen Storage Details

Storage capacity (kg)	4.16E+5
Compressor cooling water (Lit/hr)	5.18E+5
Electricity requirement (KWe)	5.67E+3
Overnight Capital cost (USD)	6.47E+7
Compressor operating cost (USD)	9.08E+3
Other O&M cost (% of capital cost)	0
Decommissioning cost (% of capital cost)	0

Table - 6: Hydrogen Transportation Details

Distance for transport (km)	500
Overnight Capital cost (USD)	2.39E+8
Electricity charges (USD)	0.00E+0
Other O&M cost (% of capital cost)	1
Decommissioning cost (% of capital cost)	1

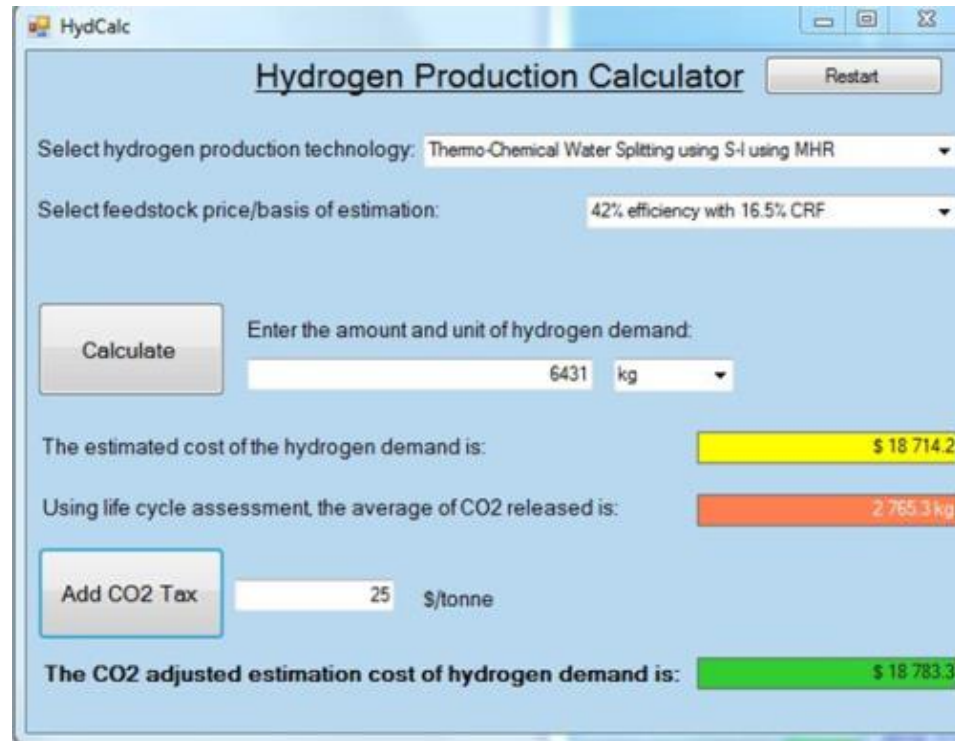
HYDCALC Hydrogen Calculator

HydCalc is a single window calculator to make rough estimate of the hydrogen production cost utilizing different technologies.

HydCalc provides cost value of hydrogen based on average estimated CO_2 release.

HydCalc also considers the effect of CO_2 tax on the production cost.

HydCalc uses current price estimate from publications and articles in open literature.

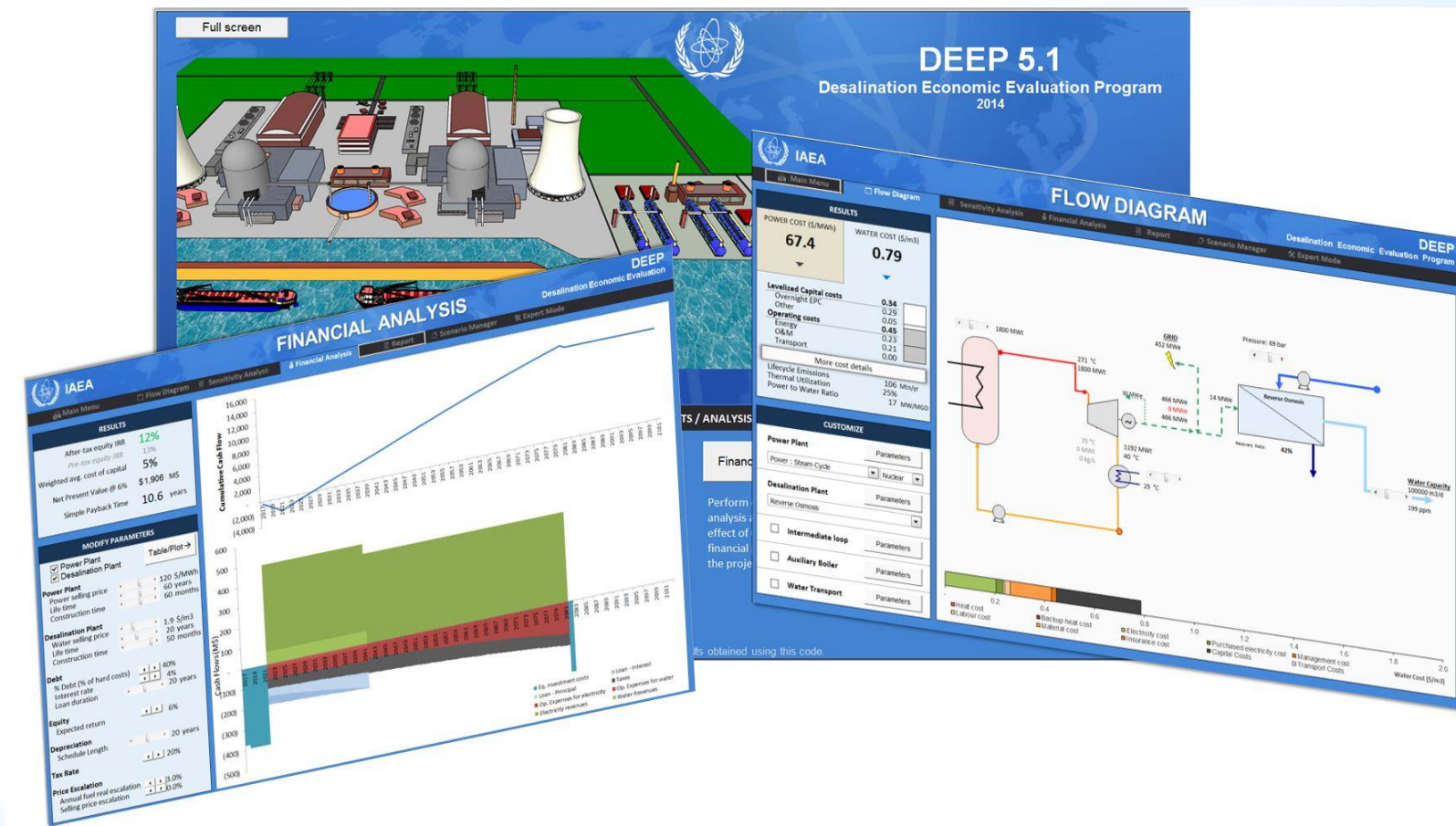


The screenshot shows the HydCalc Hydrogen Production Calculator interface. It includes a 'Restart' button in the top right. The 'Select hydrogen production technology' dropdown is set to 'Thermo-Chemical Water Splitting using S-I using MHR'. The 'Select feedstock price/basis of estimation' dropdown is set to '42% efficiency with 16.5% CRF'. A 'Calculate' button is on the left. The 'Enter the amount and unit of hydrogen demand' section shows '6431 kg'. The results section displays: 'The estimated cost of the hydrogen demand is: \$ 18 714.2' (yellow bar), 'Using life cycle assessment, the average of CO2 released is: 2 765.3 kg' (orange bar), 'Add CO2 Tax' (button) with a value of '25 \$/tonne', and 'The CO2 adjusted estimation cost of hydrogen demand is: \$ 18 783.3' (green bar).

Parameter	Value
Hydrogen Production Technology	Thermo-Chemical Water Splitting using S-I using MHR
Feedstock Price/Basis of Estimation	42% efficiency with 16.5% CRF
Hydrogen Demand (Amount and Unit)	6431 kg
Estimated Cost of Hydrogen Demand	\$ 18 714.2
Average of CO2 Released (Using life cycle assessment)	2 765.3 kg
CO2 Tax	25 \$/tonne
CO2 Adjusted Estimation Cost of Hydrogen Demand	\$ 18 783.3

DEEP

performance and cost evaluation
of various power and seawater
desalination cogeneration configurations.



Desalination Economic Evaluation Programme

NPP with NF-MED steam at 92 C and 20 effects with GOR 16 using hot water transformer.

RESULTS

POWER COST (\$/MWh)	WATER COST (\$/m3)
94	1.32
Levelized Capital 72.66	
Overnight EPC	57.39
Other	15.27
Operating costs 21.38	
Fuel	12.58
O&M	8.80
More cost details	
Lifecycle Emissions	2 Mtd/yr
Thermal Utilization	51%
Power to Water Ratio	1 MW/MGD

CUSTOMIZE

Power Plant

Power: Steam Cycle

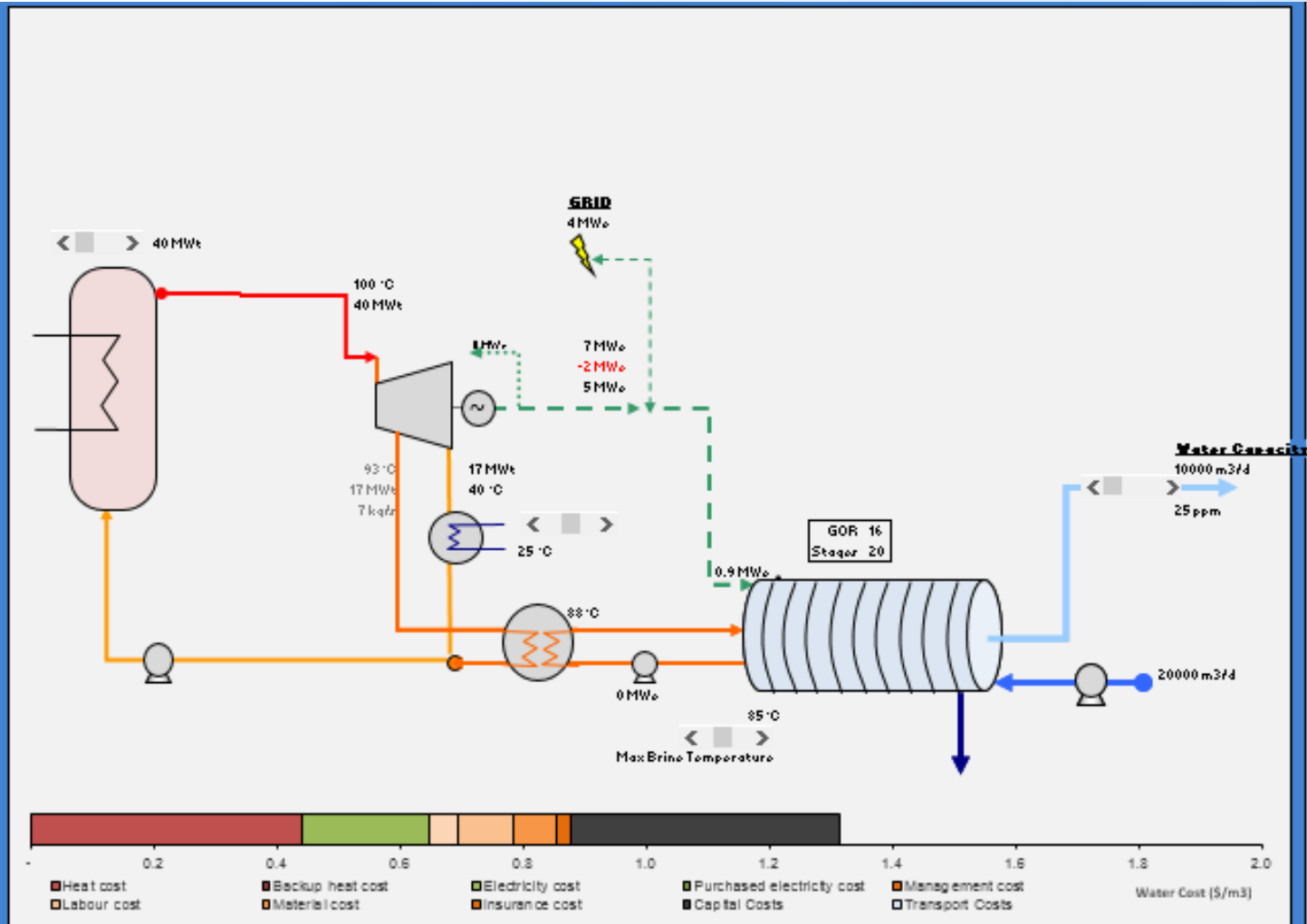
Desalination Plant

Multi Effect Distillation

☒ **Intermediate loop**

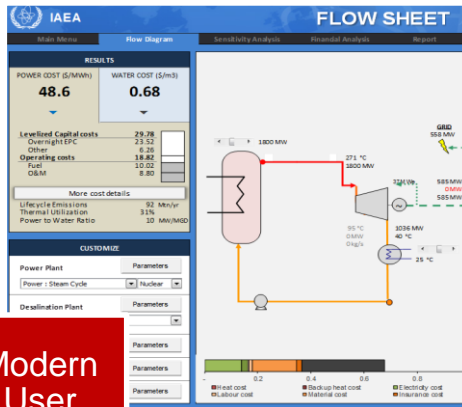
☐ **Auxiliary Boiler**

☐ **Water Transport**

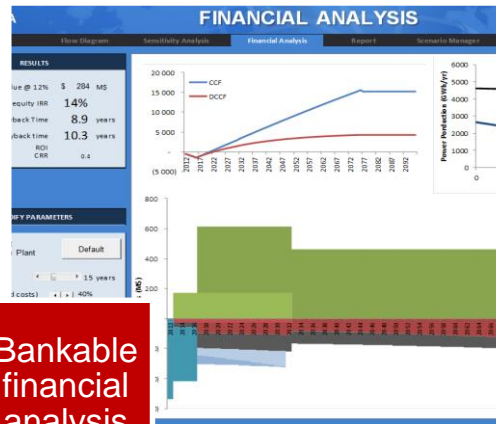


IAEA Tool on Nuclear Desalination

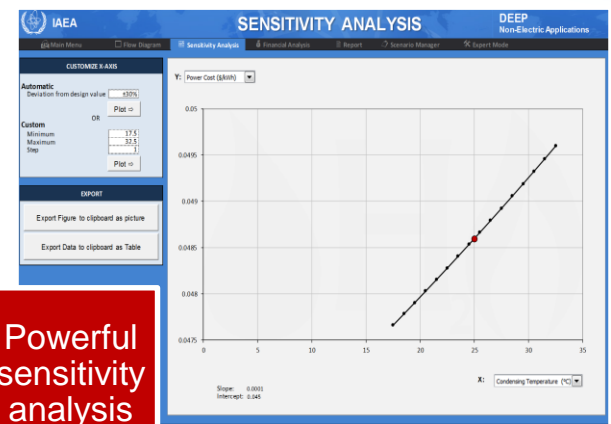
DEEP Desalination Economic Evaluation Programme



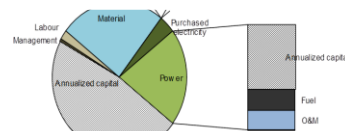
Modern User Interface



Bankable financial analysis



Powerful sensitivity analysis



Detailed Reports

Costs of Desalination Plant					
	MSF	RO	Total (MS)	Specific (\$/m³ d)	Share
Ion Cost	247	247	-	1.177	30%
Site loop cost	-	-	-	-	0%
Heat Source	-	-	-	-	0%
Cell costs	-	16	16	77	5%
Initial on-line cost	-	12	12	59	4%
Initial contingency cost	-	26	26	124	8%
During Construction	-	7	7	34	2%
Capital Costs	293	309	1470		
Annual Cap Costs				0.31	

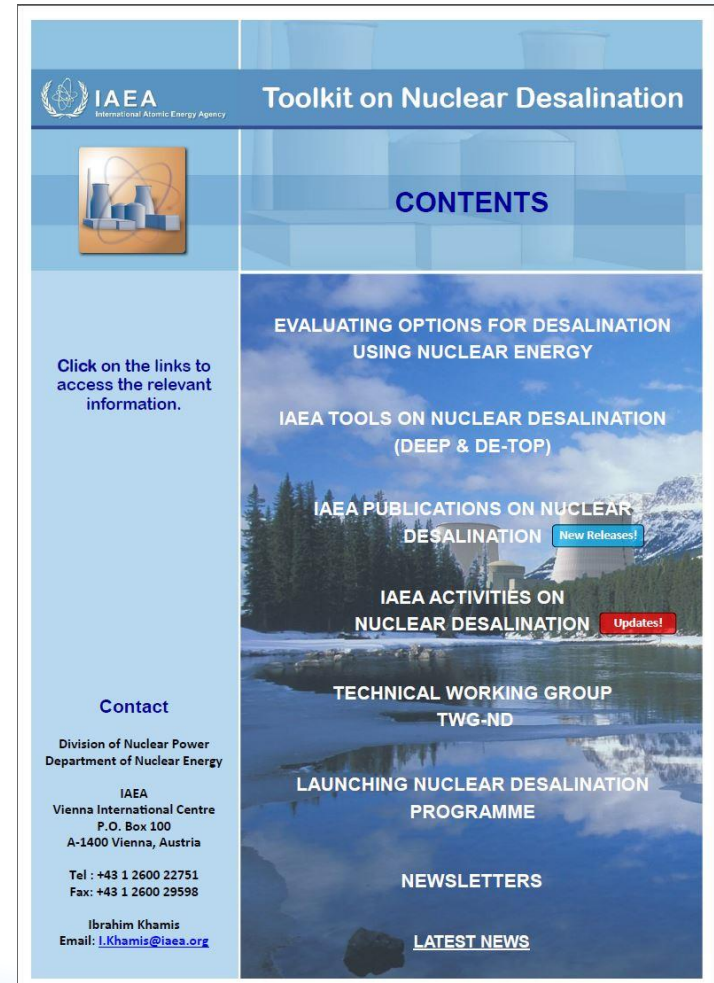


Versatile scenario Manager

IAEA TOOLKIT

Nuclear Desalination

- Up-to-date information
- Link to IAEA tools
- Highlights of IAEA Publications
- News on IAEA Activities
- Summaries of the TWG-ND
- Newsletter on nuclear desalination



The screenshot displays the IAEA Toolkit on Nuclear Desalination website. The header features the IAEA logo and the title 'Toolkit on Nuclear Desalination'. Below the header, there is a 'CONTENTS' section with a grid of links. The links include 'EVALUATING OPTIONS FOR DESALINATION USING NUCLEAR ENERGY', 'IAEA TOOLS ON NUCLEAR DESALINATION (DEEP & DE-TOP)', 'IAEA PUBLICATIONS ON NUCLEAR DESALINATION' (with a 'New Releases!' button), 'IAEA ACTIVITIES ON NUCLEAR DESALINATION' (with an 'Updates!' button), 'TECHNICAL WORKING GROUP TWG-ND', 'LAUNCHING NUCLEAR DESALINATION PROGRAMME', 'NEWSLETTERS', and 'LATEST NEWS'. On the left side, there is a sidebar with a 'Contact' section providing the IAEA Division of Nuclear Power, Department of Nuclear Energy, Vienna International Centre, P.O. Box 100, A-1400 Vienna, Austria, along with telephone, fax, and email contact information for Ibrahim Khamis.

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Toolkit on Nuclear Desalination

Click on the links to access the relevant information.

CONTACT

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EVALUATING OPTIONS FOR DESALINATION
USING NUCLEAR ENERGY

IAEA TOOLS ON NUCLEAR DESALINATION
(DEEP & DE-TOP)

IAEA PUBLICATIONS ON NUCLEAR
DESALINATION **New Releases!**

IAEA ACTIVITIES ON
NUCLEAR DESALINATION **Updates!**

TECHNICAL WORKING GROUP
TWG-ND

LAUNCHING NUCLEAR DESALINATION
PROGRAMME

NEWSLETTERS

LATEST NEWS

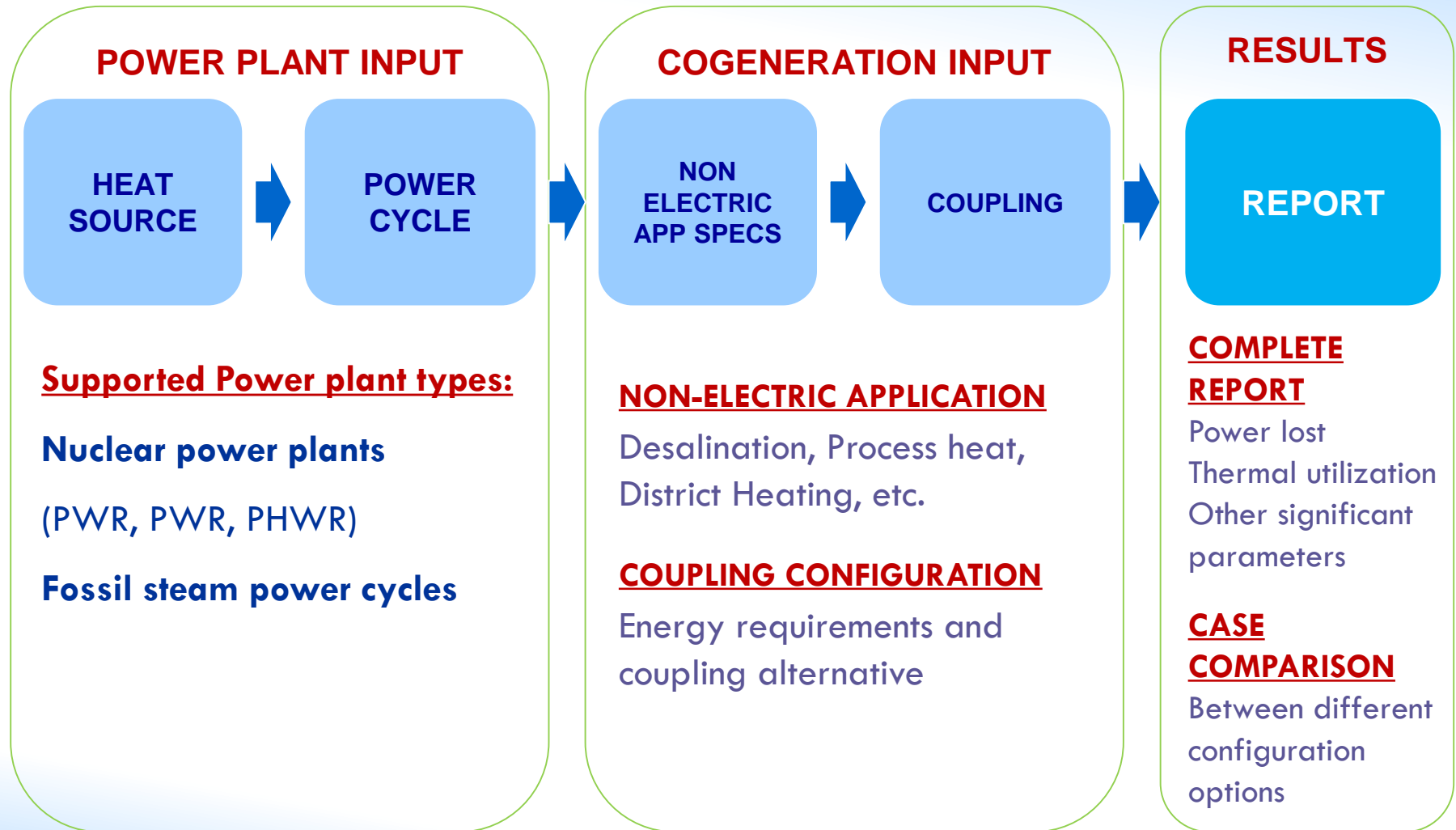
DE-TOP

models the steam power cycle of different WCRs coupled with nonelectrical applications



Desalination Thermodynamic Optimization

DE-TOP Structure



Inputs for the NPP

Main-Input Parameters

Advanced-Input Parameters

Power Plant Description

Select new case or a predefined case from the list below. Predefined cases can be customized by the user.

Select case: Nuclear Power Plant PWR (1600 MWe)

Main Parameters | Advanced Parameters

Steam Generator

Thermal Input [MW(th)] 4590

Live steam pressure [bar] 76.6 ☐ Saturated ☐ Superheated

Live steam temperature [°C] 293 T sat = 292 °C

Reheat

Reheat Type: Moisture separator and reheater (Nuclear power plant)

Pressure (HP Turbine exhaust) [bar] 11.17

Temperature [°C] 280

Feedwater line

Final Feedwater temperature [°C] P sat = 28 bar 230

Number feedwater preheaters (including deaerator) 7

Deaerator position in the feedwater line 5

Main cooling condenser

Condensing steam pressure [bar] 0.05 Calculate

Cancel Apply

Power Plant Description

Select new case or a predefined case from the list below. Predefined cases can be customized by the user.

Select case: Nuclear Power Plant PWR (1000 Mwe)

Main Parameters | Advanced Parameters

Component efficiencies

Steam Generator Efficiency [%] 1 Generator Efficiency [%] 0.98

HP turbine Efficiency [%] 0.85 Pump efficiency [%] 0.85

LP/IP turbine efficiency [%] 0.83

Power plant Auxiliary loads [%] 0.05

Feedwater Preheating Line (Pressures of steam extractions to preheaters)

Preheater 1 [bar]	0.46	Preheater 5 [bar]	11.31
Preheater 2 [bar]	1.12	Preheater 6 [bar]	29.16
Preheater 3 [bar]	1.88	Preheater 7 [bar]	0
Preheater 4 [bar]	4.79	Preheater 8 [bar]	0

[View complete model](#)

Cancel Apply 17

Plant Simulation Pickering CANDU-6 NPP

Next step

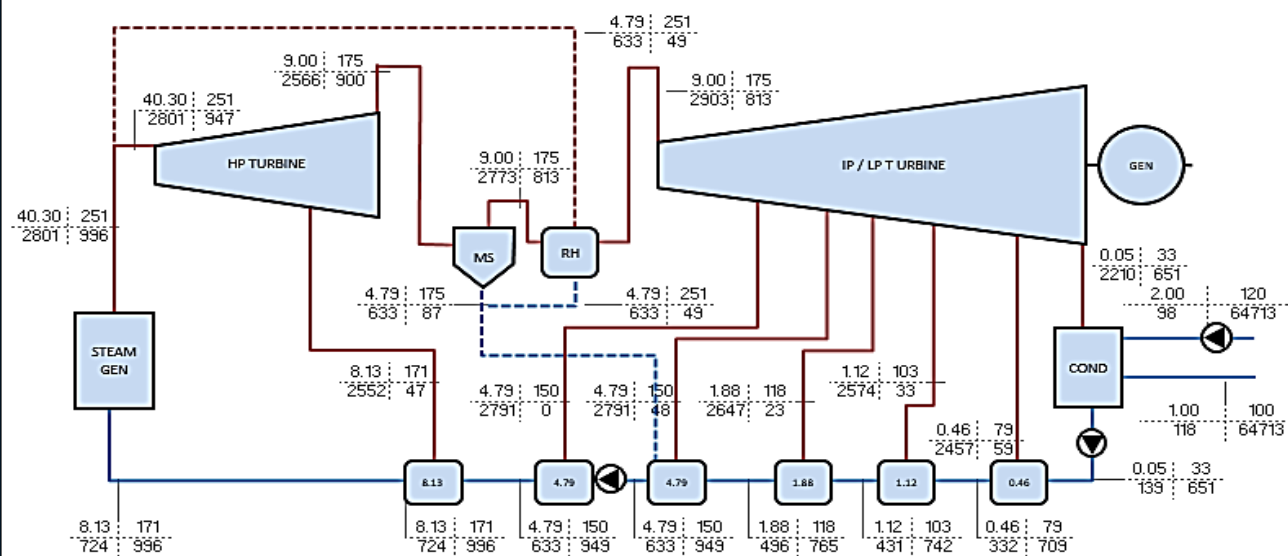
PLANT PERFORMANCE

Gross efficiency	%	34.2%
Net efficiency	%	32.5%
Heat rate	kJ/kWh	11,081

PLANT PERFORMANCE

Total heat input	MW(th)	2,069.0
Live steam	kg/s	996.1
HP turbine output	MW	223.1
IP/LP turbine output	MW	498.9
Mechanical output	MW	722.0
Gross output	MW(e)	707.6
Auxiliary loads	MW(e)	35.4
Net output	MW(e)	672.2
Heat to condenser	MW(th)	1,347.0
Cooling water	ton/s	64.7

POWER PLANT DIAGRAM



MODIFY POWER PLANT PARAMETERS

Thermal Input [MW(th)]	2,069	Reheat pressure [bar]	9.0	Feedwater heaters [-]	6
Live steam pressure [bar]	40.3	Reheat temperature [°C]	230.0	Condenser pressure [bar]	0.05
Live steam temperature [°C]	250.9	Final feedwater temp [°C]	171.1	more parameters	

LEGEND:

P [bar]	Tsat [°C]
h [kJ/kg]	m [kg/s]

Inputs for Cogeneration Plant

Desalination

District Heating

Non-Electric Application Description

Select new case or a predefined case from the list below. Predefined cases can be customized by the user.

Application: Desalination

Desalination | District Heating / Process heat

Desalination technology: MED

Operation parameters

Desalination plant capacity [m3/day]	0
Seawater TDS [ppm]	35000
Top brine temperature [°C]	70
Intermediate Loop operating pressure [bar]	8

[Modify default parameters](#)

Cancel Apply

Non-Electric Application Description

Select new case or a predefined case from the list below. Predefined cases can be customized by the user.

Application: District Heat

Desalination | District Heating / Process heat

Operation parameters

District heating temperature to target [°C]	
District heating return temperature [°C]	
District heating main line operating pressure [bar]	

Design parameters

District heating main line length [m]	
Number of main lines to target [-]	
Main pipeline internal diameter [mm]	
Insulation thickness [mm]	Standard thickness

[Modify default parameters](#)

Cancel Apply

Extraction Point for Cogeneration Application

COGENERATION PLANT

Net power output [MW(e)] **1,038**

Reference plant net output 1,041

Var. **0%**

Water production [m³/d] **8,800**

Cogeneration plant eff. **34.8%**

Reference plant efficiency 34.0%

Var. **2%**

DESALINATION PLANT

Plant specifications

Desalination technology MED

Max brine Temperature [°C] 65

Number of effects [-] 11

GOR [-] 8.8

Energy use

Heat to desalination [MW(th)] 27.1

Power lost due to extract [MW(e)] 3.0

Desal. electric cons. [MW(e)] 0.5

Int. Loop electric cons. [MW(e)] 0.1

Equiv. specific cons. [KWh(e)/m³] 9.71

COUPLING OPTIMIZATION

Power lost ratio **10.9%**

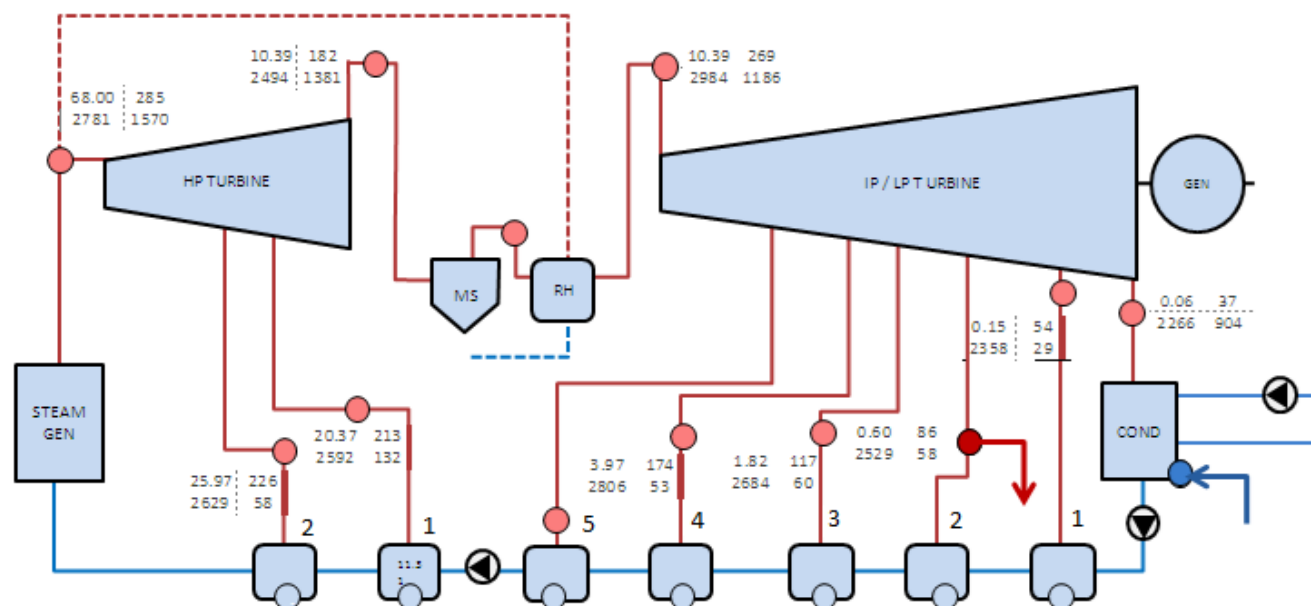
Optimize steam extraction flows for:

Current size

Design size

Modify Desalination parameters

Parameters



CHANGE LEGEND

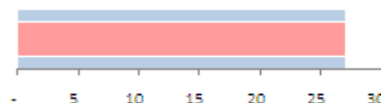
P [bar] T [°C]

h [kJ/kg] m [kg/s]

Reset



SELECT STEAM EXTRACTION PARAMETERS



Heat supply
27 MW(th)

Target: 27 MW(th)

Temp steam
86 °C

Min Required: 75.5 °C

Steam at 0.6 bar, 86 °C:

Select extraction clicking a red point

Select extraction clicking a red point

kg/s **12.5**



Results Report

Project details

Project title	Standard PWR Case
Application	Thermal Desalination
Coupling configuration	Bleed from Low Pressure Turbine

ENERGY BALANCE		REF	COGEN
Thermal input	MW(th)	3 400	3 400
Gross electrical output	MW(e)	1 199	1 180
Gross mechanical output	MW	1 223	1 205
HP Turbine output	MW	464	464
LP Turbine Output	MW	759	740
Net electrical output	MW(e)	1 177	1 159
Additional turbine	MW(e)	-	-
Auxiliary loads	MW(e)	22.2	21.1
Heat rejected through condenser	MW(th)	2 179	1 948
Heat to desalination plant	MW(th)	-	250
Total power lost	MW(e)	-	-17.5
Power lost due to extraction	MW(e)	-	-19.6
Positive effect of ext steam red downstream	MW(e)	-	0.6
Positive effect of condensate upstream	MW(e)	-	0.5
Auxiliary loads decrease (pumps)	MW(e)	-	1.1

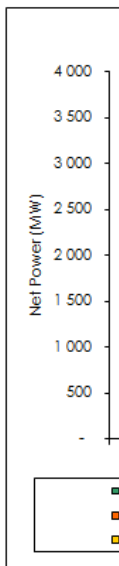
MASS BALANCE		REF	COGEN
Feedwater to Steam Generator	kg/s	1 833	1 833
Steam to reheater	kg/s	156	156
Steam to the HP turbine	kg/s	1 677	1 677
HPT total preheating bleeds	kg/s	202	202
Exhaust from HP turbine	kg/s	1 475	1 475
Moisture separator condensate	kg/s	200	200
Steam to the LP turbine	kg/s	1 276	1 276
LPT total preheating bleeds	kg/s	249	242
Steam to desalination	kg/s	-	116
Steam to condenser	kg/s	1 027	918
Relative steam to desalination	[-]	0%	11%

Cooling Water	ton/s	37	33
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[Go to model calculations](#)

SYSTEM EFFICIENCY
Gross efficiency
Net efficiency
Thermal utilisation

Plant performance



ENERGY BALANCE		REF	COGEN
Thermal input	MW(th)	3 400	3 400
Gross electrical output	MW(e)	1 199	1 180
Gross mechanical output	MW	1 223	1 205
HP Turbine output	MW	464	464
LP Turbine Output	MW	759	740
Net electrical output	MW(e)	1 177	1 159
Additional turbine	MW(e)	-	-
Auxiliary loads	MW(e)	22.2	21.1
Heat rejected through condenser	MW(th)	2 179	1 948
Heat to desalination plant	MW(th)	-	250
Total power lost	MW(e)	-	-17.5
Power lost due to extraction	MW(e)	-	-19.6
Positive effect of ext steam red downstream	MW(e)	-	0.6
Positive effect of condensate upstream	MW(e)	-	0.5
Auxiliary loads decrease (pumps)	MW(e)	-	1.1

MASS BALANCE

Feedwater to Steam Generator	kg/s	1 833	1 833
Steam to reheater	kg/s	156	156
Steam to the HP turbine	kg/s	1 677	1 677
HPT total preheating bleeds	kg/s	202	202
Exhaust from HP turbine	kg/s	1 475	1 475
Moisture separator condensate	kg/s	200	200
Steam to the LP turbine	kg/s	1 276	1 276
LPT total preheating bleeds	kg/s	249	242
Steam to desalination	kg/s	-	116
Steam to condenser	kg/s	1 027	918
Relative steam to desalination	[-]	0%	11%

Cooling Water	ton/s	37	33
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[Go to model calculations](#)

IAEA Tool on Nuclear Water Management

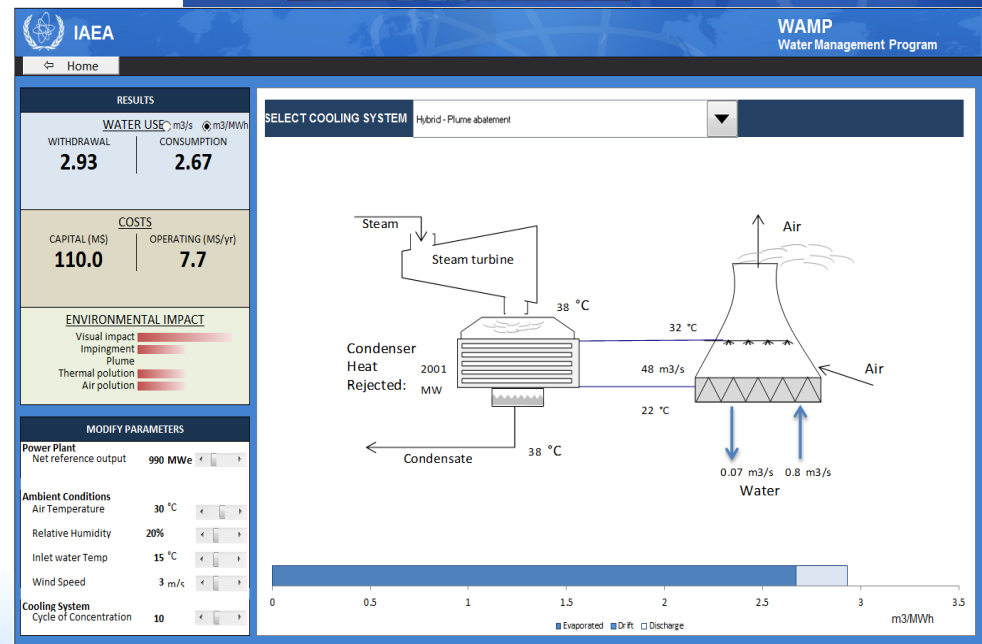
WAMP Water Management Program

WAMP helps in the selection of cooling systems by evaluating three different criteria: Water resources, environmental, economical.



WAMP estimates water needs in NPPs especially for water cooled nuclear power plants.

WAMP estimates both the needs for cooling water and other essential systems.



Define Power Plant Data

Define New Case

Case Name:

Nuclear Power Plant

Reference Thermal Power: MWt

Reference net efficiency: % 1102 MWe

Live Steam Temperature: °C

Type:

☒ Light Water

☐ Heavy Water

Site/Weather Data

Site Location:

Air Temperature (Dry Bulb): °C

Humidity:

☒ Relative Humidity: %

☐ Air Temperature (Wet Bulb): °C

Inlet water temperature: °C

River flow (if applicable): m³/s

Wind speed: m/s

Economic Data

Lifetime of the power plant: years

Discount Rate: %

Levelized cost of Electricity: \$/MWh

Power Plant Availability: %

OK Cancel

Select Cooling System

Select Cooling System

In nuclear power plants, waste heat has to be dissipated to the environment via a cooling system, also known as ultimate heat sink. Please select one of the following cooling systems:

Cooling System:

Approaches and Condenser Approaches:

- Once Through
- Once Through - Cooling Pond
- Closed loop - Cooling Pond
- Wet cooling - Mechanical Draft
- Wet cooling - Natural Draft
- Dry cooling (Air condenser)**
- Hybrid - Plume abatement

Cycles of concentration (COC) is defined as the ratio of the concentration of dissolved solids (i.e., chlorides, sulfates, etc.) in the recirculating water to the concentration found in the entering makeup water. The higher the COC, the lower is the required bleed rate.

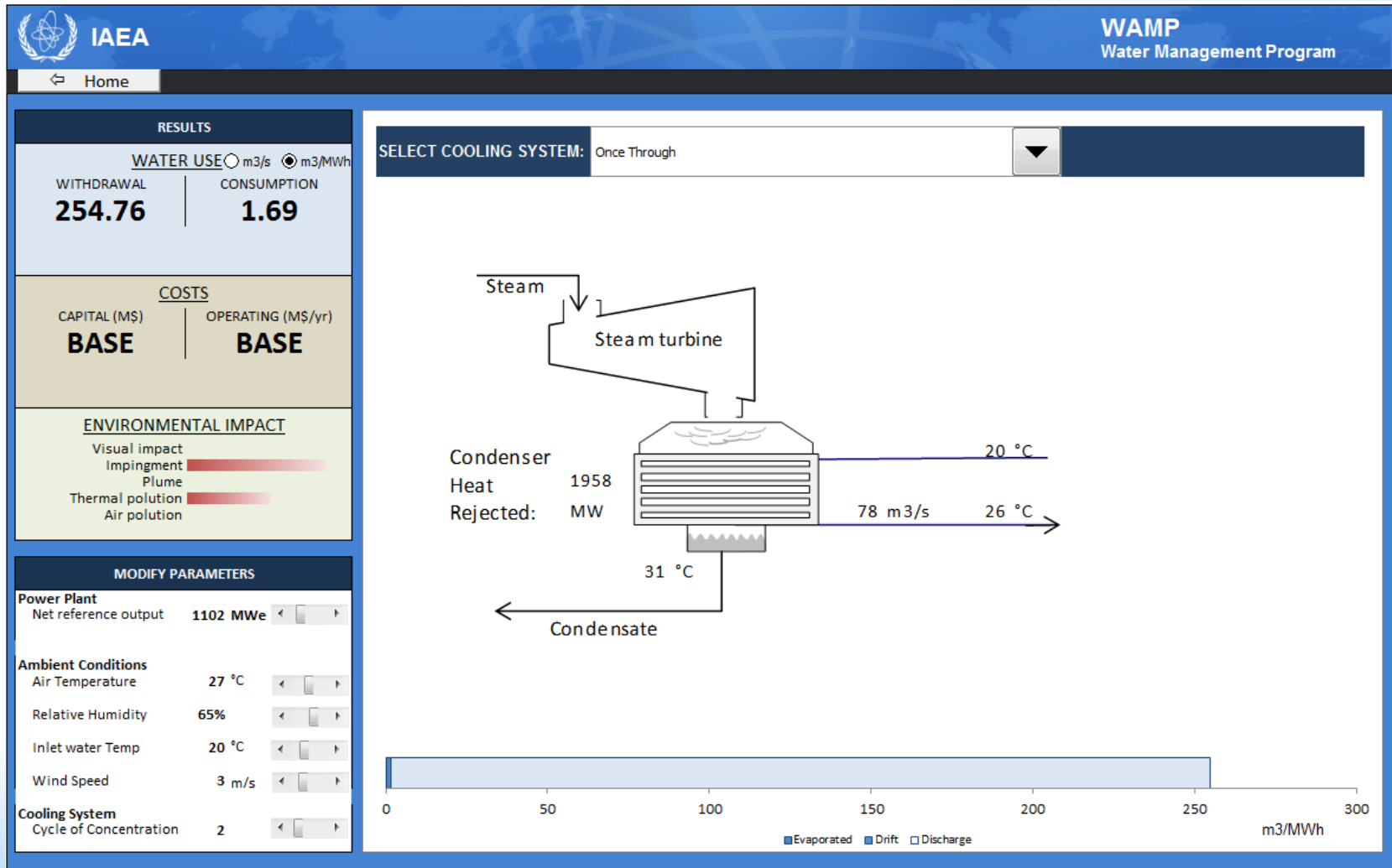
It is recommended to use a maximum of 3 cycles of concentration if the water hardness is more than 200 ppm

Cycles of Concentration:

Cooling Pond Data (only for once through mode)

Cooling pond size: km²

Summary Results



Report

Water Management Program Summary of Results

Case Study:
WAMP - k-2

Home

Sav
PI

Power Plant Specifications

Type	Light Water Reactor	
Reactor electric capacity	1102 MWe	4000
Reactor thermal capacity	3060 MWth	3000
Reference efficiency	36%	2000
Rejected heat	1958 MWth	1000
		0

Site conditions

Location	Coast
Dry bulb temperature	26.5 °C
Wet bulb Temperature	21.5 °C
Relative Humidity	65%
Surface water temperature	20 °C
River flow	100 m ³ /s
Average wind velocity	3 m/s

Summary of results

	Cooling system	Supporting systems
Recirculating cooling water	78.0 m ³ /s	1.20 m ³ /s
Evaporation losses	0.52 m ³ /s	0.02 m ³ /s
Blow-down losses	77.44 m ³ /s	0.01 m ³ /s
Make-up water	77.96 m ³ /s	0.03 m ³ /s

Total Water needed

During Construction	570 980 m ³
During commissioning	47 540 m ³
During operation	
Condenser cooling (withdrawal)	660 334 Million m ³ /month
Other Supporting systems	10 298 m ³ /month

Total Water inventory needed

Fresh Water	3 000 m ³
Demineralized water	9 550 m ³

Water Management Program Cooling system analysis

Case Stud

Design variables

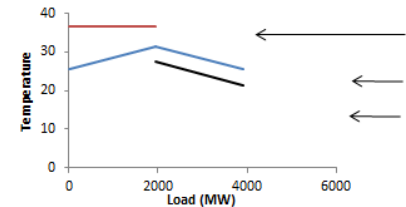
Cooling system type	Once Throu
Cycles of concentration	
Condenser Approach	
Condenser Range	
Cooling Tower Approach	

Results

Evaporation loss	0.
Drift loss	0.
Blowdown	77.
Cooling system makeup water	77.
Total consumption	0.



Temperature Profile



Total Annual Revenues / Profits

	BASE	MS
Investment Costs		
Annualized Investment Cost	BASE	MS
Total Operating Costs	BASE	MS
Total Cost		0.0 MS

Water Management Program Supporting Systems cooling

Case Study: WAMP - k-2

Water needs during construction

Excavation	25 080 m ³	
Concrete mixing	95 100 m ³	
Supply for construction staff	450 800 m ³	(Peak: 6000 m ³ /d)

Water needs during comissioning

Flushing, cleaning etc	25 000 m ³	
Drinking water	22 540 m ³	(Peak: 300 m ³ /d)

Water needs during operation (except from condenser cooling)

Makeup for Secondary loop	4100 m ³ /month	Demineralized
Makeup for primary loop	138 m ³ /month	Demineralized
Waste Treatment	1736 m ³ /month	Fresh Water
Condensate Polishing Plant	1188 m ³ /month	Demineralized
Component cooling water make up	361 m ³ /month	Demineralized
Fire protection	223 m ³ /month	Fresh Water
Sanitary and potable	2551 m ³ /month	Fresh Water

Water system inventories during operation

Condenser cooling water circuit	0 m ³	Fresh water
Service water circuit + 7 days storage	0 m ³	Fresh water
Fire water circuit - pipes	300 m ³	Demineralized
Fire water circuit - storage	3000 m ³	Fresh water
Nuclear systems& component cooling circuit	500 m ³	Demineralized
TG component cooling circuit	450 m ³	Demineralized
Feed water circuit	1800 m ³	Demineralized
Steam generator secondary side inventory	300 m ³	Demineralized
Reactor auxiliary circuits	500 m ³	Demineralized
Spent fuel bay cooling circuit	1700 m ³	Demineralized
Emergency core cooling circuit (and dump inventc	1900 m ³	Demineralized
Emergency feed water pools and circuit	1700 m ³	Demineralized
Primary heat transport system	400 m ³	Demineralized
Moderator system	0 m ³	-



OVERVIEW OF THE SAMG-D TOOL



The Tool to enhance Severe Accident Management

The SAMG-D describes the elements necessary to develop a full package of Severe Accident Management Guidelines (SAMG), which serve to achieve the main goals of severe accident management at a Nuclear Power Plant (NPP). Severe accident management is a subset of accident management as follows:

Accident management is the taking of a set of actions during the evolution of a beyond design basis accident:

- (a) To prevent the escalation of the event into a severe accident;
- (b) To mitigate the consequences of a severe accident;
- (c) To achieve a long term safe stable state.

The second aspect of accident management (to mitigate the consequences of a severe accident) is also termed **severe accident management**. It includes measures to: [Read more →](#)

- (1) terminate the progress of core damage once it has started,
- (2) maintain the integrity of the containment as long as possible and
- (3) minimize releases of radioactive material.

See *Accident Management, Anticipated Operational Occurrence, Beyond Design Basis Accident, Design Basis Accident, Operational states, Severe Accident, and Severe Accident Management*.

Guidelines that have been developed for the operating staff for managing severe accidents are called Severe Accident Management Guidelines (SAMG).

The SAMG-D is also an education and training tool to help plant staff understand the context of severe accidents and the associated procedures and guidelines. The SAMG-D describes the elements that a full package of SAMG should encompass to achieve the goals of severe accident management. It is set up to help utilities to select proper SAMG products from the various vendors and implement those at their plants. The SAMG-D is designed for use with LWRs and PHWRs. **The SAMG-D is not designed to independently construct a full SAMG package.**

The IAEA Nuclear Power Technology Development Section (NPTDS) developed the SAMG-D also as a contribution to the [IAEA Action Plan on Nuclear Safety](#).

Please, before starting the use of SAMG-D have a look at the [DISCLAIMER](#) and the information provided in [About](#).