

International Atomic Energy Agency

INPRO
Area of Economics

F. DEPISCH
ICTP, 11-2005

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- **SRES scenarios**
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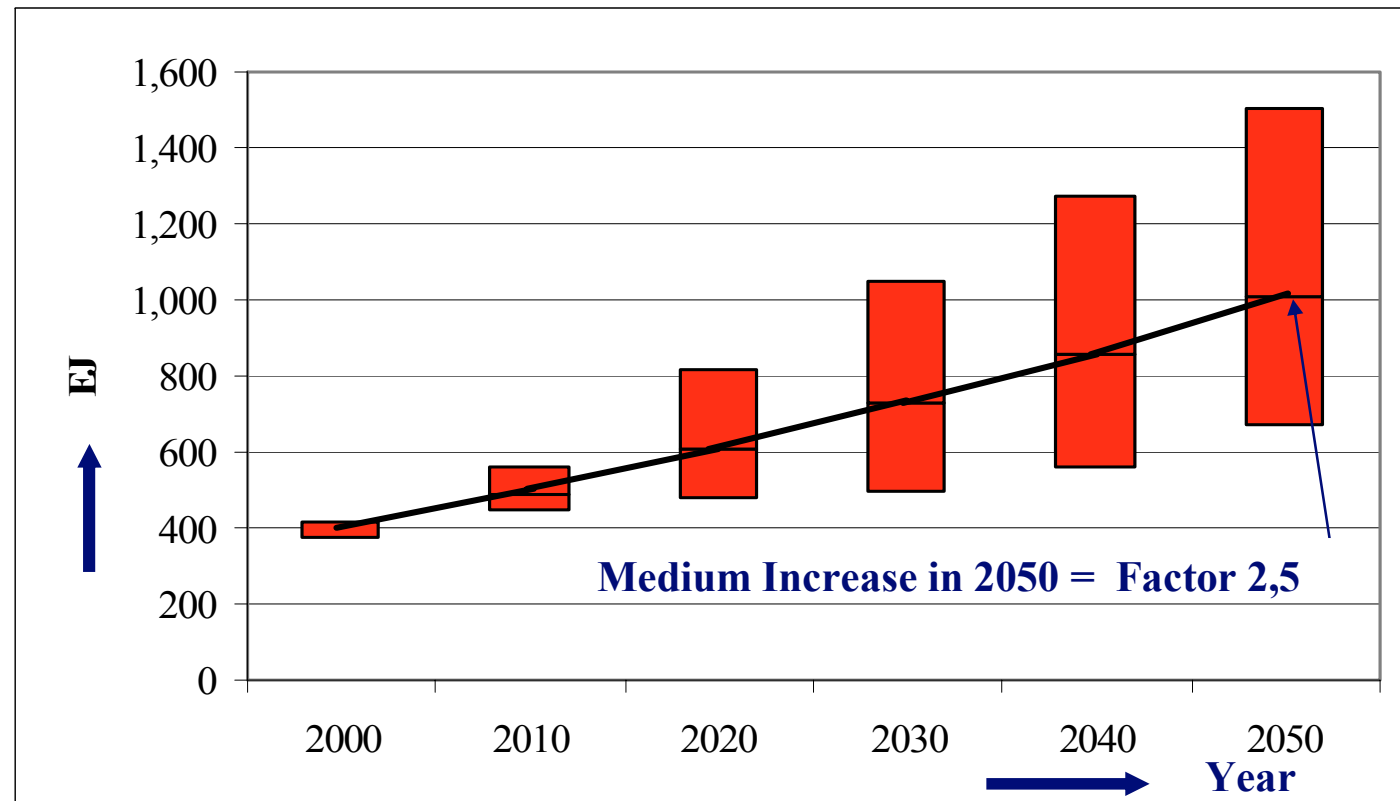


Six Areas of INPRO Methodology



Special Report on Emission Scenarios

SRES = Special
Report on Emission
Scenarios of the
Intergovernmental
Panel on Climate
Change (IPCC)



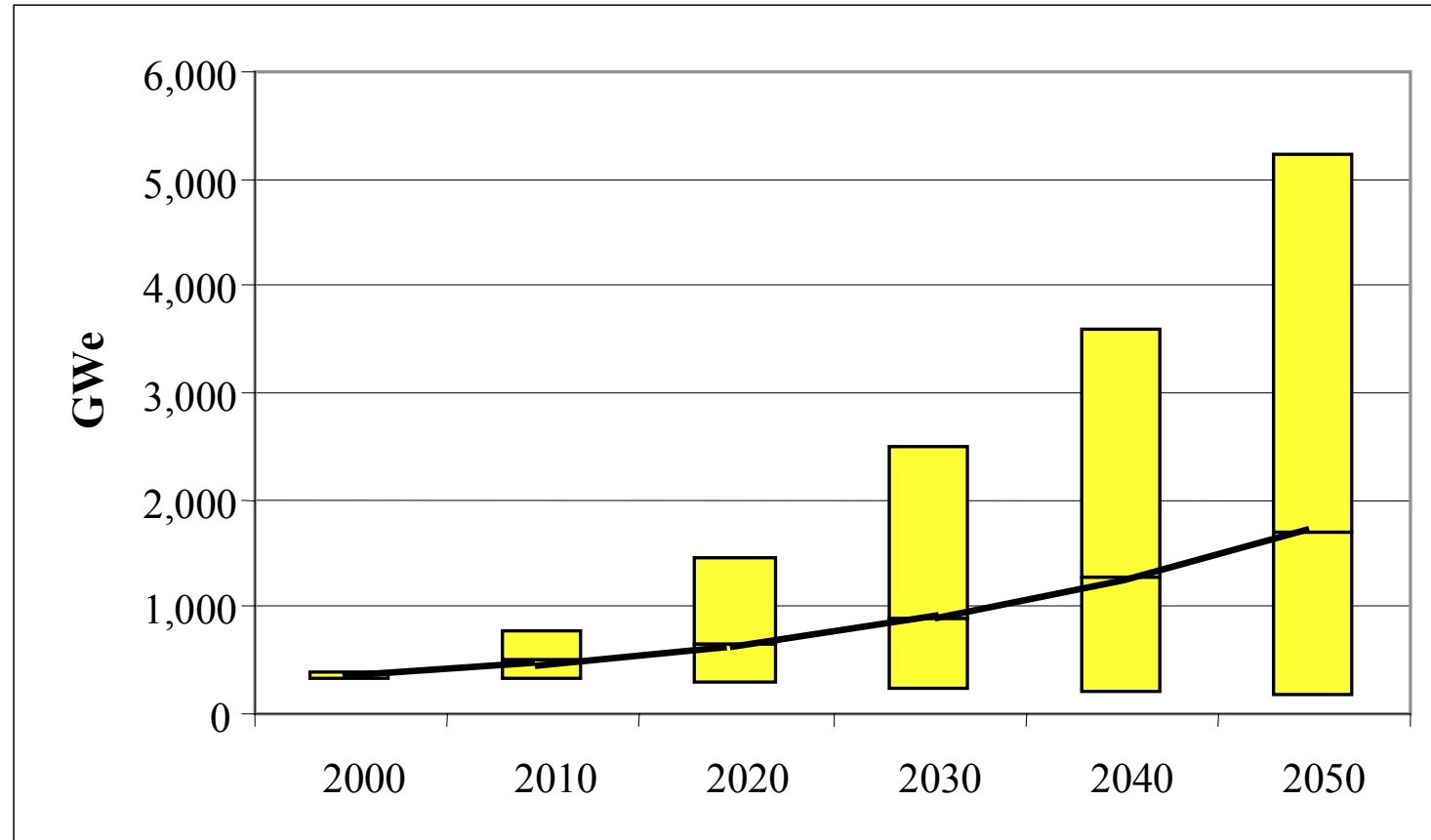
Projected World Primary Energy Demand (EJ)

(Source: Intergovernmental Panel on Climate Change, IPCC2000)



Special Report on Emission Scenarios

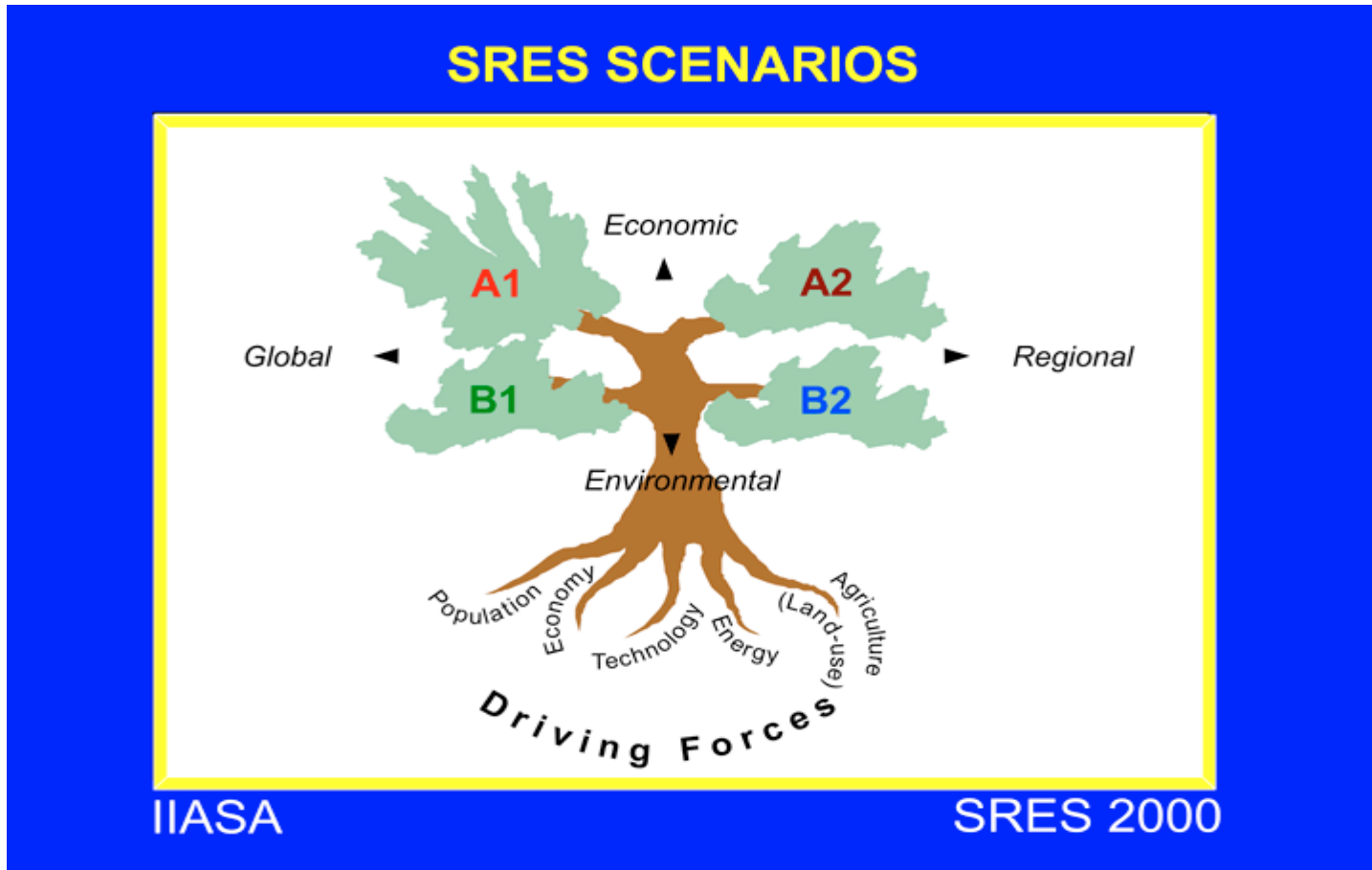
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World Nuclear Electricity Production (GWe)



Family of SRES Scenarios

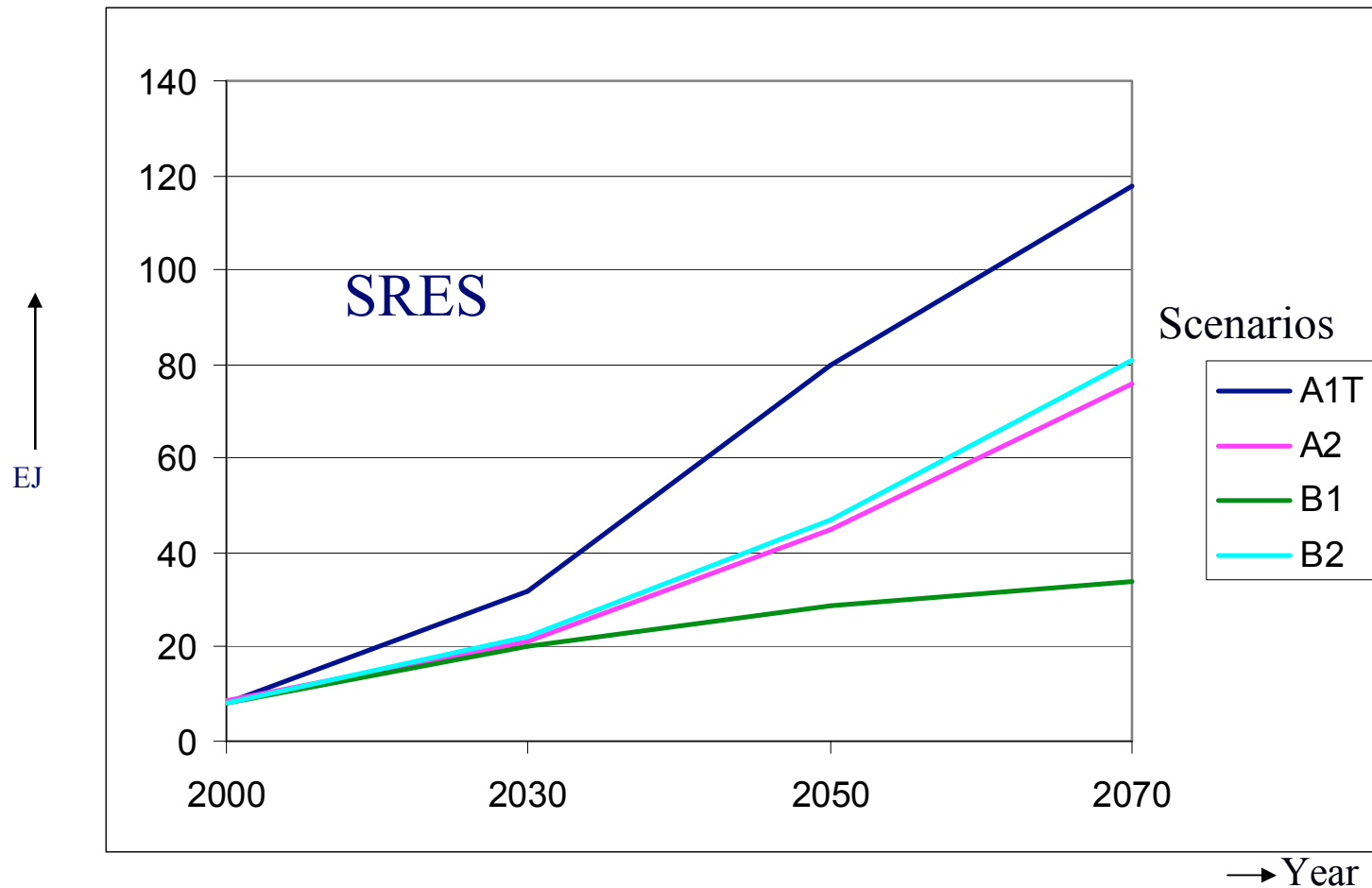


SRES = Special Report on Emission Scenarios of the Intergovernmental Panel on Climate Change (IPCC)

IIASA = International Institute for Appplied System Analysis

➔ **INPRO: Selection of 4 Representative Scenarios**

Evaluation of SRES Scenarios



***Nuclear electricity production (EJ)
for four selected SRES scenarios***

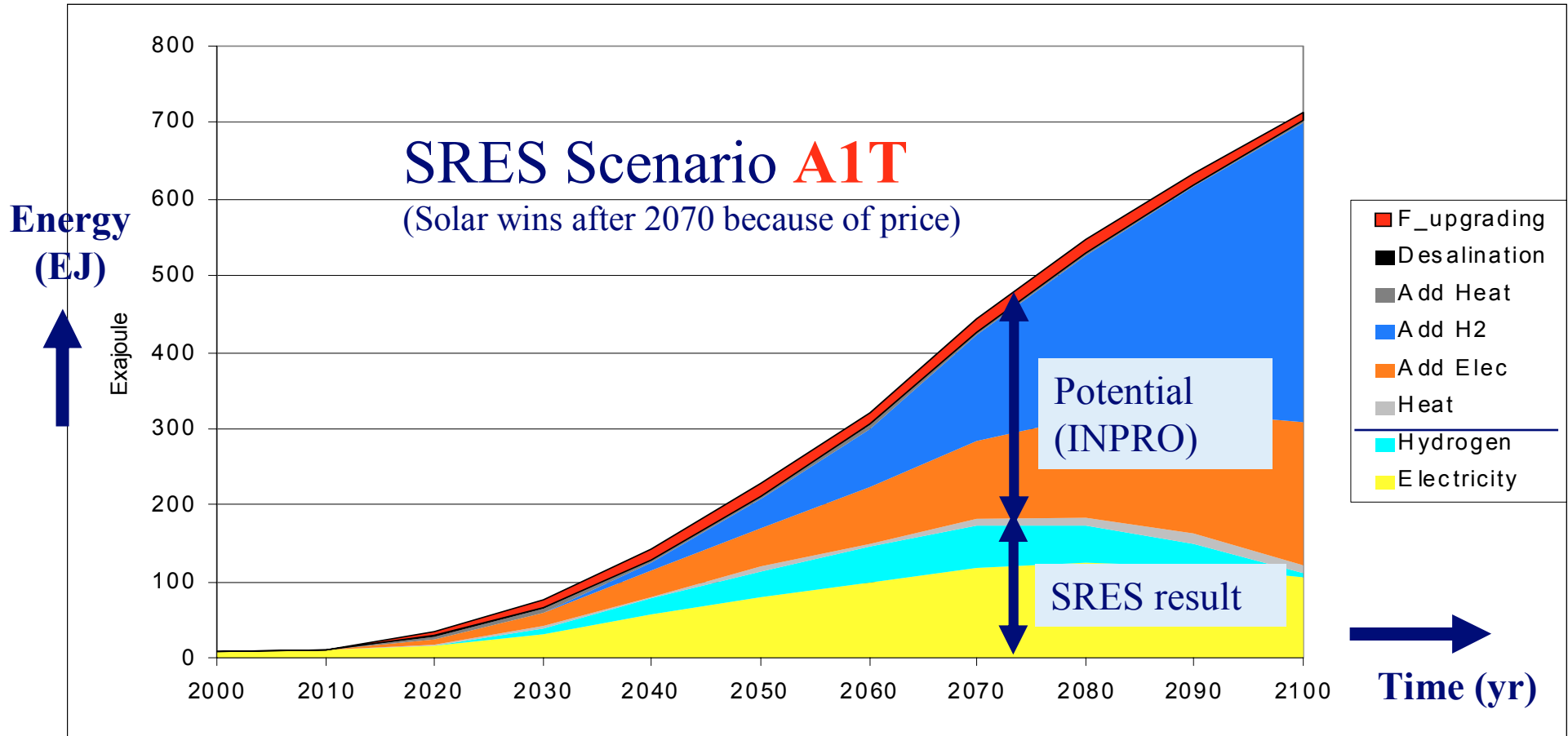


Evaluation of SRES Scenarios

- SRES Predictions for 4 Scenarios:
 - Competition to Nuclear is Dependent on Scenario and Region
 - Main Competitors to Nuclear are:
 - Solar in Scenario A1T,
 - Coal in Scenario A2,
 - Renewables & Solar in Scenario B1,
 - Coal+Gas+Biomass+Solar in Scenario B2



Evaluation of SRES Scenarios



Potential Global Market for Nuclear Energy (Electricity, Hydrogen, Heat and Desalination)



INPRO Basic Principle in the Area **Economics**

- One Basic Principle defined:
 - *Energy and related products and services from INS shall be affordable and available.*
- **Affordable nuclear energy (NE) means: costs must be competitive to alternative energy sources**
- **Available NE means: Investment in NE must be attractive.**
- Four User Requirements and Several Criteria defined



INPRO UR1.1 of Economics

- User Requirement UR1.1:
*The **cost of energy** from INS, taking all relevant costs and credits into account, C_N , **should be competitive with that of alternative energy sources, C_A .** in the same time frame and geographic region.*
- Criterion CR1.1: $C_N < k \cdot C_A$
- Value of k-factor close to 1, depending on e.g., :
 - Security of energy supply
 - Long-term stability of energy cost
 - External costs
- $C = LUEC = LUAC + LUOM + LUFC$
 - Amortization, O&M, fuel cost



INPRO UR1.2 of Economics

- User Requirement UR1.2:
*The **total investment** required to design, construct, and commission INS, including interest during construction, should be such that the necessary investment funds can be raised.*
- Criterion CR1.2.1: Financial figures of merit (e.g., **IRR, ROI**) of INS **comparable or better than alternatives.**
- Criterion CR1.2.2: Size of **total investment compatible** to raise capital in a given market.



INPRO UR1.3 of Economics

- User Requirement UR1.3:

The risk of investment in INS should be acceptable to investors taking into account the risk of investment in other energy projects.

- Criterion CR1.3.1: Licensing status, pre-licensing possible.

- Criterion CR1.3.2: realistic project construction times comparable to alternatives.

- Criterion CR1.3.3: political long term support available.



Example of INPRO assessment of **Economics**

Scenario	Boundary Conditions
Economical criteria	Liberalized market, cheapest option will be selected for year 2010
Technical Constraints	Power limited to 10% of total grid power output: Power lower than 890 MWe
Investment Rules	Attractive IRR
	Attractive ROI
Growth Constraints	Power limited by annual new power requirement range: 1 to 4 years range: 170 to 725 MWe
Fuels availability	Fuels obtained only from the international markets



Example of INPRO assessment of **Economics**

Option Number	Energy Type	Technology	Fuel
1	Nuclear	SMR PWR	Enriched Uranium
2	Nuclear	SMR HWR	Natural Uranium
3	Gas	GT	LNG - Diesel
4	Gas	CCGT	LNG - Diesel



Example of INPRO assessment of Economics

INS Indicators	Indicator Value	Acceptance Limit AL1.1.1:	Units
Indicator IN1.1.1		CCGT	
$C_{N-SMR\ PWR}$	47.14	< 50.95	mills/KWh
$C_{N-SMR\ HWR}$	48.79	< 50.95	mills/KWh
Indicator IN1.2.2		AL1.2.2 Utility	
$Investment_{SMR\ PWR}$	1391	≤ 900	M\$
$Investment_{SMR\ HWR}$	1565	≤ 900	M\$



Concluding Remark

“Thank you very much for your attention!”

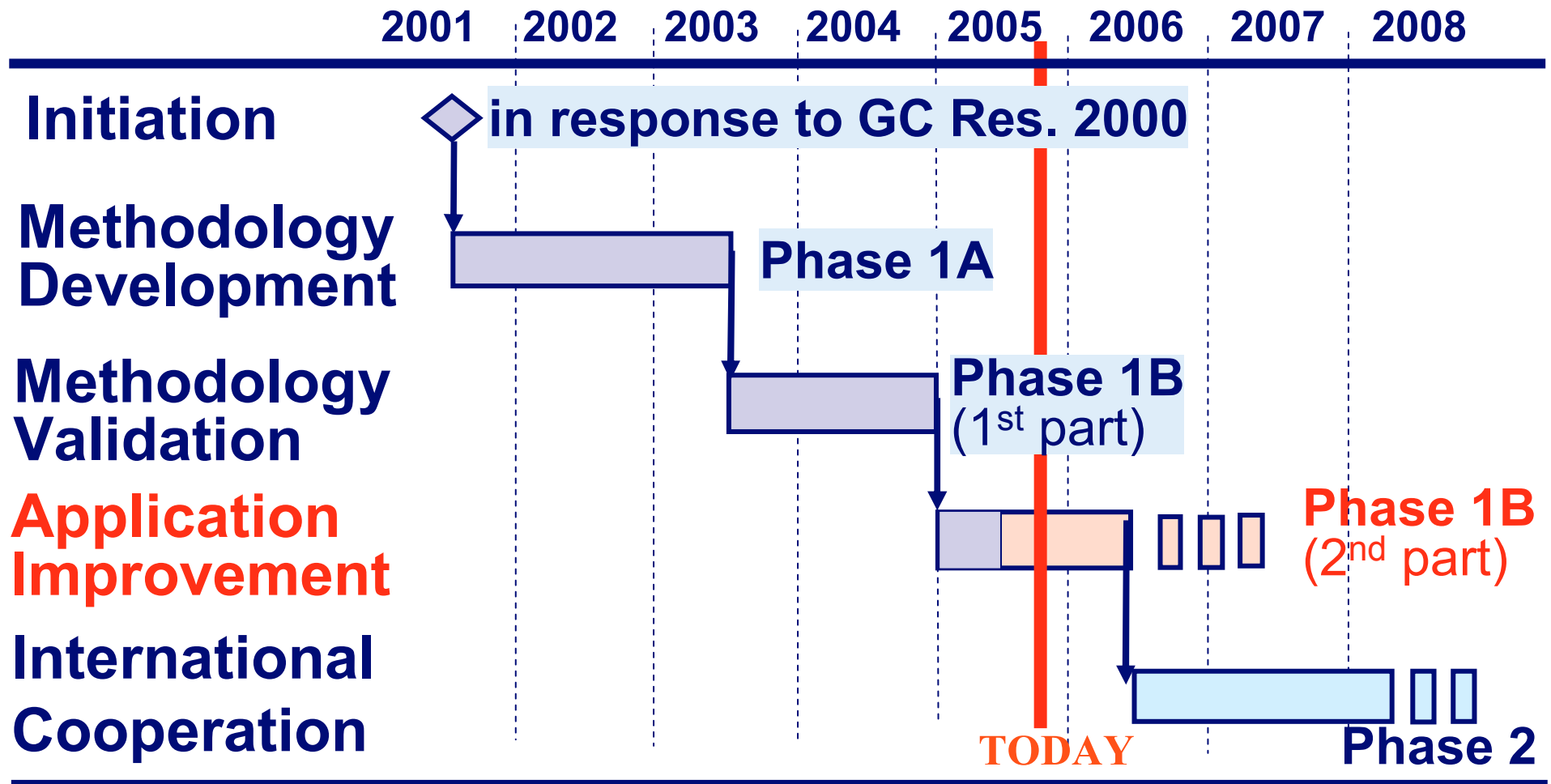


INPRO area of **Economics**

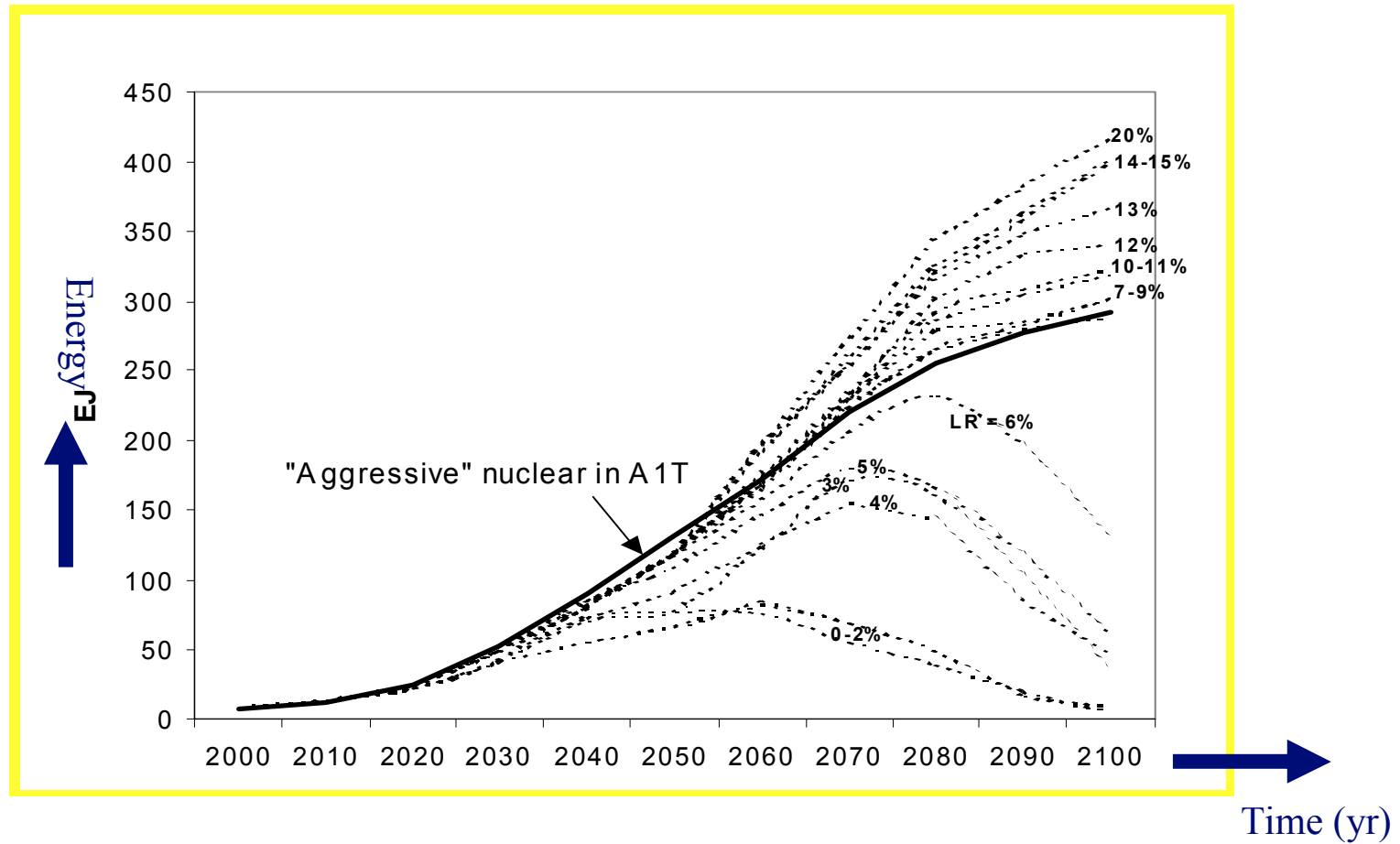
- **Status and outlook**
 - **Draft manual for economics assessment distributed to participants of ongoing INPRO case studies.**
 - **Feedback from studies expected in 2006.**
 - **Manual of economics to be upgraded based on feedback in 2006.**



Overall INPRO Schedule



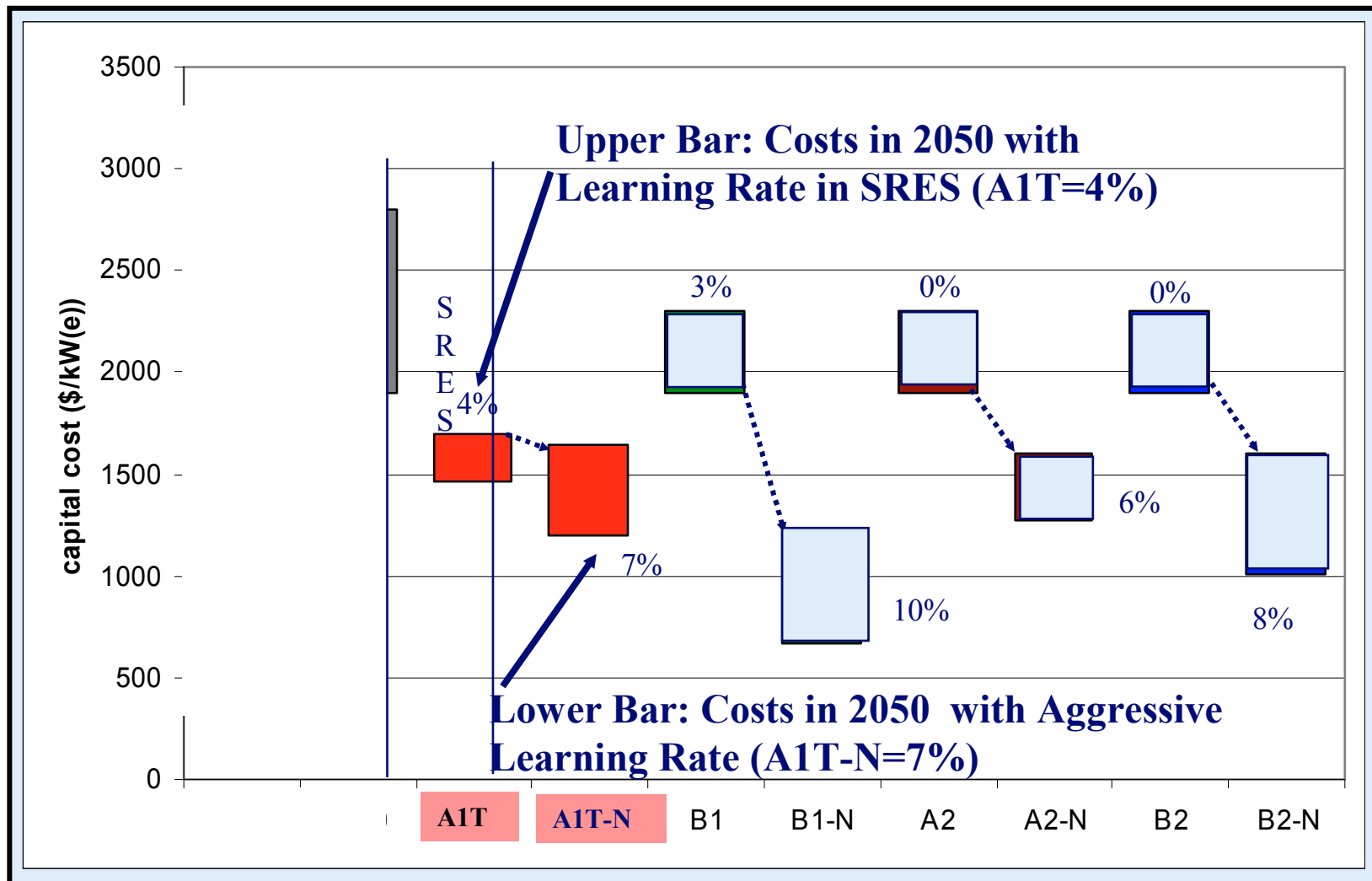
Evaluation of SRES Scenarios



Concept of Learning Rates: 7% learning rate for Nuclear necessary to compete against other technologies



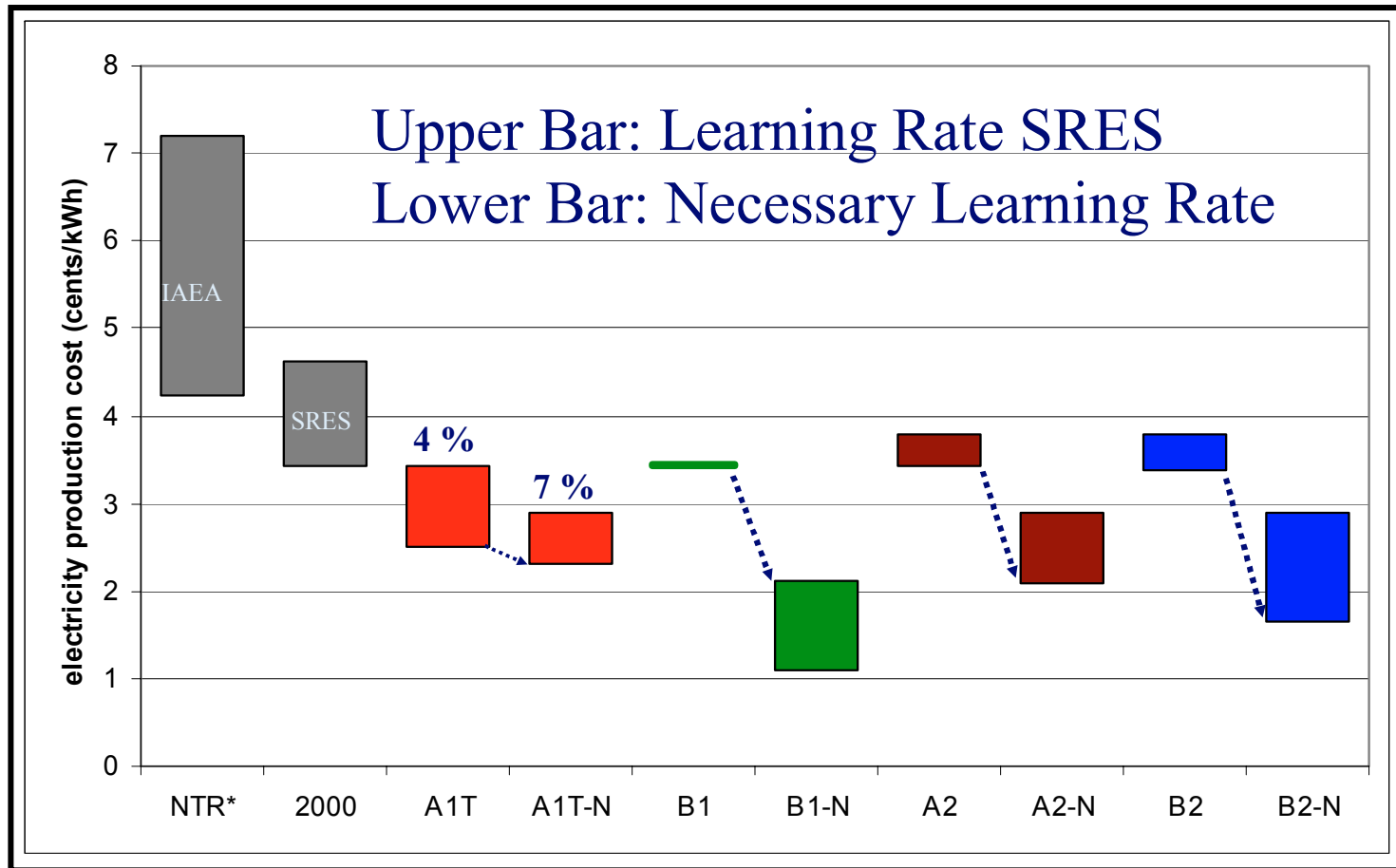
Evaluation of SRES Scenarios



Specific Capital Costs for NPP in 2050 (SRES and INPRO)



Evaluation of SRES Scenarios



Ranges for electricity production costs in 2050 for NPP (SRES)

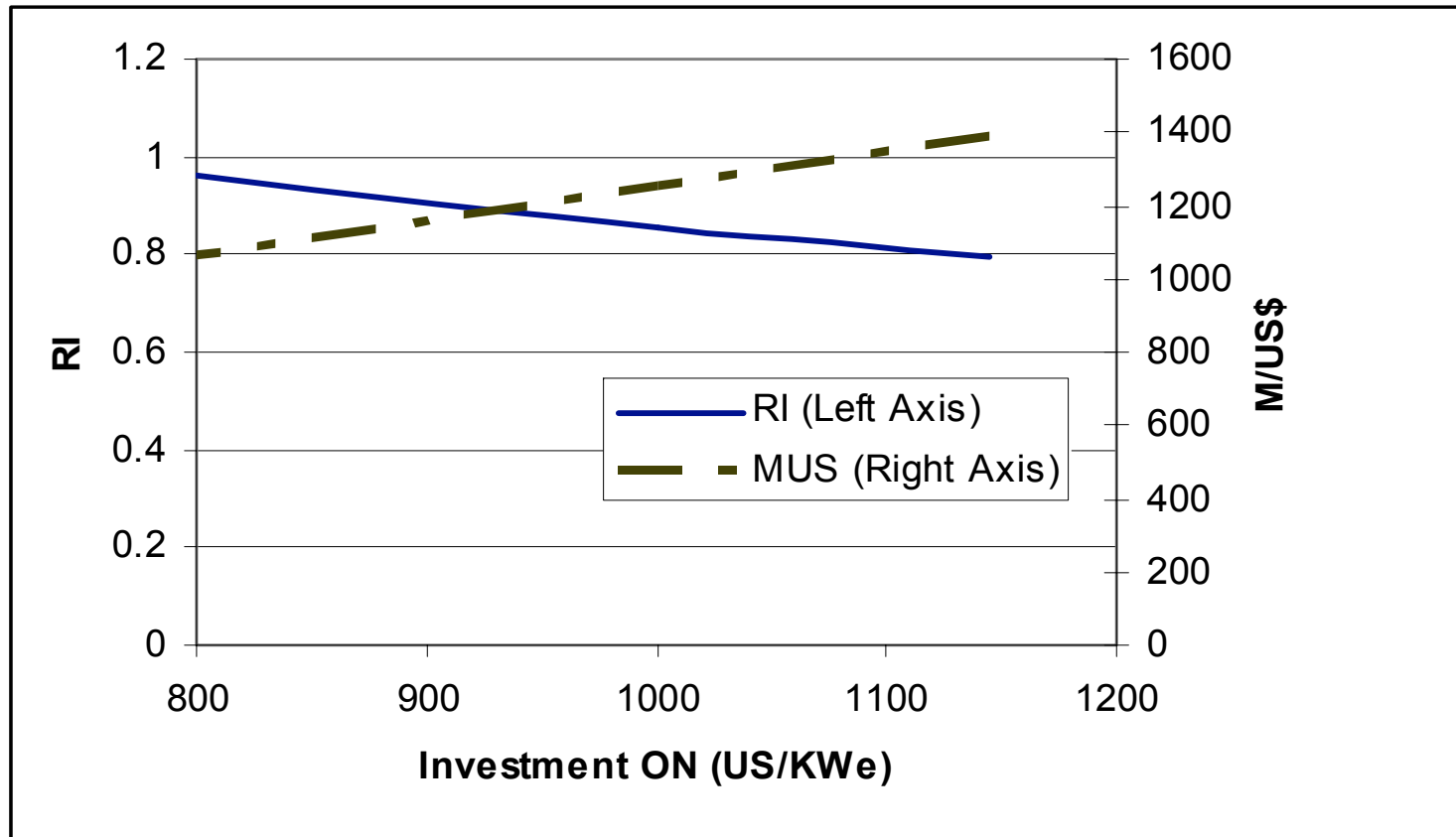


INPRO UR1.4 of Economics

- User requirement UR1.4:
INS should be compatible with meeting the requirements of different markets.
- Criterion CR1.4.1: robustness index of economics data ≥ 1



Example of INPRO assessment of Economics



Variation of the Robustness Index **RI** and the total investment **M/US\$** with changes in the investment (overnight capital cost) **ON** of a SMR

