Uncertainty Analysis on CDM Methodology

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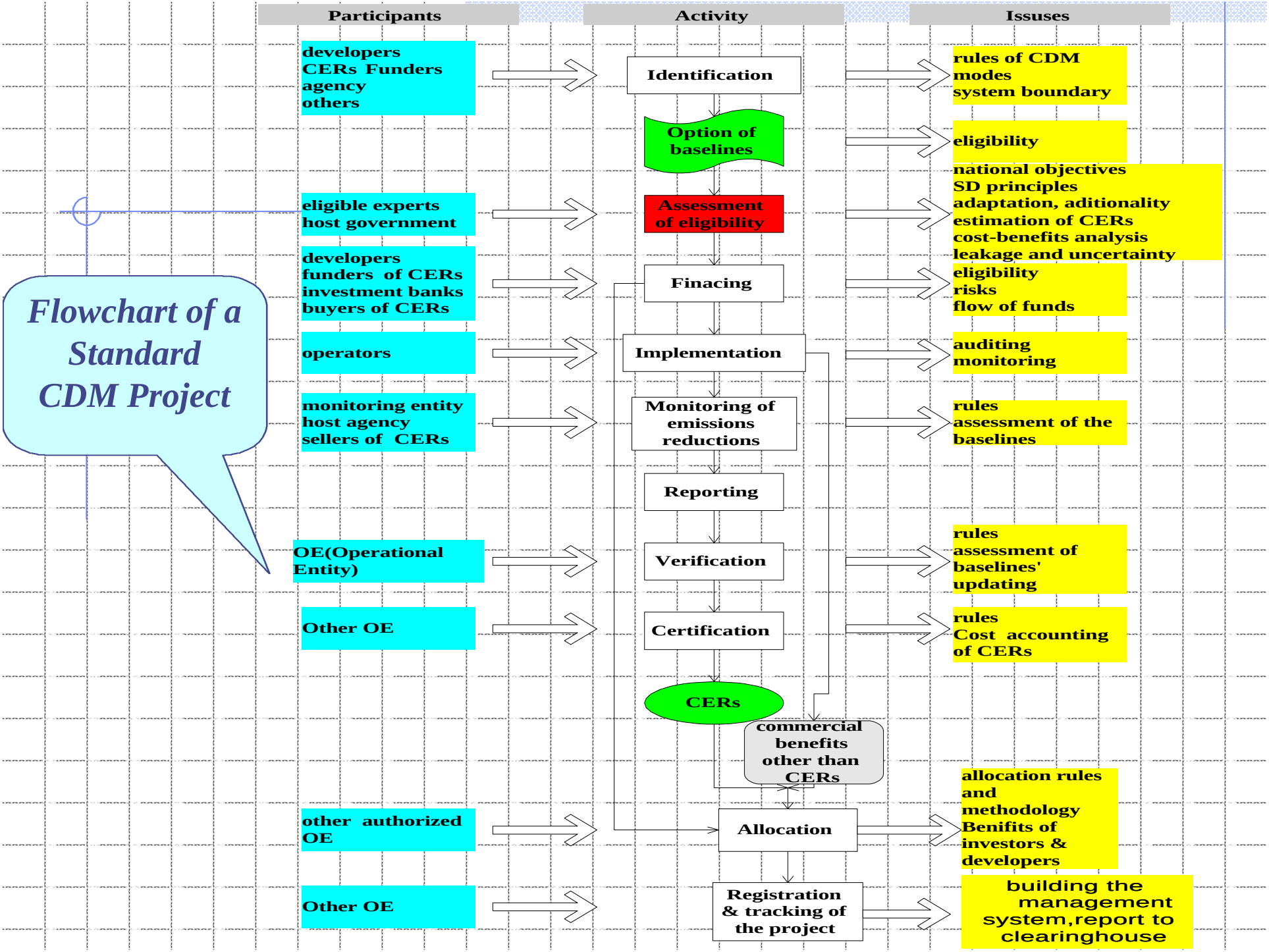
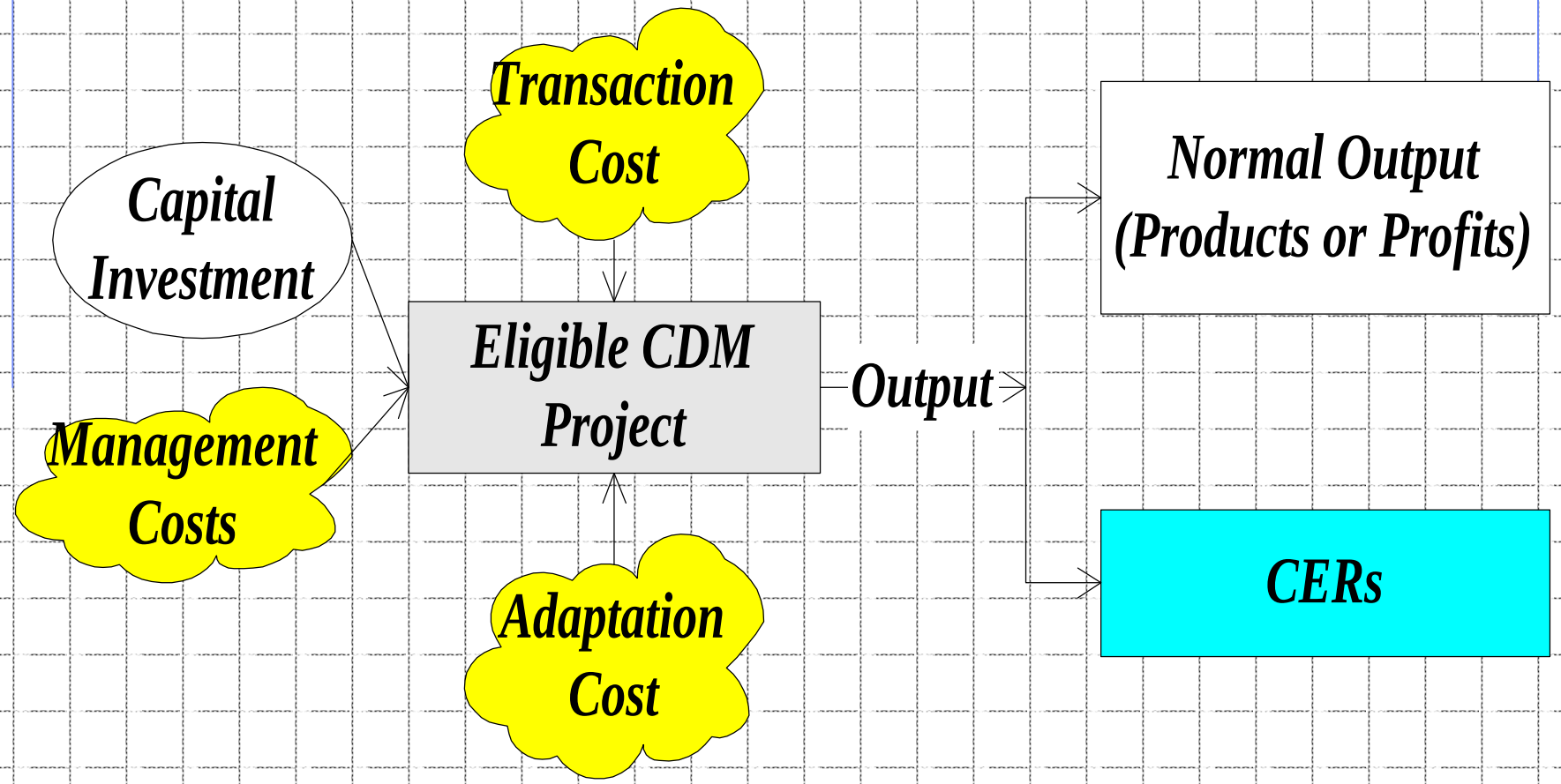
4th Sino-Korea-U.S. Economic and Environmental Modeling Workshop, Beijing China. May 23-25, 2001

Outline

- ***Uncertainty analysis on CDM Projects of Carbon Reductions (sources)***
  - ***Baselines***
  - ***Leakage***
  - ***Cost-benefit***
- ***Uncertainty analysis on Carbon Sequestration Projects(sinks): basic framework for the potential LULUCF as CDM projects(though un-ratified by COP)***

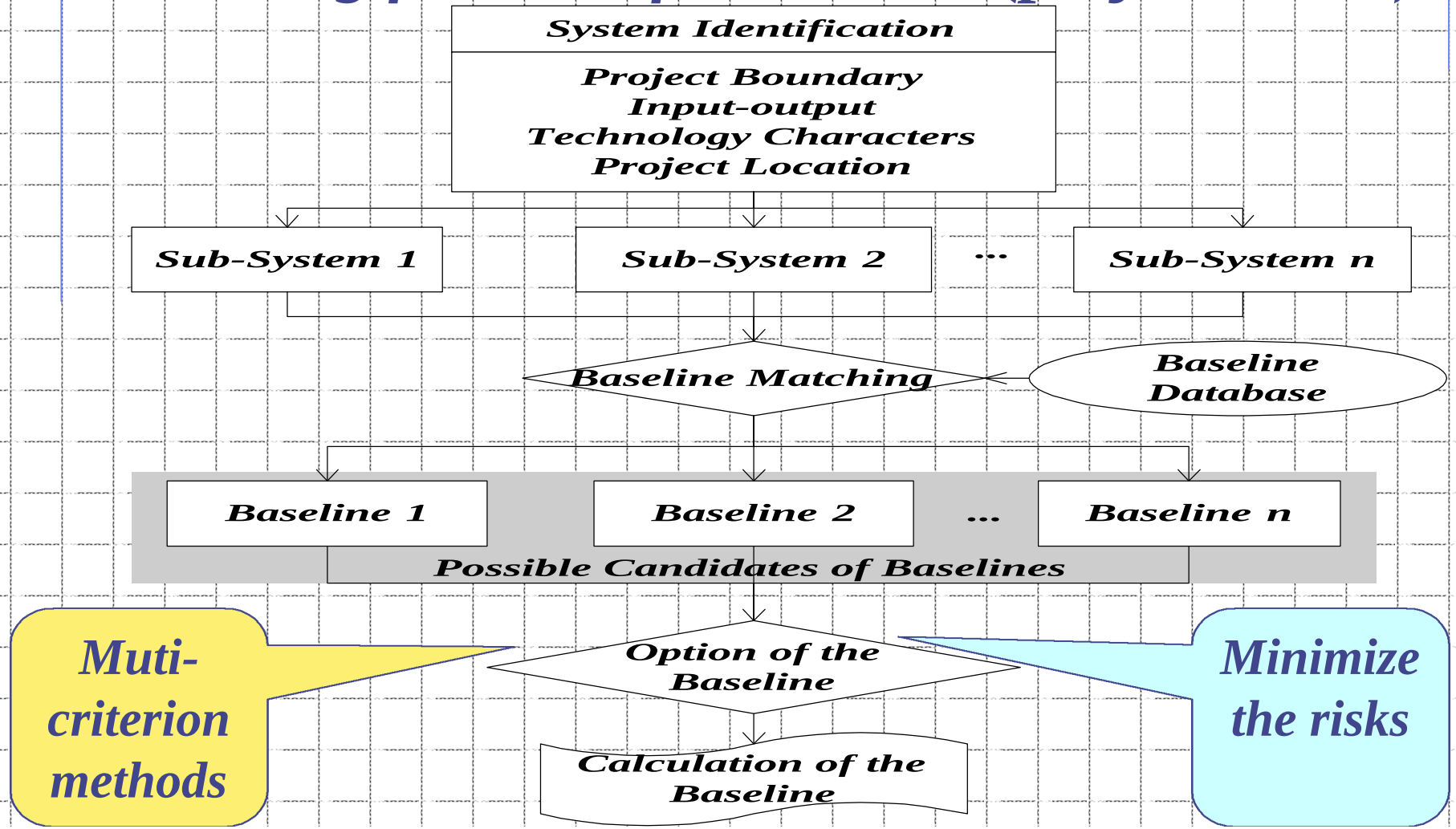

Flowchart of a Standard CDM Project
Participants
Activity
Issuses
developers
CERs Funders
agency
others
Identification
rules of CDM
modes
system boundary
Option of baselines
eligibility
eligible experts
host government
Assessment of eligibility
national objectives
SD principles
adaptation, aditionality
estimation of CERs
cost-benefits analysis
leakage and uncertainty
developers
funders of CERs
investment banks
buyers of CERs
Finacing
eligibility
risks
flow of funds
operators
Implementation
auditing
monitoring
monitoring entity
host agency
sellers of CERs
Monitoring of emissions reductions
rules
assessment of the baselines
Reporting
OE(Operational Entity)
Verification
rules
assessment of baselines'
updating
Other OE
Certification
rules
Cost accounting
of CERs
CERs
commercial benefits other than CERs
other authorized OE
Allocation
allocation rules
and
methodology
Benifits of
investors &
developers
Other OE
Registration & tracking of the project
building the management system,report to clearinghouse

Basic Input-output of a CDM Project



Uncertainty Sources from Baselines

- Looking for the reference case(project-based)



Uncertainties from baselines estimation (project-based carbon emissions)

- *Uncertainties of* CO_2 *emitted from fossil fuels in China*
  - *Consumed amounts of the fossil fuels*
  - *Oxidation ratio*
  - *Carbon content*
  - *Combustion efficiency*
- *Uncertainties of* CH_4, N_2O *from stationary sources in China*
  - *Limited monitoring*
  - *Use of aggregate emission factors*
  - *Recognized emissions factors from different combustion conditions and technology categories are limited*
- *Uncertainties of* CH_4, N_2O *from mobile sources in China*
  - *Out-dated relatively Combustion conditions, technologies*
  - *Speed and traffic problems*
  - *Uninstalled pollution control equipment or un-available*
  - *long life-cycle for Replacement with new one*

Uncertainties from baselines simulation (aggregate sectoral or national baseline)

- *Generally, simulated by models*
- *Give hypothetical or default values for the exogenous variable in the models, update those variables changed with time, for instance, GDP, energy intensity, carbon dioxide emissions, etc., as parts of baselines*
- *Using above hypothetical or default values to calculate the endogenous variable for the baselines using models*
- *Building the complete baselines*
- *Different uncertainties in every step*
- *Generally, often need design multi-baselines cases other than only a single one*
- *At present, include four categories of models:*

  Project-based models, Sectoral models, CGE models, Integrated-models

Basic concept of uncertainty analysis

Input conditions

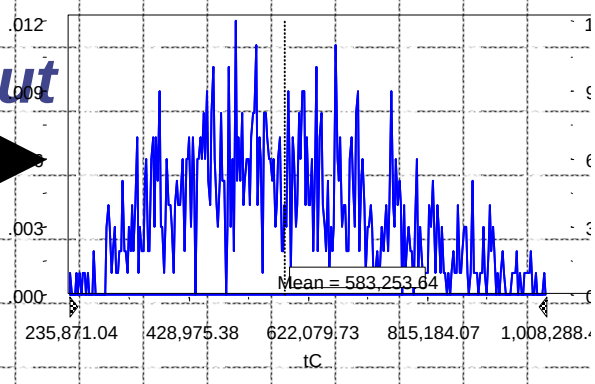
- Uncertainty variables
- Statistical Data
- Statistical distribution

input

Monte Carlo Simulation model

output

Uncertainty results of Decision variables



Basic assignation and distribution assumptions of uncertainty variables

variables	meanings	Value interval	distribution
f_1	Carbon emission factor(Electricity)(tC/Mwh)	0.1-0.8	triangular
f_2	Carbon emission factor(Heat)(tC/tce)	0.5-1.2	triangular
f_3	CH_4 factor from mining(m3 /tce)	1.2-3.8	uniform
f_4	CH_4 factor from surface mining(m3 /tce)	0.073-0.85	uniform
f_5	CH_4 factor from process (U)(m3 /tce)	0.38-3.0	beta
f_6	CH_4 factor from process (S)(m3 /tce)	0.03-0.45	beta
d	Discount rate	0.06-0.10	lognormal
TC	Cost of heat(US$/GJ)	1.5-3.5	lognormal
EC	Cost of electricity(US$/kWh)	0.03-0.05	lognormal

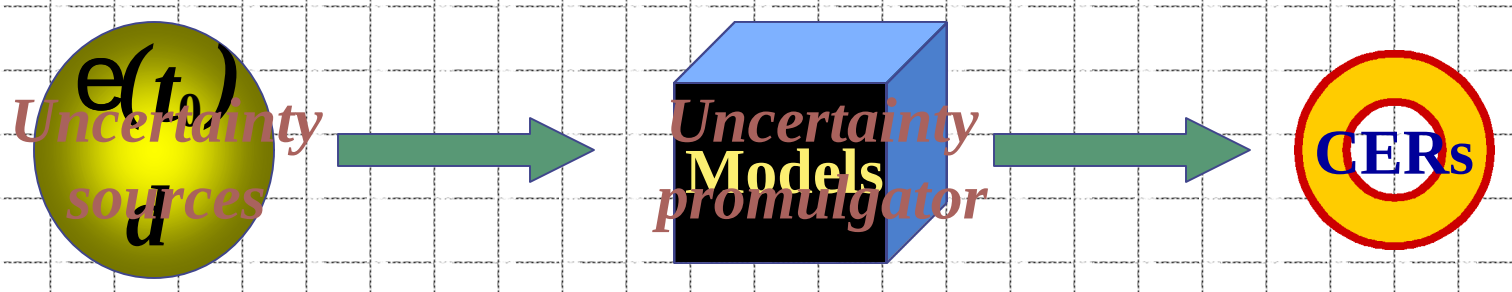
Uncertainties of Baselines

project based case analysis(H-E project)

$$CERs(t) = \sum_{t=t_0+1}^{t+t_0+1} \frac{E_{CDM}(t)(e(t_0) - e_{CDM}(t))}{(1+d)^t}$$

$$= \sum_{t=t_0+1}^{t+t_0+1} \frac{(E_{CDM}(t)e(t_0) - EM_{CDM}(t))}{(1+d)^t}$$

Uncertainty sources:



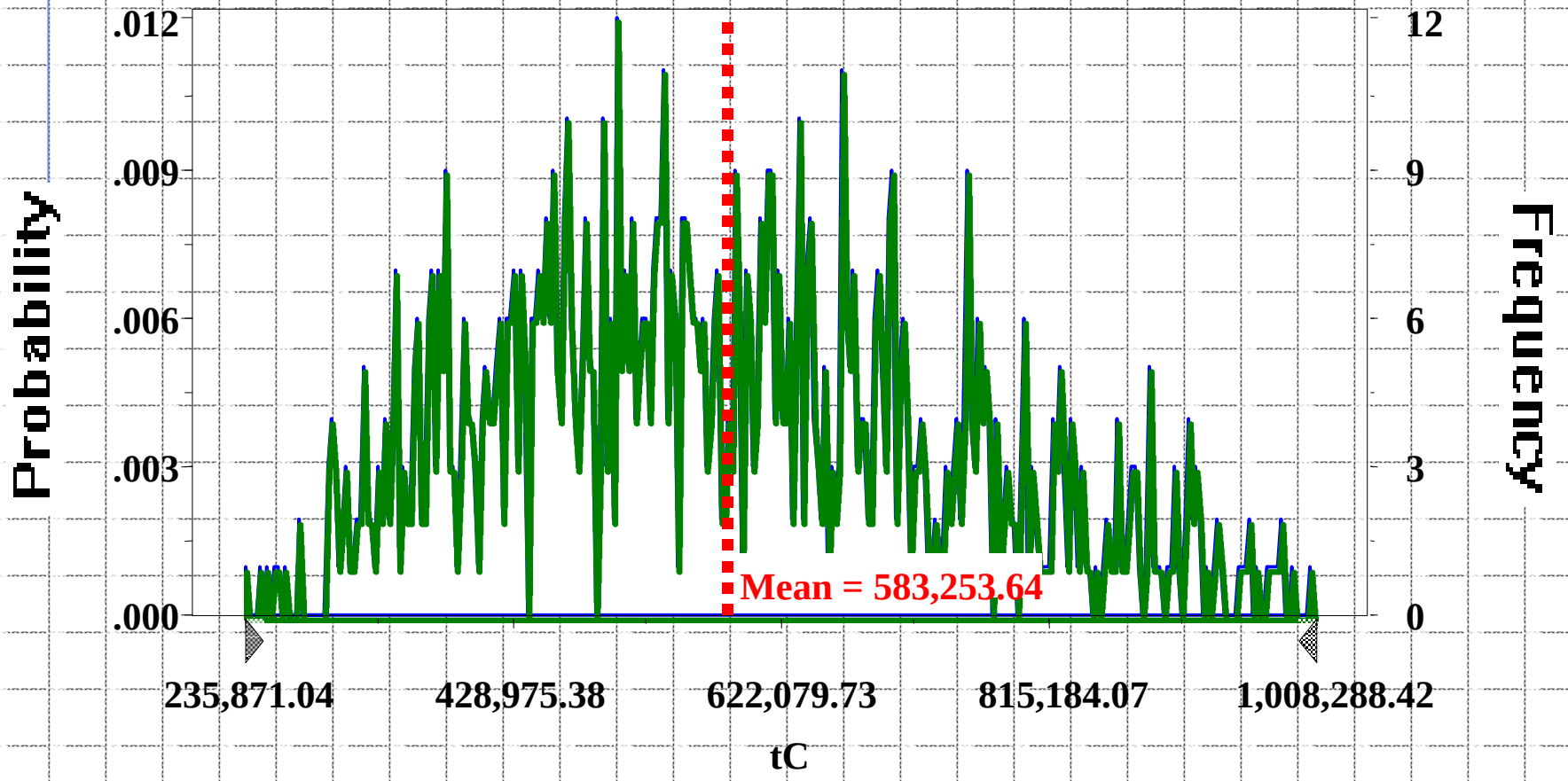
Incremental Reduction Cost

$$ICER = \frac{\sum_{i=t_0+1}^{t+t_0+1} \left(\frac{\sum_{j}^{m} (ICER_{ij} \times CERs_{ij})}{(1+d)^i} \right)}{CERs(t)}$$

$$ICER_{ij} = \left(\frac{C(CERs)_{ij}}{CERs_{ij}} \right) = \left(\frac{(UCCDM_{ij} - UCB_{ij})}{E_{CDM}(t)(e(t_0) - e_{CDM}(t))} \right)$$

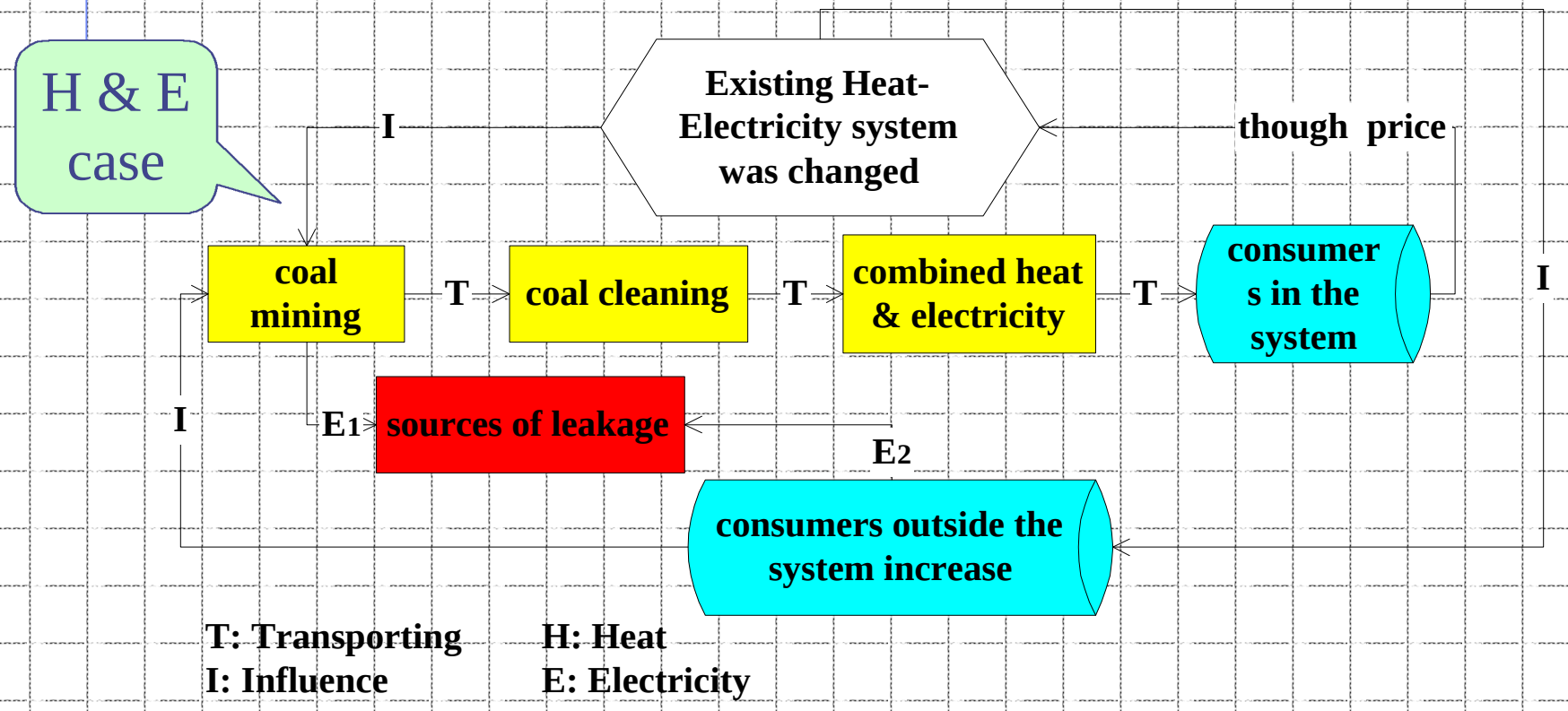
Relationship of incremental reduction cost and Price of the CERs

Uncertainty Estimation of the CERs



Estimating uncertainties from leakages

- ***System boundary design:***
  - *Time(to identify project's CERs life-cycle)*
  - *Space(system's emissions increase)*



Estimation of leakages

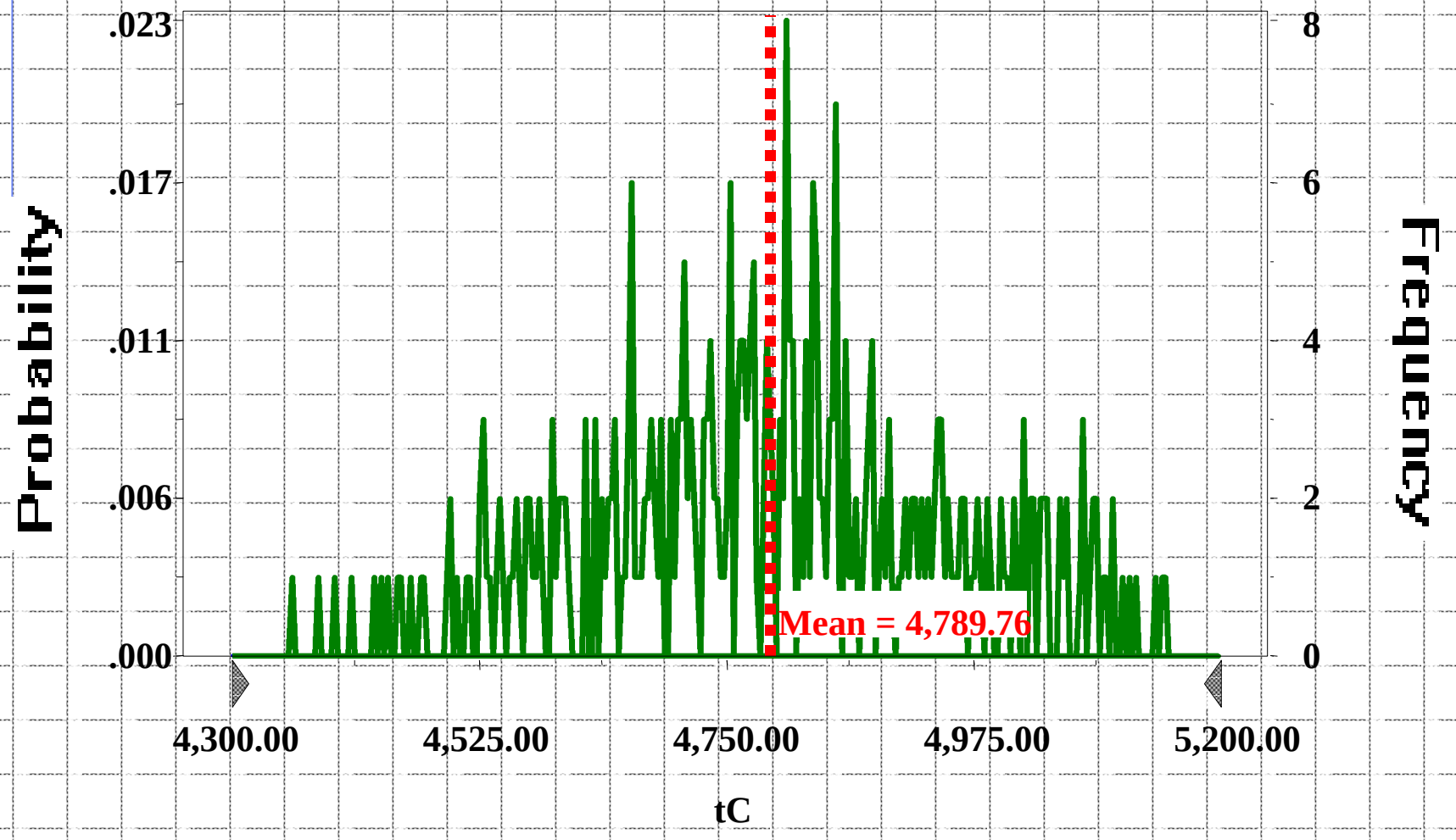
$$E_1 = I_{EC} \times f_1 + I_{TC} \times f_2$$

$$E_2 = (DUM \times f_3 \times (1 - R_{CH_4}) + DSM \times f_4 + DUP \times f_5 + DSP \times f_6)$$
$$\times 19.2g / 0.0283m^3 \times 12/44 \times 21 \times 1t / 10^6 g$$

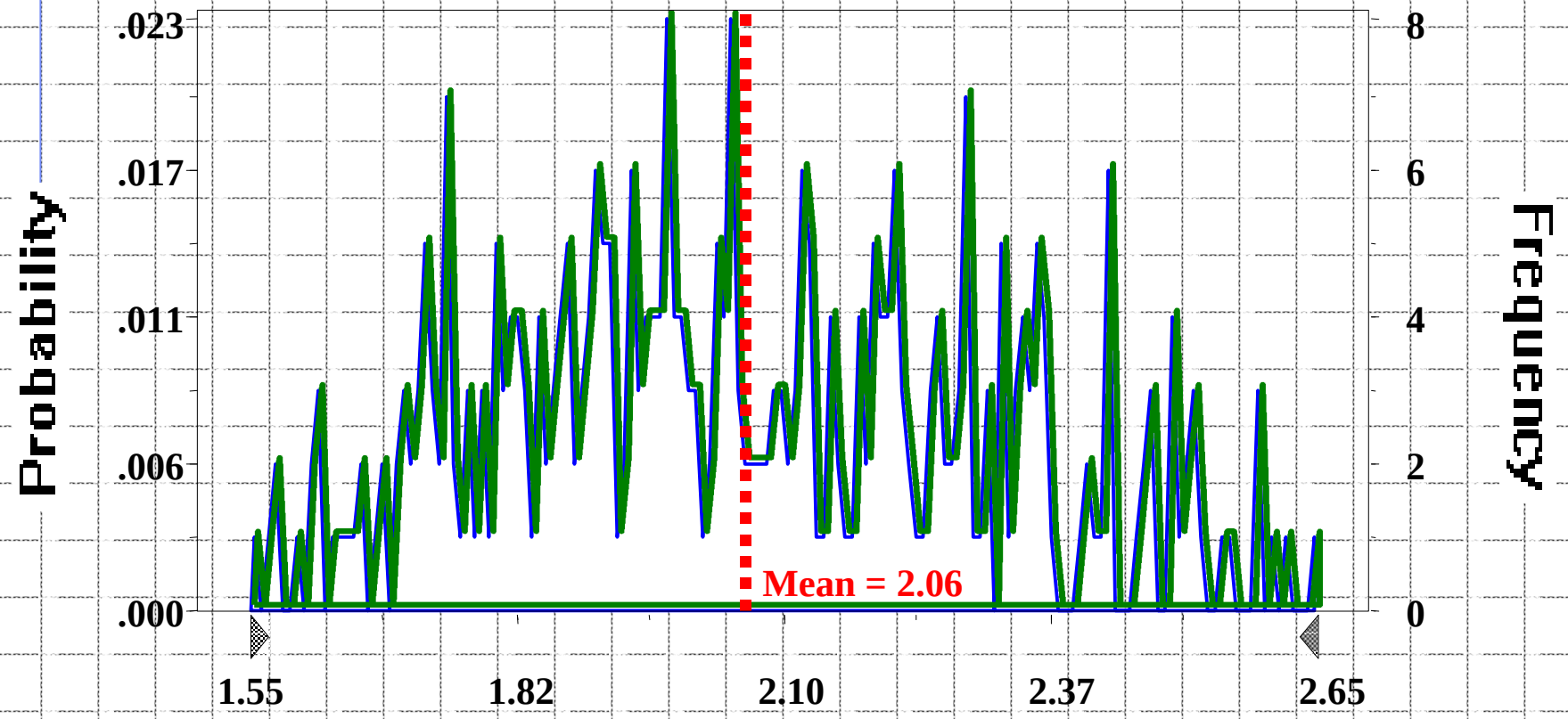
$$E = E_1 + E_2$$

Uncertainty sources: f_1, f_2, f_3, f_4, f_5, f_6

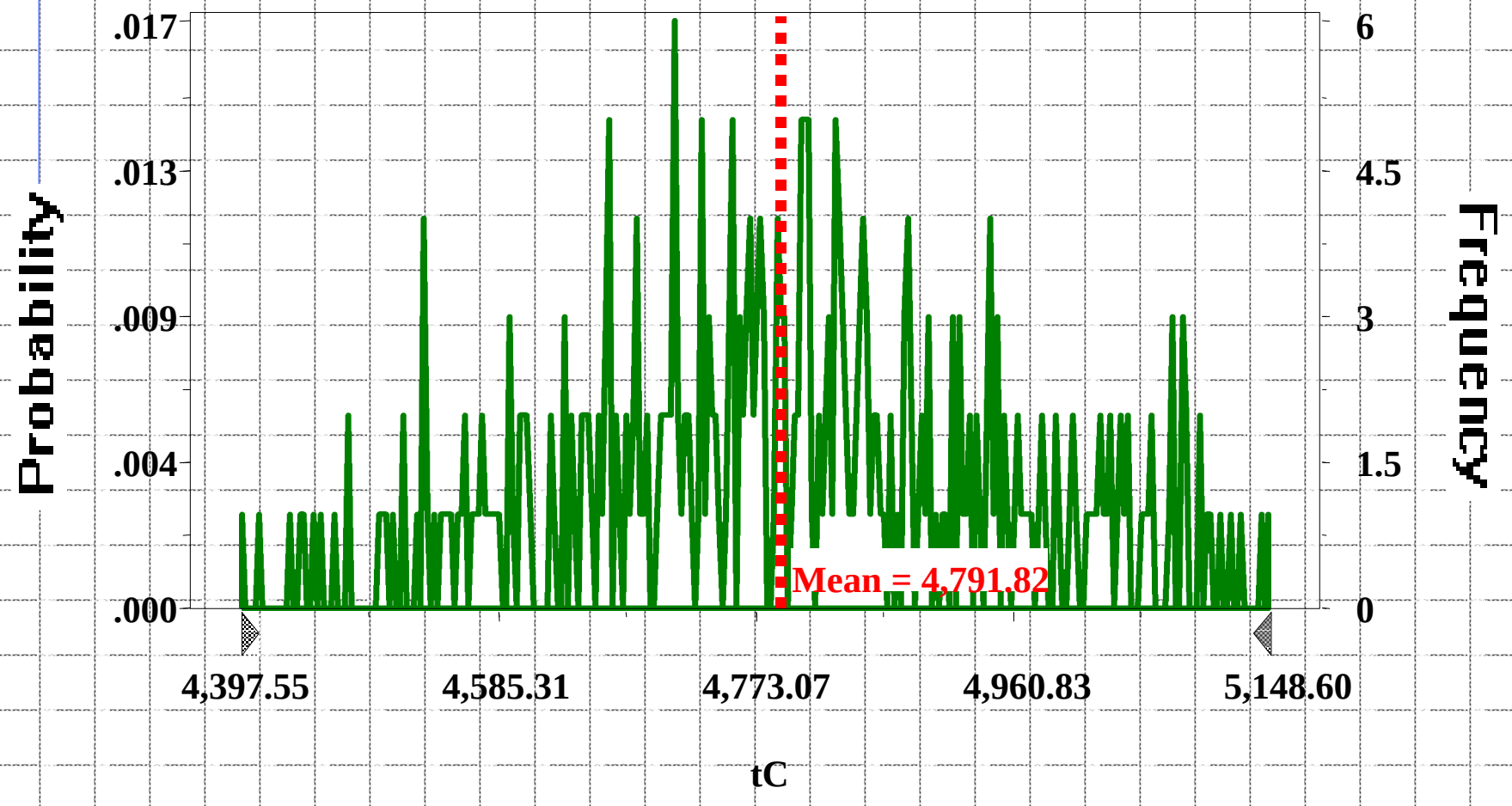
Estimation of leakage uncertainty from the increase of H-E in the system



Estimation of leakage uncertainty from the increase of coal mining



Estimation of leakage uncertainty from the whole system



Cost-Benefits Analysis

$$C = CI + CT(I) + CT(NI) + NPV\left(COM + EP \times \left(\frac{CF}{p} + CV\right)\right)_d$$

$$= CI + CT(I) + CT(NI) + \sum_{i=1}^{n} COM_i (1+d)^{-t} + \sum_{j=1}^{m}\left(\sum_{i=1}^{n} EP_{ij} \times \left(\frac{CF_i}{p_i} + CV_i\right)(1+d)^{-i}\right)$$

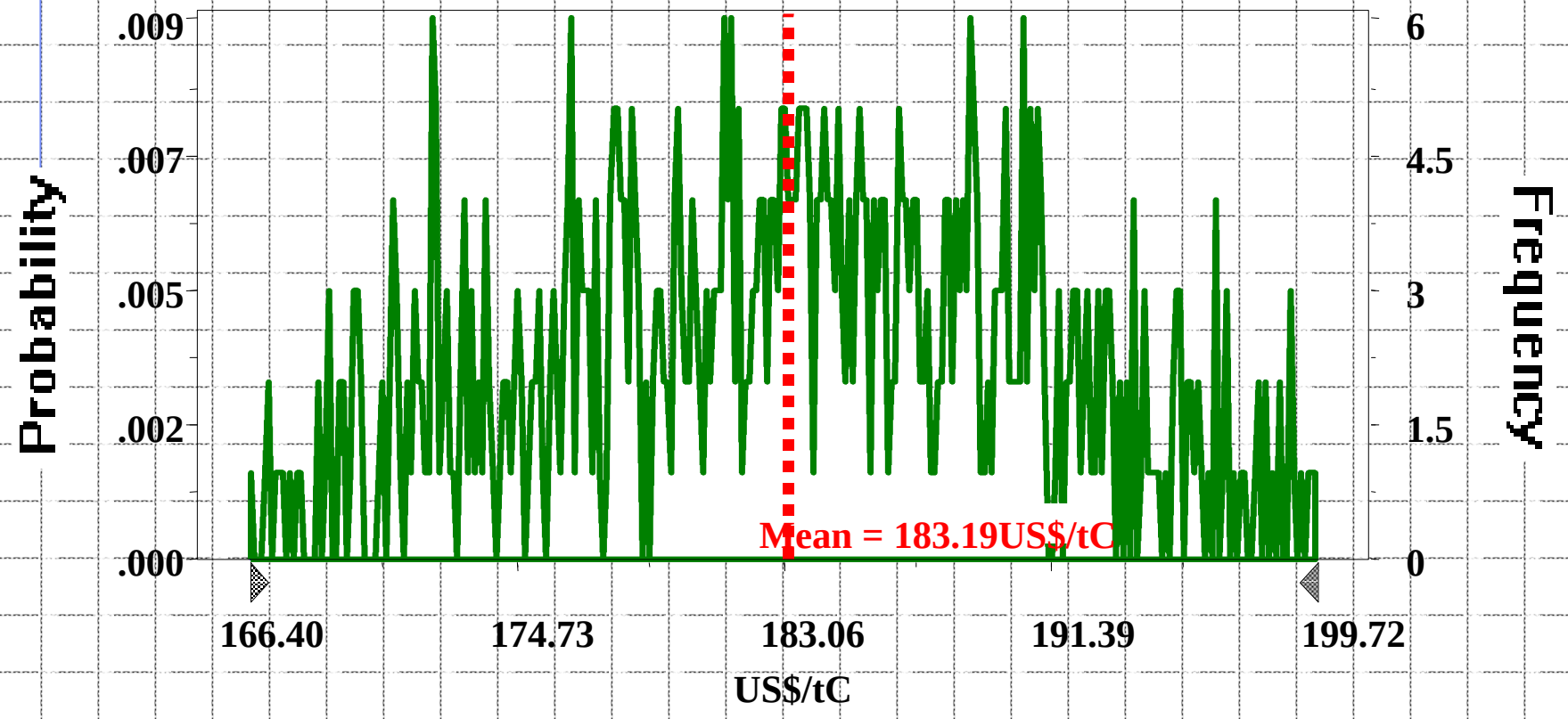
$$B = NPV\left(E \times p(E) + T \times p(T)\right)_d + NPV\left(CERs(t) \times p(CERs)\right)$$

$$= \sum_{i=1}^{n} \frac{(E_i \times p_i(E) + T_i \times p_i(T))}{(1+d)^i} + \sum_{t=t_0+1}^{t+t_0+1} \frac{(E_{CDM}(t) \times (e(i_0) - e_{CDM}(t)) \times p_t(CERs))}{(1+d)^t}$$

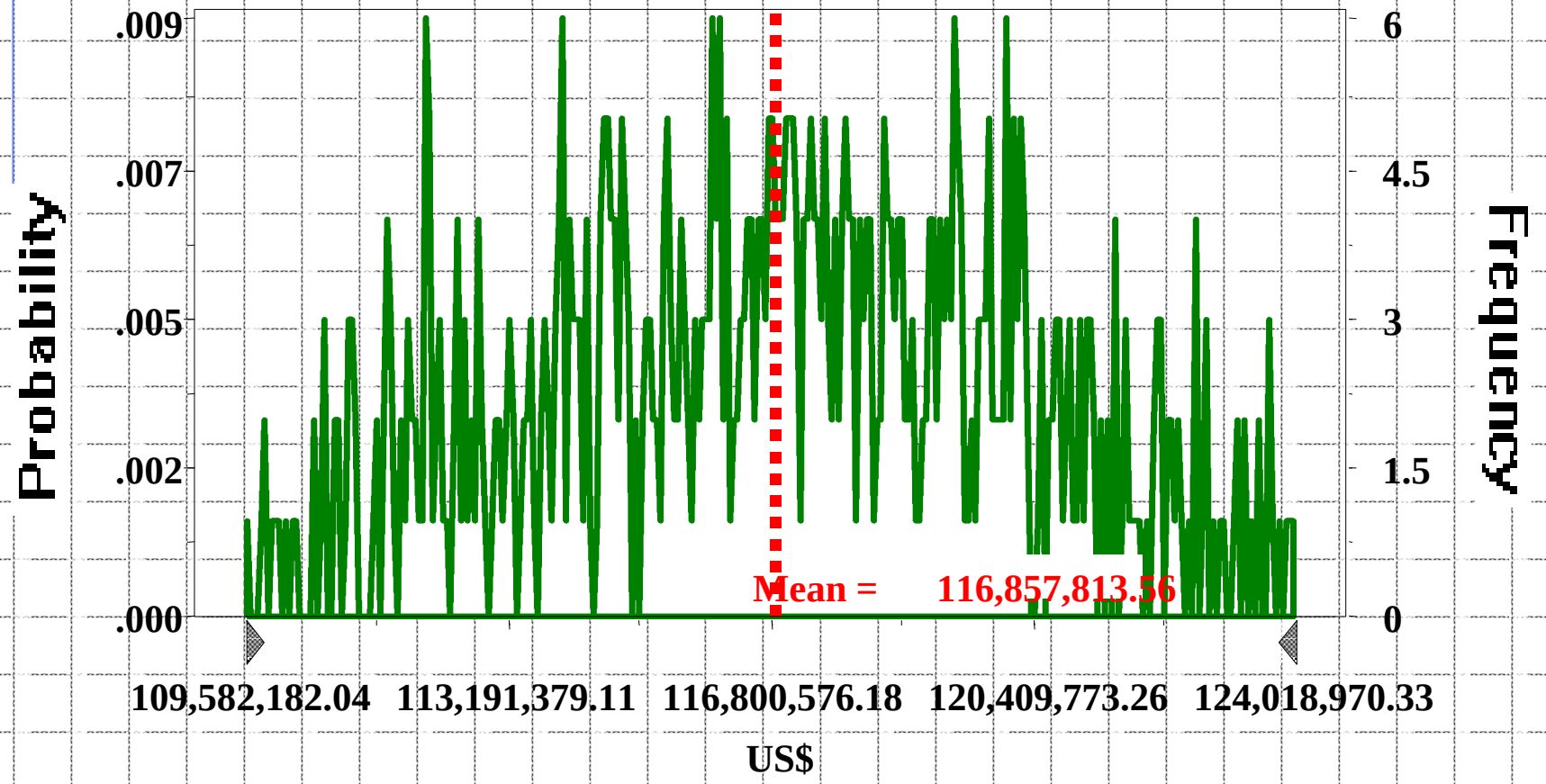
Criterion: B/C>1

Uncertainty sources: d, $e(t_0)$

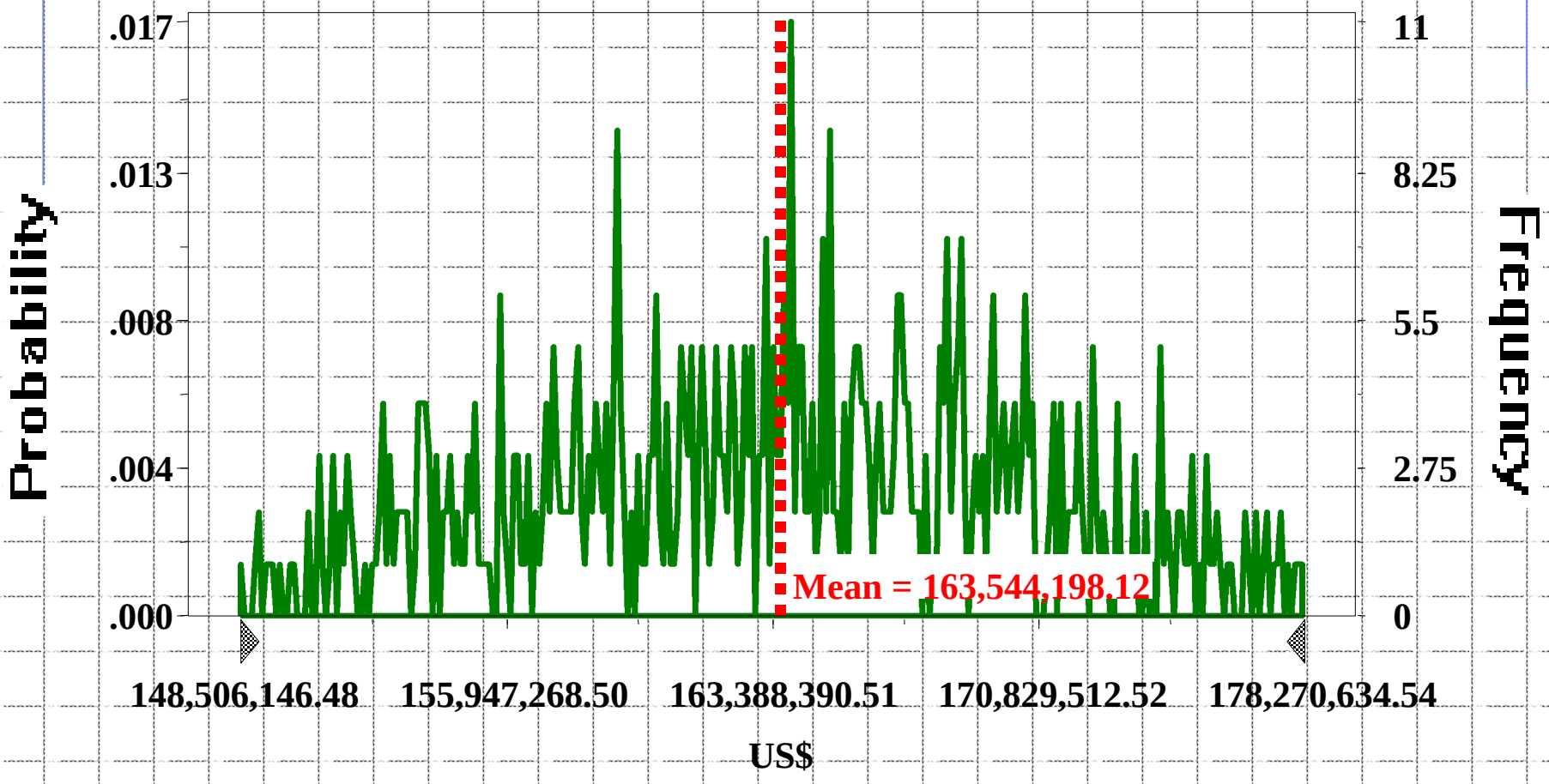
Uncertainty estimation of ICER



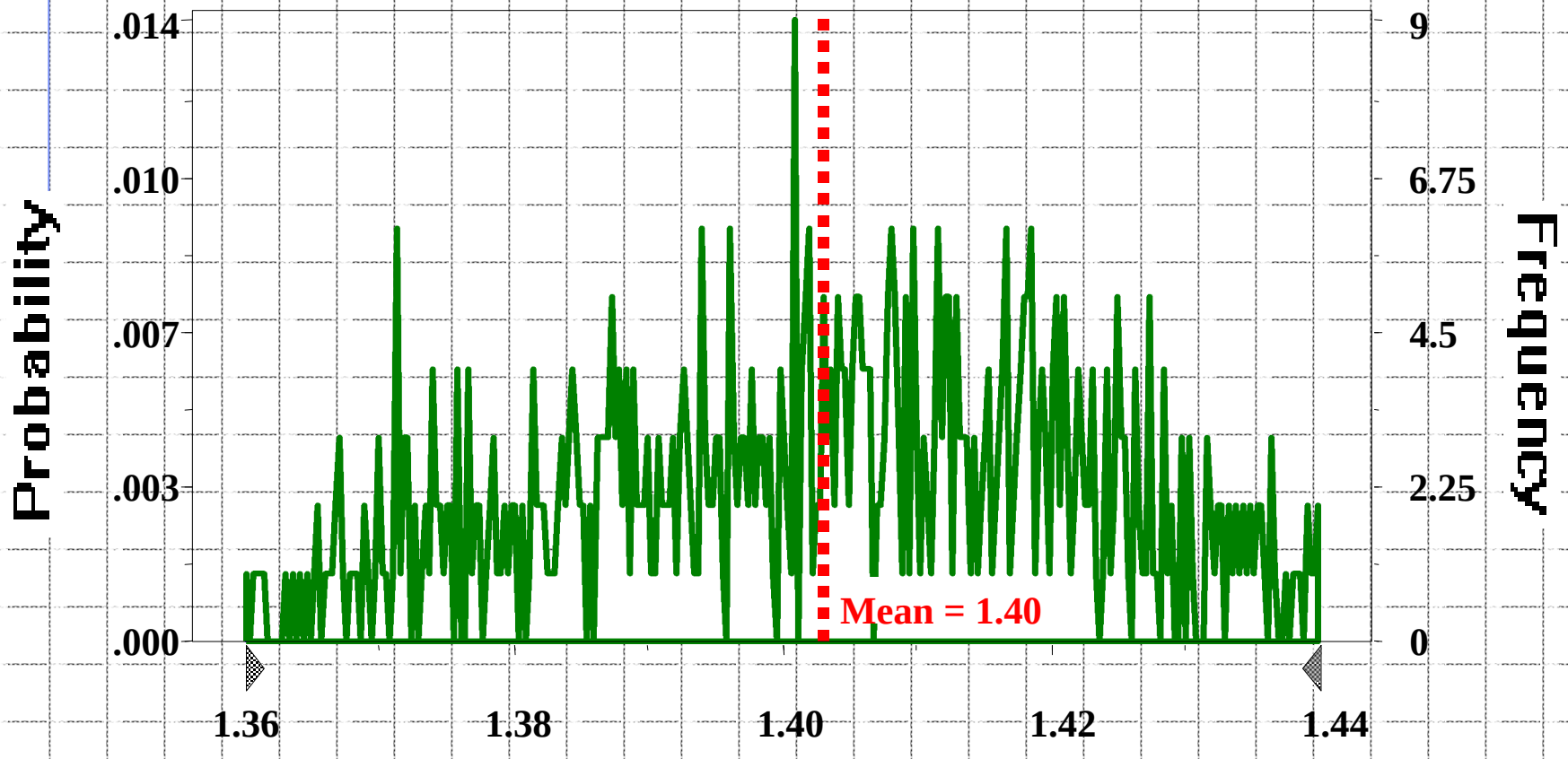
Uncertainty estimation of the total cost



Uncertainty estimation of the total Benefits



Uncertainty estimation of the B/C



Uncertainty analysis on Carbon Sequestration Projects(sinks): basic framework for the potential LULUCF as CDM projects(though un-ratified by COP)

- *Considering the social and environmental effects*

Basic additionality criterions:

- *promote sustainable development*
- *improve sustainable forest management*
- *affect large areas of land and the people who live in and around those lands*
- *possible concentration on one or several species will inevitably results in a reduction in genetic, species and ecosystem diversity*
- *any project that fail to recognise and address negative impacts should not be considered as eligible CDM projects*
- *this requires the independent third party certification*

Leakage assessment

Categories:

- ***Direct leakage: activity-shifting leakage***
- ***Indirect leakage: market-based leakage***

Solutions:

- ***At the project design phase, identifying and managing the direct leakage***
- ***Development of econometric supply and demand models to estimate the impact of the project***

Uncertainty sources

- *Parameters that are used to estimate carbon flows within sinks projects*
- *Quantitative risks include threats such as fire, drought, insect and pest attack*

  Possible Solutions:

  - *give definite Confidence limits*
  - *conservative parameters and default values*
  - *risk assessment approach*

LULUCF as CDM projects: how to choose and recognize the eligible projects for a local or regional area

- *Develop multi-criteria model analysis method specifically and solve the conflictive feature of local or regional LULUCF planning projects*
- *Compute a Pareto-Optimal solution that corresponds to the set of the aspiration/reservation levels.*
  - *Minimizing energy consumption*
  - *Maximizing grassland in local or regional areas*
  - *Maximizing forests areas inside and outside(in the scope of system boundary) local or regional areas*