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Ente per le Nuove tecnologie, l'Energia e l'Ambiente

Ministero dello Sviluppo Economico

RICERCA SISTEMA ELETTRICO

Linee guida per comunicazione e informazione – Attività di comunicazione nell'ambito della valutazione e gestione della sicurezza di un deposito di rifiuti radioattivi. Analisi critica di esperienze internazionali

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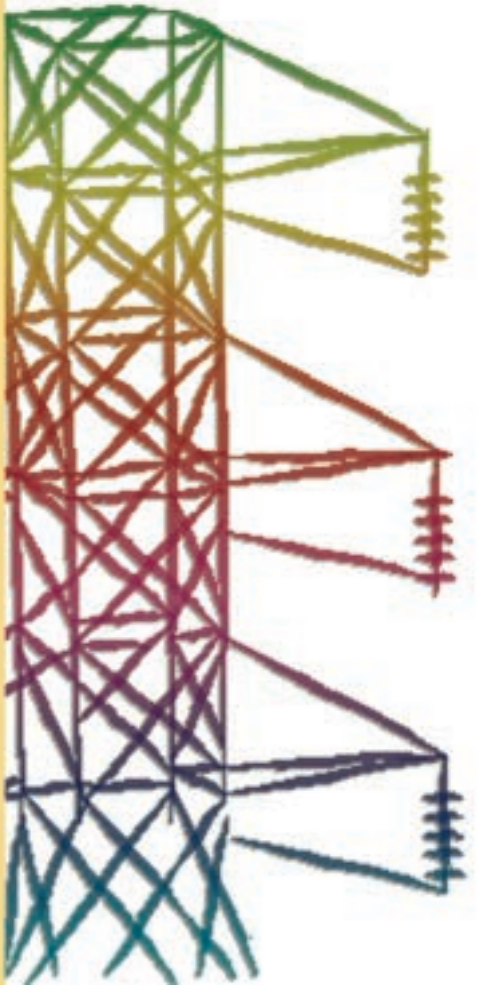

Report RSE/2009/125

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LINEE GUIDA PER COMUNICAZIONE E INFORMAZIONE – ATTIVITÀ DI COMUNICAZIONE NELL'AMBITO DELLA VALUTAZIONE E GESTIONE DELLA SICUREZZA DI UN DEPOSITO DI RIFIUTI RADIOATTIVI. ANALISI CRITICA DI ESPERIENZE INTERNAZIONALI

E. Zio, F. Cadini, D. Avram (CIRTEN)

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CIRTEN

CONSORZIO INTERUNIVERSITARIO

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POLITECNICO DI MILANO

DIPARTIMENTO DI ENERGIA

Linee Guida per Comunicazione ed Informazione

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AUTORI

E. Zio, F. Cadini, D. Avram

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INDICE

Lista acronimi

Organizations	
AECB	Atomic Energy Control Board, Canada
ANDRA	Agence Nationale pour la gestion des Dechets RAdioactifs, France
BMU	Bundesministerium für Umwelt - German Federal Ministry for the Environment Nature Conservation and Nuclear Safety
CIRTEN	Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare, Italy
CNSC	Canadian Nuclear Safety Commission
CSN	Consejo de Seguridad Nuclear, Spain
DEFRA	Department for Environment, Food and Rural Affairs, UK
DOE	U.S. Department of Energy
ENEA	Ente per le Nuove tecnologie, l'Energia e l'Ambiente, Italy
ENRESA	Empresa Nacional de Residuos Radioactivos SA, Spain
FSC	Forum on Stakeholder confidence of the OECD NEA
HAEA	Hungary Atomic Energy Agency
HSK	Swiss Federal Nuclear Safety Inspectorate
JNC	Japan Nuclear Cycle Development Institute
NAGRA	National Co-operative for the Disposal of Radioactive Waste, Switzerland
NEA	Nuclear Energy Agency
NGO	Non-Governmental Organization
NIRAS	Nationale Instelling voor Radioactief Afval en verrijkte Splijtstoffen, Belgium
NIREX Ltd.	Waste Disposal Service, UK
NRC	National Research Council of the United State Academy of Science
OECD	Organisation for Economic Co-operation and Development
ONDRAF	Organisme National des Déchets Radioactifs et des matières Fissiles enrichies
POSIVA	Expert organisation responsible for the final disposal of spent nuclear fuel, Finland
RAWRA	Radioactive Waste Repository Authority, Czech Republic
SKI	Swedish Nuclear Power Inspectorate
SKB	Swedish Nuclear Fuel and Waste Management Co.
SSI	Swedish Radiation Protection Authority
STA	Science and Technology Agency, Japan
STUK	Radiation and Nuclear Safety Authority, Finland
USNRC	U.S. Nuclear Regulatory Commission

Technical acronyms	
EIA	Environmental Impact Assessment
LILW	Low and Intermediate Level Waste
LLW	Low Level Waste
LULU	Locally Unwanted Land Uses
NWPA	Nuclear Waste Policy Act, USA
RWG	Radioactive Waste Governance
RWM	Radioactive Waste Management
RWMC	Radioactive Waste Management Committee of the OECD NEA
SEA	Strategic Environmental Assessment
URL	Underground Research Laboratory

Sommario

L'insediamento locale di impianti e strutture antropiche ad alto rischio rappresenta un problema decisionale di difficile soluzione, a causa sia delle complessità tecniche relative alla valutazione del rischio che delle difficoltà di accettabilità sociale. Questo tipo di insediamenti, spesso identificati con l'acronimo LULUs della parola inglese Locally Unwanted Land Uses, ha la caratteristica di minacciare di esternalità negative gli ambienti circostanti [1]. Paradossalmente, i benefici legati allo sviluppo di questi insediamenti sono distribuiti su larga scala mentre i costi e rischi sono localizzati sulla piccola scala degli ambienti circostanti l'insediamento [2].

Gli insediamenti nucleari sono tra i più temuti dai residenti locali, perché fuori dalla loro volontà e controllo, nonché ritenuti fatali e catastrofici. Per questo i rischi nucleari ricevono un'attenzione prioritaria dal pubblico.

D'altra parte, le esigenze energetiche mondiali sono tali da rendere il nucleare un'irrinunciabile fonte di energia. Attualmente, vi sono nel mondo 438 impianti nucleari in operazione, per una capacità totale installata pari a 371773 GWe; alcuni Paesi hanno un'alta percentuale di energia prodotta per via nucleare (78% Francia, 54% Belgio, 48% Svezia, 38.6% Korea) [3]; sebbene l'espansione dei programmi nucleari abbia subito un rallentamento negli anni '90, il numero di installazioni nucleari è ancora in crescita in alcuni Paesi in via di sviluppo [4] e l'atteggiamento dei governi e delle popolazioni di molti Paesi (inclusa l'Italia) sta cambiando, di fronte alle preoccupazioni per l'approvvigionamento di risorse energetiche sicure e stabili e per la salvaguardia dell'ambiente.

In questo quadro di "rinascimento nucleare", gli impianti di smaltimento dei rifiuti radioattivi mantengono un'accezione fortemente negativa e costituiscono LULUs soggetti a forte opposizione pubblica. Per questo, è uso comune indicare il problema della gestione dei rifiuti radioattivi come "tallone d'Achille" per lo sviluppo dell'industria nucleare [4].

Attraverso una sintesi ed analisi critica delle pratiche di comunicazione del rischio adottate in altri Paesi, il presente lavoro si propone di contribuire alla costituzione di una coscienza di sicurezza per la gestione partecipata dei rifiuti radioattivi in Italia.

In particolare, il rapporto illustra l'attività di studio delle esperienze sviluppate da Enti nazionali ed esteri, nell'ambito della comunicazione dei rischi derivanti dallo smaltimento di rifiuti radioattivi in un deposito ingegneristico superficiale.

Il lavoro è inserito in quanto previsto dal Piano Annuale delle attività oggetto dell'Accordo di Collaborazione fra ENEA e CIRTEN, nell'ambito dell'Accordo di Programma MSE-ENEA, tema di ricerca n. 5.2.5.8 "Nuovo nucleare da fissione"; linea progettuale LP4: Attività a supporto della individuazione e scelta di un sito e per la successiva realizzazione di un deposito di smaltimento dei rifiuti radioattivi di II Categoria e di un deposito di stoccaggio a medio-lungo termine dei rifiuti ad alta attività e lunga vita.

L'obiettivo dell'attività complessiva è quello di fornire una base per lo sviluppo di una strategia partecipativa di comunicazione e informazione, con il coinvolgimento di tutti gli attori che svolgono un ruolo (sia attivo che passivo) nel problema della gestione dei rifiuti radioattivi. L'attività deve contribuire a ricreare, aggiornare e/o consolidare le competenze in Italia nella materia in oggetto.

1. Introduzione

1.1 Motivazioni del lavoro

In tutto il mondo, la governance a lungo termine dei rifiuti radioattivi (radioactive waste governance - RWG) continua a costituire uno dei principali problemi decisionali ancora irrisolti, a causa dell'elevata complessità socio-tecnica. Ad oggi, l'opinione comune è che la gestione di un sistema così complesso richieda una prospettiva integrata [5]. La maggior parte della responsabilità dell'assenza di una gestione efficiente in questa delicata area è da ascrivere all'insufficiente livello di considerazione nei riguardi dei diversi aspetti coinvolti. Negli anni '90 le agenzie nucleari internazionali riconobbero che non fosse loro compito esclusivo quello di prendere decisioni su problematiche così complesse. Così la Nuclear Energy Agency (NEA) nel 1999 affermava che: "piuttosto, è necessario un giudizio "informato" della società nel suo complesso" [6]. Di conseguenza, in accordo con gli sforzi della International Atomic Energy Agency (IAEA) [7][8], la NEA creò il cosiddetto *Forum on Stakeholder Confidence* (FSC), "per facilitare la condivisione di esperienza internazionale nell'affrontare l'aspetto sociale della gestione dei rifiuti radioattivi" [9]. Coerentemente, il Sesto Programma Quadro della Comunità Europea per la Ricerca e lo Sviluppo Tecnologico avviato nel 2002 affermò che la ricerca "da sola non può assicurare l'accettazione sociale; tuttavia è necessaria al fine di ... promuovere la comprensione scientifica di base legata alla sicurezza e ai metodi per la sua valutazione, e di sviluppare processi decisionali che sono percepiti come giusti ed equi dalle terze parti coinvolte" [10].
Nel riassumere le complesse ed interconnesse argomentazioni sorte da diverse esperienze internazionali nella gestione dei rifiuti radioattivi, emergono le seguenti problematiche:

Gestione dei rifiuti radioattivi: Un problema "tecnico" o "politico"?

- Come tema ricorrente, l'apparente contrapposizione tra il "tecnico" (cioè *tecnicamente risolto*) e il "politico" (cioè *politicamente problematico*) pervade tutti i periodi storici. Gli attuatori e le autorità, hanno storicamente mantenuto tutte le problematiche tecniche sotto controllo e le "motivazioni dei ritardi" sotto la responsabilità "politica"; d'altra parte, gli attori che appartengono principalmente alla sfera "NGO-oriented" hanno asserito che, a tuttoggi, persino gli aspetti tecnici non sono stati risolti. Questo fenomeno non è specifico delle decisioni in materia nucleare essendo, come noto, "l'essenza della politica basata sulla comprensione di opzioni tecniche" [11].
- Il problema dei rifiuti radioattivi è politicamente strumentalizzato sia dagli oppositori che dai fautori dell'energia nucleare: "irrisolvibilità" come argomentazione per la cessazione contro "soluzione" come prova della legittimità dell'utilizzo prolungato dell'energia nucleare.

Posizione rispetto alle problematiche tecniche (dibattito sul rischio, fenomeni a lungo termine)

- Come per altri campi sociali/tecnologici complessi, le problematiche sono state spesso dibattute in ordine invertito: per prime quelle tecniche e commerciali, poi quelle politiche ed economiche, quelle sociali ed infine quelle etiche.
- Le opinioni divergenti nei confronti delle problematiche tecniche diventano evidenti nelle differenti posizioni riguardo la gestione della sicurezza e del rischio. Mentre la comunità responsabile della gestione dei rifiuti radioattivi assume come inevitabile un rischio "residuo", da controllare e ridurre mediante opportune valutazioni e conseguenti misure di mitigazione, alcune fazioni oppositrici facenti parte del movimento anti-nuclearista pretendono "sicurezza assoluta", "miglior soluzione possibile" e "migliori siti".
- Gli aspetti di lungo termine non sono stati presi in considerazione prima della metà degli anni '70. In quegli anni la comunità scientifica legata al problema dei rifiuti radioattivi propose il concetto di smaltimento definitivo mentre parte di altri esperti e del pubblico sostenevano con forza l'esigenza di controllabilità e reversibilità.
- La consapevolezza che una rigorosa prova matematica della sicurezza a lungo termine non sia perseguibile ha fatto emergere la necessità di una procedura per passi iterativi che includano l'"insieme di argomentazioni" a cui si è fatto riferimento in precedenza, basata su approcci tecnici (ad es., specifici indicatori di sicurezza e impianti pilota) e componenti istituzionali (ad es., controllo di qualità, procedure di revisione).

Coinvolgimento di terze parti e procedura

- Fino agli anni '80, le "terze parti", che non appartenevano né agli sviluppatori/fautori, né agli enti regolatori, né ad esperti del settore, non furono coinvolte nel processo decisionale. Il modello lineare del "Decidi – Annuncia – Difendi (DAD)" [12] prevalse, in una apparentemente contraddittoria miscela di modelli tecnocratici e decisionistici [13]: l'"establishment" [14] industriale nucleare, l'ente regolatore e la politica costituivano un cerchio chiuso. Questa situazione è gradualmente cambiata con la creazione di sottogruppi di interesse supportati da esperti esterni.
- I summenzionati gruppi esterni agirono come "impeto iniziale" o incoraggiarono altri su problematiche decisive, quali ad esempio il criticismo della programmazione, la non-tracciabilità del processo di selezione del sito, il processo di revisione, la partecipazione del pubblico.
- In alcune situazioni, il pubblico ottenne il proprio coinvolgimento con la forza dei voti popolari e dei referendum, potendo così esercitare pressioni per cambiamenti e modifiche ai programmi.

- Le considerazioni politiche predominarono su quelle basate su problemi e fatti. In vari Paesi, partiti politici e associazioni di terze parti strumentalizzarono il problema dei rifiuti radioattivi all'interno delle loro politiche energetiche. Questo fece sì che gli aspetti procedurali di programmi di smaltimento così complessi non fossero seguiti pedissequamente e, se anche lo furono, furono considerati e imposti come problema politico.

Concepimento ed evoluzione di un programma di smaltimento e processi di apprendimento

- I concetti ed i requisiti dei programmi di smaltimento sono stati spesso cambiati in corsa, ancora senza concertazioni e decisioni partecipate, e in maniera non trascurabile in alcune occasioni. Solo recentemente le revisioni di programmi di smaltimento sono state dibattute in una cerchia più allargata di terze parti.
- Come accennato, le considerazioni politiche spesso prevaricano quelle basate su problemi e fatti. La questione dei rifiuti radioattivi è spesso stata strumentalizzata da tutti i principali gruppi coinvolti ed assunta come "campo di battaglia" politica.
- Con riferimento alla programmazione e agli aspetti pratici, il passato fu caratterizzato da un eccessivo ottimismo, in particolare negli anni '80. Inizialmente, fu data priorità alle più familiari problematiche di ingegneria strutturale, mentre quelle legate alle esigenze di sicurezza a lungo termine furono trascurate e sottostimate.
- La padronanza completa di una procedura complessa di RWG è pressoché impossibile per qualunque soggetto. Per questo è necessario introdurre deleghe sui vari aspetti. Esempi in campo tecnico sono la controllabilità, la reversibilità, i criteri di esclusione dei siti, gli indicatori di sicurezza o la tracciabilità delle argomentazioni. La separazione di promozione e supervisione, la pubblicazione estensiva di documenti, le revisioni esterne costituiscono deleghe di aspetti procedurali.
- Per quanto riguarda i processi di acculturamento ed apprendimento, le forme di "apprendimento adattativo" e "*trial and error*" prevalgono nel complesso e politicamente coinvolto mondo della gestione dei rifiuti radioattivi. Esse sono tipicamente indotte da "impasse" programmatiche o pressioni politiche come il rifiuto all'applicazione di una decisione (vedi il caso dei potenziali siti di smaltimento dei rifiuti di basso livello a Wellenberg (Svizzera) nel 1995 ed a Scanzano (Italia) nel 2003).
- L'interazione dei gruppi di terze parti coinvolte [15] suggerisce una convergenza parziale e un'acquisizione graduale di valori e nozioni come la controllabilità e la reversibilità o l'estensione del concetto di smaltimento.
- Lo scambio di risorse e di informazioni è ostacolato dalla strumentalizzazione politica della questione. Tipicamente esistono associazioni tra i fautori e gli sviluppatori, così come tra gli enti

regolatori (enti di supervisione nazionali, forum NEA) [16]. Assieme a queste associazioni, esperti di ingegneria, istituti universitari e comitati di supporto costituiscono la comunità nucleare in un senso più ristretto (ad esempio il forum IAEA). Nella fase di sviluppo, la mancanza di una rete di lavoro totalmente interconnessa è destinata a portare ad un fallimento: il trasferimento della conoscenza ed una programmazione rinforzata dal punto di vista tecnico e sociale possono essere sostenibili solo se alimentate dalle risorse necessarie.

Da quanto sopra evidenziato, emerge chiaramente che lo sviluppo di un progetto di smaltimento di rifiuti radioattivi costituisce un problema decisionale difficile, a causa sia delle complessità tecniche relative alla valutazione della sicurezza a lungo termine che delle difficoltà di accettabilità sociale.

La soluzione dei problemi emersi nelle diverse esperienze internazionali richiede lo sviluppo di un approccio che permetta di garantire la robustezza del progetto di smaltimento dei rifiuti tramite l'integrazione di tutti i punti di vista tecnici, sociali e politici coinvolti. Questo richiede lo sviluppo di un processo comprensibile, a passi iterativi e plausibile con la finalità di costruire una soluzione finale condivisa per la sicurezza a lungo termine. La procedura adottata deve essere tracciabile per i non-esperti e scevra da difficoltà legate a scarsa conoscenza e infondati pregiudizi che contribuiscono al "terrore radioattivo".

Per questo è ormai considerato di primaria importanza che lo sviluppo tecnologico e la progettazione ingegneristica di un programma di smaltimento di rifiuti radioattivi siano accompagnati da adeguate attività di comunicazione, sensibilizzazione e coinvolgimento delle popolazioni locali, senza la cui approvazione ogni iniziativa è destinata a fallire.

1.2 Generalità

L'incidente nucleare di Černobyl' (Aprile 1986) ha dato inizio ad una sorta di "radiofobia" mondiale nell'opinione pubblica, generando la sfiducia delle organizzazioni non governative nei confronti di qualunque attività di tipo nucleare e contribuendo alla nascita di un forte movimento internazionale anti-nuclearista, che hanno causato un rallentamento significativo nello sviluppo dell'energia nucleare [17]. Dopo Černobyl' non si sono verificati incidenti seri nell'industria nucleare per più di venti anni. Sebbene ciò abbia contribuito ad una riduzione dell'opposizione all'industria nucleare, molti paesi del mondo si sono trovati a combattere forti opposizioni delle comunità locali per la scelta di un sito per lo smaltimento di rifiuti radioattivi [17]. La gestione dei rifiuti radioattivi e la relativa scelta di un sito adatto per la costruzione di un impianto di smaltimento generano l'opposizione del pubblico sensibile all'importanza sociale e politica degli aspetti di salvaguardia della salute e dell'ambiente.

L'approvazione o il rifiuto da parte del pubblico della costruzione di un impianto di smaltimento di rifiuti radioattivi è legato al modo in cui il rischio associato è percepito. La percezione è un fenomeno selettivo per il quale persone o gruppi sociali differenti recepiscono cose differenti sulla stessa realtà a causa di un processo soggettivo [18]. La percezione e la fiducia pubblica sono i problemi piu' critici del processo di ottenimento dell'approvazione per lo sviluppo di impianti di smaltimento di rifiuti radioattivi in siti specifici, la qual cosa solleva la questione di come sia meglio ottenere la fiducia sugli aspetti etici, economici, politici e tecnici della strategia di gestione dei rifiuti in generale, e del loro smaltimento in particolare [18].

Fin dalla metà degli anni '80 il tema dell'inventario radioattivo, inclusa la definizione e l'allocazione a siti specifici, ha preoccupato le parti interessate in RWG. A livello internazionale è stata richiesta la definizione di una coerente classificazione dei rifiuti: nel corso del IAEA's 3rd Scientific Forum del 2000 ci si è lamentati ufficialmente del fatto che "esiste un'aria di mistero attorno ai rifiuti radioattivi, che è almeno parzialmente il risultato della complessa, ed a volte oscura, terminologia utilizzata dagli specialisti" [19]. Una raccomandazione dell'International Regulatory Review Team (IRRT) alle autorità Svizzere per la sicurezza è basata sulle medesime preoccupazioni [20].

In conformità con gli standard internazionali, la comunità nucleare ha, fino a poco tempo fa, evitato di definire l'inventario prima della costruzione del deposito corrispondente. Pur riconoscendo l'intrinseca complessità del fornire evidenze conclusive di sicurezza a lungo termine, appare fondamentale la presentazione della valutazione di sicurezza (*safety case*) [21][22]:

- L'evidenza di sicurezza a lungo termine di un deposito di smaltimento deve essere supportata da analisi di sicurezza revisionate in accordo con lo stato dell'arte.
- Gli obiettivi di protezione contenuti nelle linee guida normative devono evidentemente essere osservati, ma ulteriori indicatori possono essere sviluppati per aiutare a ridurre le incertezze e stabilire la trasparenza del processo di valutazione della sicurezza.
- Criteri singoli quali il periodo di dimezzamento dei radionuclidi, la loro origine, ecc. non sono commisurati alla complessità del problema e devono essere sostituiti da un insieme di diversi indicatori.
- La selezione dei criteri e dei siti proposti, e la relativa valutazione devono essere continuativamente tracciabili e plausibili.
- La robustezza del progetto di smaltimento adottato deve essere garantita integralmente, rispetto a tutte le problematiche tecniche, sociali e politiche. La trasparenza e la tracciabilità sono attributi chiave del processo, poiché la robustezza del sistema di smaltimento può essere verificata e valutata solo se i suoi parametri sono chiaramente definiti [23].
- In un mondo dotato di risorse limitate, la recuperabilità di un materiale specifico e ingegneristicamente processato come il rifiuto radioattivo rappresenta un'opzione che dovrebbe essere presa in considerazione in una prospettiva di gestione delle risorse. I rifiuti nucleari incorporano un potenziale utilizzo per scopi attualmente sconosciuti per le generazioni future. Tornando al concetto di un ciclo del combustibile chiuso, questa è una nuova prospettiva che richiede nuovi tipi di soluzioni nel RWG. Pertanto, è necessario essere al corrente delle implicazioni legate a questa scelta, rispetto alla continuazione dell'opzione nucleare, agli investimenti su e all'impegno nella ricerca nucleare, ecc.

L'estensione dell'analisi di sicurezza per l'integrazione di tutti gli aspetti tecnici, sociali e politici, è argomentata dalle seguenti motivazioni. Nel passato, tipicamente tutte le parti terze, con l'eccezione dei pochi analisti di "performance assessment", si sono trovate a confrontarsi con decisioni già confezionate e soluzioni definitive. A livello tecnico, alle terze parti erano forniti rapporti di sicurezza contenenti informazioni comprovanti il soddisfacimento dei requisiti di sicurezza; a livello legale, esse ricevevano direttamente i documenti di richiesta della licenza o concessione dell'impianto. Sebbene fosse garantito che la decisione fosse "aperta", gli aspetti fondamentali del processo decisionale non venivano presentati prima della fase finale del processo deliberatorio.

Al contrario, una procedura di integrazione percepita dal pubblico come "a passi iterativi", persino per quanto riguarda gli aspetti tecnici, collegherebbe direttamente tra loro le discussioni su rifiuti e ricerca del sito attraverso la discussione dei criteri, in modo ricorsivo. In parallelo a criteri consensualmente ottenuti in

campo scientifico, un insieme di criteri per la definizione dell'inventario e classificazione dei rifiuti dovrebbe essere sviluppato. I necessari sforzi di diversificazione degli indicatori di sicurezza, aumento di trasparenza e coinvolgimento delle parti terze sono in accordo con le recenti discussioni internazionali [7][21][22][24][25][26][27][28][29][30][31] ed i recenti impegni di ricerca della Comunità Europea [10][32].

Nell'ottica di un approccio integrato alla robustezza dei progetti di gestione dei rifiuti radioattivi, la comunicazione e l'informazione al pubblico ed alle terze parti in genere, è cruciale per la costruzione del consenso. In generale, la condivisione di informazioni adeguate è la base dei Paesi democratici ove la società ha ogni diritto di prendere parte al processo decisionale. In tale contesto, una regola per una comunicazione attiva permanente, trasparente e ben coordinata tra tutte le aree di un'organizzazione deve essere realizzata. Deve essere mantenuta attiva la comunicazione tra la società e i rappresentanti legittimi nazionali, provinciali e municipali, assieme ad altri esperti quali, ad esempio, le organizzazioni non governative, compagnie private, scuole, professionisti, ecc [17]. Inoltre, qualunque lacuna di informazione lasciata dalle istituzioni responsabili della gestione dei rifiuti radioattivi può essere colmata dalle opinioni di coloro che apertamente si oppongono alle attività di tipo nucleare o di altri che diventano i portavoce di gruppi fondamentalisti-ambientalisti [17]. A questo riguardo, il modo in cui i mezzi di comunicazione trasmettono le informazioni relative alla questione e riportano ricerche e studi a riguardo può avere grande rilevanza a causa degli effetti che la loro opinione esercita sul pubblico. I mezzi di comunicazione possono formare l'immagine della realtà sociale su una problematica controversa, quale può essere la selezione del sito per lo smaltimento dei rifiuti radioattivi.

Sebbene per un'istituzione sia difficile avere un unico inquadramento coerente sulla sicurezza e relativa piattaforma di comunicazione per tutte le applicazioni legate alla gestione dei rifiuti radioattivi, dallo smaltimento dei rifiuti radioattivi al ripristino ambientale delle miniere di estrazione [17][33], ogni processo comunicativo efficace deve essere basato sulla presentazione del problema, sulla discussione delle soluzioni alternative e sulla partecipazione alle decisioni, in riconoscimento del fatto che il rischio percepito dal pubblico è tanto importante quanto il rischio reale o quello stimato scientificamente. Questo implica che alle terze parti sia concessa l'opportunità' di interagire il più presto possibile nel processo di sviluppo del progetto di smaltimento, che le proposte siano portate avanti attraverso una procedura di fiducia e che le decisioni siano prese avendo cura delle preoccupazioni locali. Questo richiede di prendere in considerazione come ottenere un più significativo coinvolgimento del pubblico nel processo decisionale, poiché i bisogni delle terze parti non sempre sono anticipabili ma, piuttosto, emergono attraverso il dialogo.

In sintesi, per la progettazione di nuovi impianti a rischio oggi è obbligatorio ottenerne l'approvazione sociale e politica. Questo richiede un processo condiviso di comunicazione, informazione e coinvolgimento decisionale che si spinge oltre la valutazione del solo rischio tecnico ed include le percezioni e le preoccupazioni delle terze parti. D'altra parte, le istituzioni coinvolte nella gestione dei rifiuti radioattivi vivono cambiamenti sociali in rapida evoluzione, con nuove tecnologie di informazione e nuove regole per i mezzi di comunicazione. Questo avviene contemporaneamente al passaggio di alcuni programmi nazionali di smaltimento dei rifiuti dalla fase di ricerca e sviluppo a quella di selezione dei siti e costruzione, mentre altri stanno revisionando e definendo le loro normative in materia di gestione dei rifiuti.

La necessità di condividere le informazioni e l'esigenza di partecipazione del pubblico nel processo decisionale fanno emergere il bisogno di nuovi approcci integrati [18] nei quali il "performance assessment" continua a svolgere un ruolo precipuo nell'affrontare le problematiche tecniche legate alla sicurezza dei progetti di smaltimento proposti. A causa della necessaria longevità degli impianti di smaltimento, "lo scopo del "performance assessment" non è quello di predire il comportamento del sistema di smaltimento a lungo termine, bensì quello di verificare la robustezza del progetto rispetto ai criteri di sicurezza [26]. Tenendo conto di questo aspetto, e dell'esigenza di controllo sui rischi da parte della società occorre introdurre il concetto di "robustezza integrata" – tecnica e sociale – per un'efficace RWG [34][35][36]. Questo implica l'ampliamento del concetto di sicurezza all'integrazione degli aspetti sociali nella strategia di "difesa in profondità" tipica della comunità nucleare [37].

Per quanto riguarda la robustezza tecnica, la NEA fa le seguenti distinzioni [21]:

- Robustezza ingegneristica: "accorgimenti progettuali per il miglioramento delle prestazioni", quali la ridondanza di barriere, il condizionamento dei rifiuti in matrice stabile, la separazione fisica dei rifiuti in manufatti di ridotte dimensioni e pericolosità.
- Robustezza intrinseca: "accorgimenti progettuali e scelte di locazione che evitano fenomeni di degrado ed incertezze di comportamento", quali la collocazione del deposito in strati sedimentari profondi, con proprietà di self-healing, una storia geologica priva di eventi di rilievo, lontani da potenziali risorse sfruttabili dall'uomo.
- Robustezza (tecnica) di sistema: combinazione di accorgimenti progettuali e scelte di locazione, supportata da procedure di verifiche incrociate e garanzia di qualità.

La Figura 1 raffigura schematicamente la componente tecnica di robustezza in termini delle differenti barriere tra la sorgente, cioè l'inventario radioattivo, e l'obiettivo, cioè il gruppo critico esposto alla dose [38].

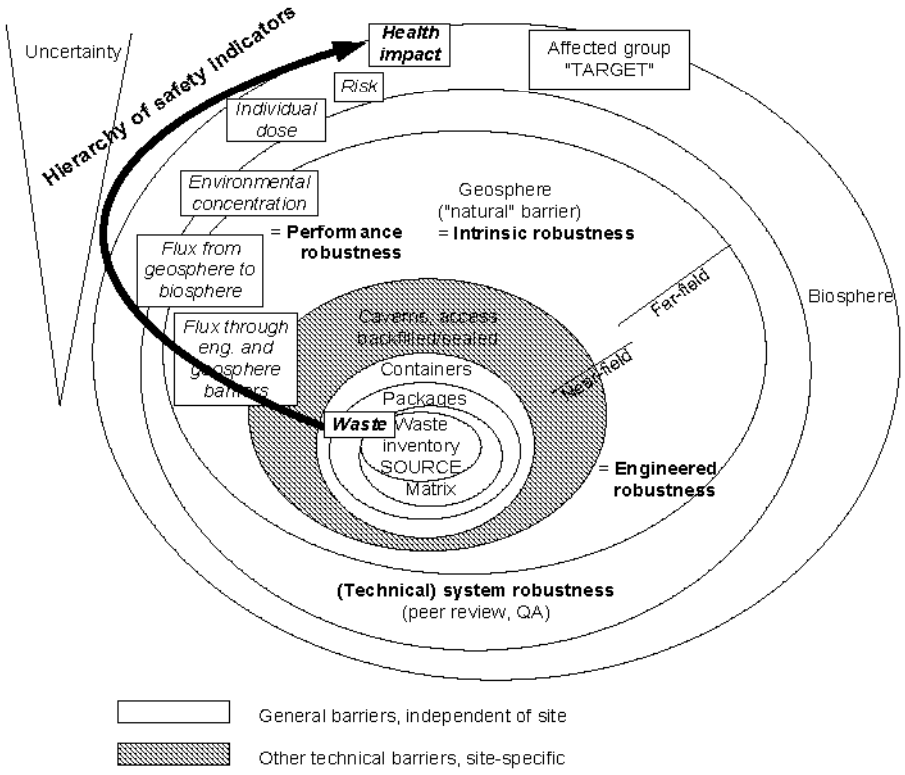

Figura 1: Robustezza tecnica [38].

L'approccio alla robustezza tecnica deve anche considerare che le fasi di progetto di un sistema di smaltimento – dalla scelta del sito, alla caratterizzazione del sistema, il suo progetto, costruzione, operazione e chiusura – si estendono su un arco temporale di alcuni decenni. Oltre alla longevità dei rifiuti radioattivi, che richiede soluzioni tecniche a lungo termine, è necessario pertanto avere a che fare con una dimensione istituzionale a lungo termine. Per questo motivo, i concetti e i principi manageriali devono essere integrati in un percorso decisionale coerente e continuativo che garantisca le robustezze socio-istituzionali del progetto di smaltimento.

In questo scenario, il processo decisionale richiede tanto la presenza di una serie di barriere tecniche contro il rilascio di radioattività, quanto una serie di programmate verifiche sociali mirate ad ottenere e sostenere la fiducia negli accertamenti tecnici e dunque l'accettazione, o quanto meno la tolleranza, da parte della società (Figura 2) [38].

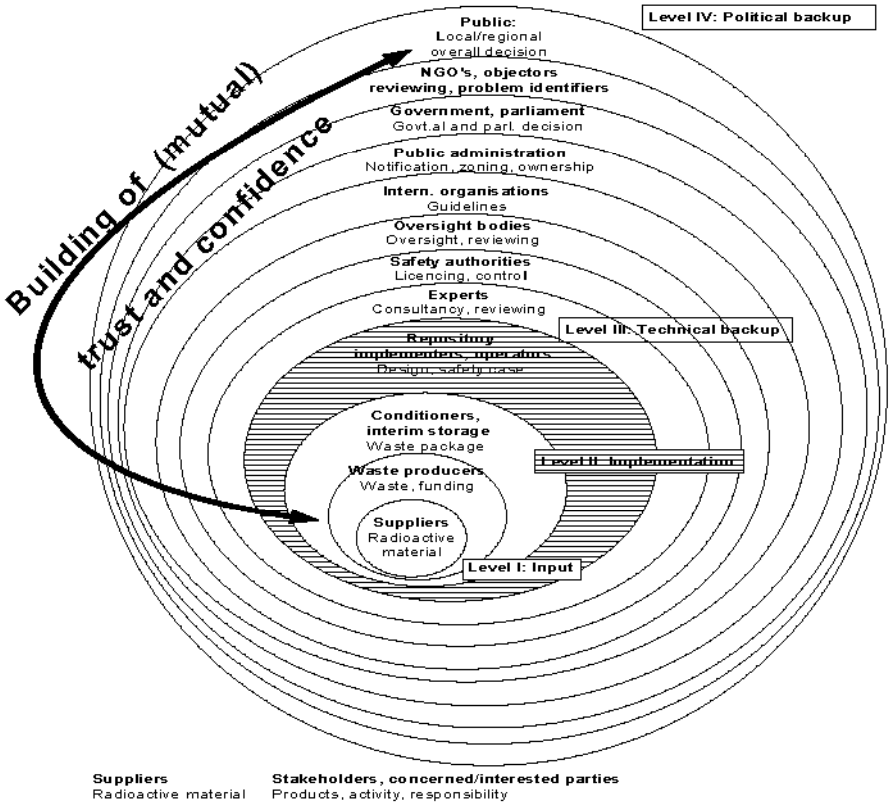

Figura 2: Robustezza socio-istituzionale [38].

La Figura 3 rappresenta l'integrazione degli aspetti tecnici e socio-istituzionali in un concetto di robustezza integrale necessaria al successo di un progetto di smaltimento di rifiuti radioattivi. Per quanto possa essere un concetto vago, la "robustezza integrale" rende conto del complesso carattere socio-tecnico del problema ed offre uno schema di lavoro per integrare iterativamente ed a passi successivi nel RWG tanto gli elementi procedurali/dinamici, quanto i diversi tipi di incertezze che affliggono il problema. Nel contesto della Figura, i termini "robusto" o "robustezza" sono utilizzati in relazione all'analisi di rischio tecnica ed ambientale. In generale un sistema tecnico si dice robusto se non è sensibile rispetto a variazioni significative dei parametri caratteristici. D'altra parte, un sistema è ritenuto "socialmente robusto" se la maggior parte delle argomentazioni, dell'evidenza, degli accordi sociali, degli interessi e dei valori culturali conducono ad un'opinione condivisa e coerente [39]. Ciò comporta che le parti interessate e con potere decisionale giungano ad un consenso su alcuni interessi comuni.

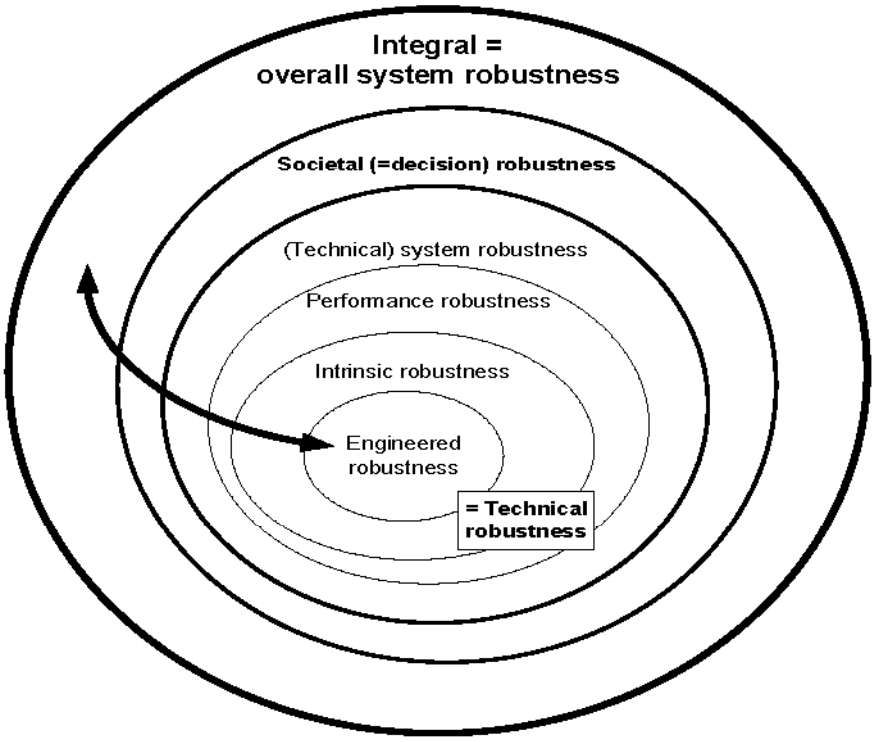

Figura 3: Robustezza integrale [38].

1.3 Obiettivi dello studio

Attraverso una sintesi ed analisi critica delle pratiche di comunicazione del rischio adottate in altri Paesi, il presente lavoro si propone di contribuire alla costituzione di una coscienza di sicurezza per la gestione partecipata dei rifiuti radioattivi in Italia.

In particolare, il rapporto illustra l'attività di studio delle esperienze sviluppate da Enti nazionali ed esteri, nell'ambito della comunicazione dei rischi derivanti dallo smaltimento di rifiuti radioattivi in un deposito ingegneristico superficiale.

Il lavoro è inserito in quanto previsto dal Piano Annuale delle attività oggetto dell'Accordo di Collaborazione fra ENEA e CIRTEN, nell'ambito dell'Accordo di Programma MSE-ENEA, tema di ricerca n. 5.2.5.8 "Nuovo nucleare da fissione"; linea progettuale LP4: Attività a supporto della individuazione e scelta di un sito e per la successiva realizzazione di un deposito di smaltimento dei rifiuti radioattivi di II Categoria e di un deposito di stoccaggio a medio-lungo termine dei rifiuti ad alta attività e lunga vita.

L'obiettivo dell'attività complessiva è quello di fornire una base per lo sviluppo di una strategia partecipativa di comunicazione e informazione, con il coinvolgimento di tutti gli attori che svolgono un ruolo (sia attivo che passivo) nel problema della gestione dei rifiuti radioattivi. L'attività deve contribuire a ricreare, aggiornare e/o consolidare le competenze in Italia nella materia in oggetto.

2. Infondere fiducia nel pubblico sulla sicurezza attraverso comunicazione ed informazione

L'esigenza di coinvolgimento di tutte le principali parti terze nella gestione dei problemi e nelle scelte legate allo smaltimento dei rifiuti radioattivi è sempre più soddisfatta dalla comunità nucleare internazionale. Nel corso di questo cambiamento di atteggiamento delle istituzioni, da un approccio puramente tecnocratico "Decidi-Annuncia-Difendi" ad uno più condiviso, gli aspetti di processo fondamentali sono stati messi evidenziati [40].

Considerazioni nate dalla ricerca sulla percezione del rischio indicano che le anomalie del processo decisionale dei proponenti e delle autorità possono essere diminuite attraverso un modello di rischio allargato che integri la percezione del rischio delle parti coinvolte. Da questo punto di vista, la modellazione del rischio deve poter essere estesa attraverso un ampliamento della stessa nozione di rischio, per includere le caratteristiche del pericolo nel contesto sociale.

D'altra parte, le considerazioni che derivano dalla normativa, dalla scienza decisionale empirica e dall'esperienza sui sistemi ingegneristici complessi mostrano che situazioni decisionali complesse possono essere trattate con successo solo se alcune condizioni a priori vengono soddisfatte. Tali condizioni inquadrano integralmente il problema nella sua complessità, con considerazioni quali:

- Una sufficiente comprensione del sistema;
- La consapevolezza dell'esistenza degli aspetti di percezione e comunicazione;
- La necessità di evitare pregiudizi;
- La capacità di implementare le procedure;
- La necessità di decomposizione del problema e sua ricomposizione;
- L'esplorazione delle relazioni tra i diversi obiettivi;
- Il trattamento dei diversi livelli ai quali il problema si pone.

A titolo di esempio, l'analisi dettagliata degli aspetti considerati e delle strategie adottate nella pratica di RWM in Svizzera mostra un evidente momento di stallo dal quale si possono trarre le seguenti conclusioni [41]:

- Le prospettive delle terze parti interessate non sono state adeguatamente prese in considerazione nella gestione del rischio;

- Sia i proponenti l'impianto di smaltimento che le autorità hanno largamente agito sulla base di definizioni esclusivamente tecniche e scientifiche di razionalità decisionale e procedure di analisi di rischio;
- Il processo decisionale non ha tenuto in debito conto la multidimensionalità e complessità del problema, la natura stratificata della sua storia e l'incertezza associata.

Coerentemente con le osservazioni precedenti, il comitato per la gestione dei rifiuti radioattivi (RWMC) dell'Agenzia per l'Energia Nucleare (NEA) ha identificato la percezione e la fiducia pubblica come aree strategiche nelle quali i progressi risulterebbero di maggior vantaggio per lo sviluppo del RWM, ed in particolare dei programmi di smaltimento. A tal fine, il comitato intende promuovere una comune comprensione del problema tra i suoi membri istituzionali e fornire le basi per un dialogo rafforzato tra tutte le parti coinvolte. Operativamente, il RWMC ha fondato il Forum on Stakeholder Confidence (FSC) [18]. Il FSC considera che il coinvolgimento delle terze parti costituisca parte integrante di un processo decisionale a passi successivi. Secondo il FSC, la definizione "terze parti" è un'etichetta conveniente per ciascun "attore" (istituzione, gruppo o individuo con un interesse o un ruolo nel processo decisionale sociale riguardante la gestione dei rifiuti radioattivi) [42].

Per guadagnare la confidenza e la fiducia del pubblico sulla sicurezza di un sistema di smaltimento di rifiuti radioattivi, le autorità di controllo coinvolte necessitano di una strategia a lungo termine per la comunicazione con il pubblico e per l'interazione con le altre parti coinvolte. Questo richiede una preparazione interna adeguata per una rapida comprensione delle preoccupazioni e aspettative in gioco; tutte le problematiche sociali devono essere ascoltate, capite e opportunamente affrontate, poiché in molti casi esse differiscono da quelle che gli esperti tecnici ritengono più importanti [43].

Una condizione preliminare per la costruzione di un dialogo costruttivo con il pubblico è lo sviluppo della cultura di base sul problema, attraverso un'informazione appropriata che deve essere tempestiva, comprensibile, credibile, coerente e legata a tutte le problematiche di interesse pubblico. I mezzi di accesso facile e distribuito all'informazione tipicamente usati dalle organizzazioni sono, per esempio, pubblicazioni divulgative, siti internet, centri di informazione presso gli impianti, esibizioni in aree di interesse, incontri pubblici, dibattiti, ecc [18].

Il dialogo con il pubblico deve essere basato su una regola di comunicazione a due vie, piuttosto che su un sistema informativo a una via. Sicuramente, uno degli obiettivi primari degli incontri, dei centri di informazione e dei siti internet è quello di stimolare la reazione del pubblico per identificare le tematiche di interesse pubblico e sociale da approfondire ulteriormente.

Naturalmente, il processo comunicativo può essere efficace solo se le parti coinvolte sono realmente motivate e desiderose di riconoscere apertamente la rispettiva dignità, i ruoli, gli interessi e le preoccupazioni. In questo senso, un errore dei primi processi di comunicazione fu la parzialità degli esperti di gestione dei rifiuti rispetto alle problematiche tecnico-scientifiche piuttosto che a quelle socio-politiche.

Alcuni approfondimenti e suggerimenti operativi per stabilire il necessario senso di fiducia tra istituzioni e pubblico sulla sicurezza dei progetti di smaltimento di rifiuti radioattivi sono forniti nell' APPENDICE 1, che sintetizza i risultati di precedenti esperienze internazionali.

3. Approcci alla partecipazione del pubblico e al coinvolgimento delle terze parti

Le problematiche di gestione dei rifiuti radioattivi sono inserite in un più largo contesto sociale di protezione dell'ambiente, rischio tecnologico, sostenibilità e gestione energetica. La dimensione del problema richiede inevitabilmente un forte coinvolgimento di tutte le parti terze interessate.

Le risposte delle organizzazioni dei Paesi membri del NEA RWMC a inchieste sulla pratica ed esperienza di coinvolgimento delle terze parti forniscono informazioni ed approfondimenti sulle iniziative prese, sui loro obiettivi e approcci e sui loro risultati. Una sintesi è offerta nell'APPENDICE 2.

Le esperienze dei differenti paesi membri indicano che approcci di coinvolgimento nella raccolta e diffusione di informazioni e nella deliberazione delle decisioni possono aumentare la credibilità ed il supporto dei processi decisionali. Tuttavia questo non è l'unico effetto positivo che ci si può aspettare da una ben avviata iniziativa di coinvolgimento; in pratica, sembra possibile distinguere tre classi di effetti che possono risultare dall'applicazione di tecniche di consultazione e delibera [44]:

- *Effetti sostanziali*: scelte più accettabili dal punto di vista ambientale, economico e tecnico.
- *Effetti procedurali*: miglior utilizzo delle informazioni; miglior gestione dei conflitti; aumento della legittimità del processo decisionale; miglioramento nell'efficacia del processo in termini di tempo e costi; maggior dinamismo dei processi.
- *Effetti contestuali*: migliore informazione alle terze parti e/o al pubblico; maggior capacità strategica dei decisori; rinforzo delle pratiche democratiche; aumento della fiducia nelle istituzioni.

È importante osservare che il coinvolgimento integrato della visione delle terze parti non solo può influenzare specifiche decisioni, ma può persino portare a cambiamenti nella pratica decisionale e nel comportamento delle organizzazioni responsabili.

Naturalmente, è inevitabile che emergano problemi laddove vi siano differenze sostanziali nell'opinione delle diverse terze parti: in tali casi si pone il problema al decisore di dover considerare tutti i punti di vista differenti. La ricerca in questo campo indica che i seguenti quattro approcci, o una loro opportuna combinazione, possono essere applicati con successo [45]:

- L'*approccio riconciliante*, con lo scopo di integrare i punti di vista delle diversi parti.
- L'*approccio statistico*, con lo scopo di aggregare i punti di vista delle parti per mezzo di metodi quantitativi.

- L'*approccio di compromesso*, con lo scopo di trovare un compromesso accettabile per ciascuna parte.
- L'*approccio del confronto*, con lo scopo di trovare una soluzione creativa attraverso il confronto diretto tra le diverse opinioni.

A commento finale sembra opportuno rilevare che:

1) Nelle diverse fasi di sviluppo di un processo decisionale per lo smaltimento di rifiuti radioattivi, il coinvolgimento delle parti può assumere la forma della condivisione di informazioni, della consultazione, del dialogo, della delibera sulle decisioni. Esso dovrebbe essere visto sempre come una parte significativa della formulazione e applicazione di buone pratiche e robuste regole di processo decisionale. Le tecniche di coinvolgimento di terze parti non dovrebbero essere viste come strumenti di convenienza per le "pubbliche relazioni", per la costruzione di immagine o per guadagnarsi l'accettazione di una decisione presa in realtà a porte chiuse [42].
2) In alcuni contesti, i tempi ed i modi per il coinvolgimento sono specificati per legge, mentre in altri contesti una parte specifica può trovarsi nella necessità di creare l'opportunità ed i mezzi per il suo coinvolgimento e quello di altre terze parti. Ricercatori ed utilizzatori stanno sviluppando, applicando e valutando varie tecniche di coinvolgimento; esiste un largo spettro di approcci, così come molta letteratura a riguardo [42].
3) Non tutti i tipi di partecipazione sono uguali. Differenti livelli di coinvolgimento sono offerti dalle diverse tecniche. Un approccio può semplicemente limitarsi a coordinare la trasmissione di informazioni ad una platea passiva di terze parti; all'altro estremo, una tecnica può mirare ad un coinvolgimento responsabile delle terzi parti nel processo decisionale. I decisori dovrebbero essere al corrente del fatto che le terze parti potrebbero desiderare che sia loro assegnato un compito specifico. Una discussione preliminare, il contatto con e l'osservazione delle terze parti interessate possono aiutare a determinare il livello appropriato di coinvolgimento. Il livello di coinvolgimento che l'organizzazione può o desidera offrire deve essere chiaramente definito e comunicato alle terze parti potenziali al momento della presentazione del programma [42].

4. Il ruolo dell'autorità di controllo

Generalmente, la responsabilità dell'autorità di controllo nucleare è quella di (i) definire la protezione dalle radiazioni e i requisiti di sicurezza, (ii) fornire una guida su metodologie e documentazione relative alla valutazione di rischio, (iii) revisionare le analisi di sicurezza fornite come base per la concessione delle licenze di impianti ed attività di gestione e smaltimento dei rifiuti radioattivi, (iv) ispezionare e revisionare la costruzione, l'operazione e la chiusura di installazioni nucleari per assicurare l'osservanza delle condizioni di licenza e (v) fornire informazioni alle autorità politiche, al pubblico e ad altre terze parti coinvolte.

Nel fare questo l'autorità gioca un ruolo fondamentale nel processo decisionale complessivo dei programmi nazionali di RWM; in particolare, deve costruirsi la credibilità necessaria per conquistare la fiducia dei suoi interlocutori. Le autorità devono poter agire ed essere percepite come indipendenti supervisori della qualità del lavoro di valutazione e dell'integrità del processo decisionale. Idealmente, e subordinatamente ad ogni limitazione legale, le autorità dovrebbero essere i "garanti" della sicurezza e servire come "esperti del popolo", costituendo una risorsa accessibile alle terze parti ed al pubblico per affrontare le diverse preoccupazioni riguardanti la sicurezza offerte dalle soluzioni di smaltimento [43].

L'indipendenza ed l'autorevolezza degli organismi di controllo sono la base per la fiducia del pubblico nei programmi nazionali di RWM. Specialmente nella fase di selezione del sito, sorge il problema se le autorità preposte siano in grado di assumere un ruolo attivo nel coinvolgimento della comunità mantenendo allo stesso tempo l'indipendenza rispetto alle successive azioni di concessione della licenza.

La pratica tradizionale nella comunità nucleare mondiale ha visto le autorità di controllo poco coinvolte, se non per nulla, a salvaguardia della loro indipendenza [18]. Tuttavia, nelle recenti evoluzioni sembra che le autorità di controllo stiano acquisendo un ruolo più attivo di coinvolgimento nell'intero processo di sviluppo del progetto di smaltimento, sebbene gli approcci e il livello a cui ciò avviene siano vari. Alcune esperienze hanno mostrato che un coinvolgimento attivo dell'autorità di controllo sia necessario e possa essere ottenuto senza mettere in pericolo la sua indipendenza ed integrità quale ente licenziatario. Un ruolo attivo è importante per guadagnare la fiducia nel fatto che l'ente regolatore adempia alla sua funzione di garante dell'intero processo [18]. Questo comporta che canali di comunicazione vengano mantenuti aperti con il pubblico, i costruttori, i dipartimenti governativi, il parlamento, i gruppi di azione coinvolti e altri. Gli appropriati meccanismi di dialogo devono essere individuati di concerto con le diverse terze parti [43].

Il coinvolgimento del pubblico nel processo regolatorio è una pratica usuale in alcuni casi (ad esempio il USNRC), ed è attualmente in fase di inclusione da parte di altri enti regolatori (ad esempio CNSC, HSK, SKI

e SSI). Gli approcci per tale coinvolgimento differiscono tra i Paesi, passando dai commenti aperti del pubblico e di altre parti coivolte, a incontri e ascolti aperti legati all'azione di concessione delle licenze. Questa rappresenta un'area di continuo apprendimento, in cui ogni nuova esperienza può offrire importanti lezioni.

In conclusione, il successo dei programmi di coinvolgimento del pubblico si fonda in larga misura sul livello al quale le autorità di controllo decidono di rendere la loro presenza e il loro ruolo noti e comunicano la loro indipendenza, dimostrando capacità di valutazione propria e integrità nell'imporre i propri requisiti.

5. Analisi dell'accettabilità locale di un sistema di smaltimento di rifiuti radioattivi

In generale, la verifica del grado di accettabilità locale di una LULU è un'attività fondamentale che dovrebbe essere condotta tanto nel corso della fase di selezione del sito ospitante, al fine di poter scartare alternative per le quali la reazione della popolazione locale potrebbe compromettere gravemente il successo del progetto, quanto in tutte le fasi successive, così da identificare opportune compensazioni per gli abitanti locali.

A questo proposito sono state effettuate diverse analisi con lo scopo di comprendere i meccanismi di accettabilità locale di un sistema di smaltimento di rifiuti radioattivi. In [46] e [47] i modelli costi/benefici e di percezione del rischio sono stati confrontati, con la conclusione che il modello di percezione del rischio sembra essere di gran lunga più influente sul grado di accettabilità di quello costi/benefici. Questo è particolarmente vero nel caso dei paesi occidentali, che hanno un fondamento socio-culturale diverso da quello dei paesi asiatici. Una breve sintesi di un recente studio condotto in Korea [48] è riportato in APPENDICE 3.

Il modello costi/benefici è la base di un approccio comune per analizzare il comportamento decisionale di una persona interessata. L'idea principale alla base del modello è che "gli esseri umani siano più o meno decisori razionali, entro i limiti delle loro capacità di ragionamento e apprendimento, le esperienze alle quali hanno accesso e il contesto nel quale vivono" [48]. I relativi approcci di decisione razionali vengono interpretati come "modelli a valore atteso", per i quali il comportamento razionale emerge dalla valutazione della verosimiglianza ed entità degli effetti della decisione.

Nelle fasi successive alla selezione del sito, l'utilizzo della compensazione è un metodo frequentemente menzionato come strumento utile ad aumentare il grado di accettabilità di una LULU, ed al contempo rimborsare le parti coinvolte di eventuali potenziali costi. Secondo il modello costi/benefici, "la compensazione monetaria funziona se il suo ammontare è sufficientemente grande da annullare le esternalità negative della soluzione proposta" [48]. Tuttavia, molti ricercatori hanno osservato che la compensazione potrebbe essere una strada non percorribile in molti casi, a causa dell'ambiente politico nel quale le decisioni di scelta del sito sono affrontate. In particolare, per selezionare il sito che deve ospitare impianti che hanno potenziali impatti su ambiente e salute, quali quelli di smaltimento di rifiuti radioattivi, l'eccessiva enfasi sulla compensazione del rischio piuttosto che sulla sua riduzione potrebbe dare luogo ad una grave sfiducia da parte dei residenti locali. L'esperienza relativa a scelte di siti di deposito di rifiuti nucleari suggerisce che la compensazione non aumenta l'accettabilità del deposito finché il rischio associato viene percepito come

grave. Al contrario, l'introduzione della compensazione può essere vista come testimonianza del fatto che il deposito introduce un rischio laddove in precedenza non si riteneva che esistesse [48].

Come alternativa alla compensazione diretta, ad esempio attraverso detrazioni fiscali, molti ricercatori hanno suggerito di ricorrere a finanziamenti mirati, che vengono con minor probabilità percepiti come "tentativo di corruzione" e possono essere utilizzati per ridurre altri rischi ai quali la popolazione locale è esposta, ad esempio se i fondi vengono destinati al miglioramento dei servizi sanitari. In generale, diverse modalità di detrazioni e finanziamenti di attività culturali, educative, sanitarie e di trasporto locali sono state proposte come tipologie di supporto all'accettabilità di un progetto di smaltimento di rifiuti radioattivi.

In conclusione, l'analisi del grado di accettabilità di un sistema di smaltimento di rifiuti radioattivi da parte della popolazione locale è un processo continuo che dovrebbe essere iniziato a partire dalle fase iniziali del progetto e continuare durante la sua fase operativa. Il processo deve prevedere e pianificare momenti di compensazione delle comunità locali, ma attuati in maniera tale da bilanciare i benefici ed il pericolo di indurre maggior timore.

6. Conclusioni

In generale, i rapidi cambiamenti che la società moderna vive fanno nascere l'esigenza di nuove forme di gestione del rischio associato ad attività potenzialmente pericolose, con il coinvolgimento delle parti interessate nei relativi processi decisionali. In particolare, il processo decisionale nell'attività di gestione e smaltimento di rifiuti radioattivi dovrebbe essere considerato nel contesto di un ben strutturato dialogo/interazione tra i costruttori, le autorità di controllo, i decisori politici e il pubblico. Una condizione necessaria per un processo di successo è quella per cui le istituzioni e i decisori si guadagnino e meritino il riconoscimento come rappresentanti di fiducia e responsabili delle esigenze delle diversi parti coinvolte.

La cultura, la politica e la storia variano da Paese a Paese, fornendo diverse opportunità per stabilire e mantenere la fiducia del pubblico. Perciò, la strategia più adatta in un Paese potrebbe rivelarsi non efficace in un altro. Ciononostante, sembrano esistere alcuni elementi comuni nei programmi che hanno avuto successo nel guadagnare la fiducia del pubblico. Questi sono:

- Una strategia chiara per la gestione delle problematiche di lungo periodo e per il completo appoggio del governo e dei legislatori, basata sul riconoscimento di responsabilità e bisogni.
- Un processo decisionale flessibile, che permetta di considerare i bisogni del pubblico e delle terze parti (passi più brevi in fase costruttiva, reversibilità, ecc.).
- L'impegno di tutte le parti coinvolte, comprese le municipalità e le autorità di controllo preposte.
- Un ben strutturato processo di dialogo/interazione tra i costruttori, le autorità di controllo, i decisori politici e il pubblico.

Tra tutte le parti coinvolte nel processo decisionale, il cambiamento più netto di ruolo spetta probabilmente alle autorità di controllo. A livello mondiale, la posizione tradizionalmente adottata è stata quella per cui le autorità di controllo non dovessero essere troppo intensamente coinvolte nei programmi di gestione e smaltimento dei rifiuti radioattivi prima dell'inizio del procedimento per la concessione delle licenze, poiché la loro indipendenza potrebbe essere compromessa dal punto di vista legale. Questa posizione sta gradualmente cambiando verso l'adozione di un ruolo più attivo e visibile nelle fasi di pre-licenziamento. Le autorità di controllo, rappresentando gli interessi della pubblica sicurezza, dovrebbero essere tempestivamente coinvolte nel processo di selezione del sito e collaborare con le potenziali comunità ospitanti al fine di valutarne l'accettabilità o tollerabilità.

Le autorità di controllo sono responsabili sia dello sviluppo degli standard e dei criteri di sicurezza che garanti della salute pubblica attraverso la verifica che questi standard e criteri siano rispettati dalla soluzione

proposta, prima della concessione delle licenze. Un processo regolatorio aperto, sequenziale e guidato da un ente di controllo rispettato può offrire la necessaria fiducia e la garanzia che le proposte siano sottoposte alle adeguate verifiche tecniche su incarico del pubblico.

L'informazione del pubblico è considerata una funzione primaria dell'autorità di controllo. Gli obiettivi della comunicazione con il pubblico sono di quelli di incoraggiare la comprensione riguardo il ruolo e le attività dell'organismo di controllo, di guadagnare la fiducia del pubblico e di fornire ai decisori locali e nazionali le informazioni rilevanti sulle problematiche più importanti.

Il processo regolatorio fa parte di un più vasto sistema decisionale, la cui applicazione pratica deve essere ben definita, prendendo in opportuna considerazione il quadro istituzionale e la cultura nazionali.

Infine, alcune problematiche emerse dall'analisi di esperienze passate di RWG e RWM sono sinteticamente riassunte qui di seguito.

Conclusioni specifiche sulla governance dei rifiuti radioattivi

- La dicotomia "politica – tecnica" è una illeggittima riduzione del problema, in particolare se si considera l'apparentemente "disturbante" coinvolgimento delle terze parti.
- Il fondamento tecnico e le motivazioni delle decisioni devono essere considerati in stretto rapporto con le decisioni politiche e gli effetti secondari, non squisitamente tecnici.
- Nell'"area transizionale" di questa interrelazione esistono alcuni aspetti quali la definizione dei criteri, la trasparenza, il dovere di pubblicazione, la tracciabilità, la plausibilità, la ragionevolezza, l'indipendenza del processo di revisione e la natura sequenziale della procedura.
- La multidimensionalità del problema richiede un appropriato sistema di riferimento. Dal punto di vista normativo, il principio di sostenibilità sembra suggerire sé stesso, per due ragioni. Esso facilita un'analisi sequenziale in accordo con le diverse "dimensioni"; inoltre, costringe tutte le parti coinvolte, decisori inclusi, ad esaminare le diverse "dimensioni" tecnico-politico-sociali del problema, incorporando cosi automaticamente i punti di vista, le esigenze, gli obiettivi e le culture di tutti gli interessati al problema.
- Le decisioni politiche sostenibili nel sistema socio-tecnico di smaltimento dei rifiuti radioattivi devono essere basate su una solida struttura tecnica, che può essere costruita solo su opportune decisioni a priori e che deve essere adatta a fornire il quadro operativo necessario e le relative risorse.

L'allargamento del gruppo "chiuso" dei decisori viene sempre più rafforzato e reso professionale in molti Paesi; il dialogo è meno caratterizzato da argomenti "puramente politici" ed è sempre più basato sui fatti. Questo aumenta le possibilità di costruire un'opzione di smaltimento definitivo dei rifiuti radioattivi, con l'obiettivo precipuo non solo della sicurezza passiva a lungo termine, ma anche dell'inclusione di sistemi di controllo in modo tale da verificare le analisi di sicurezza e ottenere un più ampio appoggio politico e sociale.

Le convergenze interdisciplinari riguardanti i processi in problemi complessi quali quelli del RWG portano alla conclusione che per la decisione finale non sono importanti solo i risultati, ma anche la procedura per ottenerli. In quest'ottica di supporto dell'obiettivo decisionale basato su protezione (anziché controllo) e processo (anziché risultato), è assodato che il sistema RWG deve essere dinamico, adattivo e persino sperimentale nei suoi strumenti, ma non nel suo obiettivo finale, la protezione passiva delle generazioni e dell'ambiente presenti e futuri.

Conclusioni generali sul processo decisionale

Le esperienze di gestione dei rifiuti radioattivi supportano la conclusione che per trattare con successo complessi sistemi socio-tecnici è necessaria una visione integrata. I sistemi caratterizzati da un'obiettiva e istituzionale longevità, dalla varietà degli aspetti coinvolti, da un forte dibattito sul rischio e sulla tecnologia e dagli associati problemi di fiducia implicano una particolare enfasi sui processi decisionali e comunicativi. Di conseguenza, l'"orientazione al processo" non è solo un problema di coinvolgimento di terze parti precedentemente escluse, ma è anche un approccio costruttivo all'integrazione di aspetti e prospettive differenti, e la spiegazione, il chiarimento e la soluzione dei problemi associati.

Una decisione è qualcosa di più di una preferenza per un'opzione. Essa coinvolge il processo decisionale con la definizione del problema, il giudizio, la scelta e l'implementazione [49]. Decisioni "buone" sono sempre sicure e orientate all'obiettivo ("buono" rispetto a cosa?); decisioni "buone" richiedono "buoni" processi che, tuttavia, non portano necessariamente a "buone" decisioni, sebbene le "bontà" del processo aumenti la probabilità di prendere decisioni intelligenti. Un gran numero di terze parti e di differenti visioni è coinvolto in questo processo. Per questo motivo, a causa in particolare della complessità del problema, il processo e la procedura, non solo il risultato, sono fondamentali per poter prendere una decisione. Le seguenti caratteristiche di un "buon" processo decisionale possono essere suggerite sulla base di varie esperienze internazionali [30][43][50]:

- Una pianificazione sequenziale: pianificare le fasi con obiettivi intermedi.

- Un continuo orientamento e revisione del processo, sulla base di decisioni intermedie che garantiscono il supporto tecnico-politico.
- Le aperte e comprensibili analisi delle opzioni disponibili.
- Una concertazione iterativa degli aspetti rilevanti, con opportunità di ricorso e apprendimento adattivo [51].
- Un processo decisionale affidabile e garantito, basato su regole chiare (eventualmente modificate previo consenso).
- La coerenza e la razionalità nell'esecuzione del processo decisionale, per minimizzare le divergenze di opinione ed i relativi conflitti, basandosi su criteri sia tecnici che non tecnici.
- La trasparenza e la coerenza dei processi, per stabilire il giusto grado di fiducia nell'intero sistema di RWG.
- La tracciabilità delle decisioni attraverso una chiara argomentazione dei ragionamenti decisionali comprensibile a tutte le parti coinvolte.
- La comunicazione trasparente e partecipazione inclusiva, attraverso la discussione libera ed ampia sin dalle prime fasi del progetto.
- L'onesta ed etica considerazione dei problemi di equità intra- e inter-generazionale.

Decisioni robuste e ben supportate richiedono un "consenso informato", sulla base di un "terreno comune" [52]. Questo, a sua volta, richiede una dimostrazione di (la maggior parte o, se possibile tutti) i potenziali percorsi e conseguenze delle azioni. Un compromesso credibile e sostenibile può, se possibile, essere raggiunto se avviene un processo di apprendimento collettivo e se il maggior numero possibile dei punti di vista delle terze parti coinvolte è preso in considerazione in tutte le fasi importanti di pianificazione. Tutte le terze parti devono capire che, alla fine, un RWG effettivamente sostenibile può risultare solo dal "mutuo apprendimento" transdisciplinare. "La transdisciplinarietà punta a cambiare *dalla ricerca per la società alla ricerca con la società*" [51]; "... sessioni di apprendimento mutuo ... dovrebbero essere trattate come uno strumento per stabilire un trasferimento efficiente di conoscenza sia dalla scienza alla società che dai responsabili del problema (cioè le componenti scientifiche, industriali e politiche) alla società". Una corrispondente decisione è ben supportata se integra le parti significative dello spettro di problemi e soluzioni delle principali parti coinvolte.

Nell'integrare il quadro di conoscenza e collegare le relazioni tra le diverse parti, la partecipazione inclusiva è un valore aggiunto per tutte le terze parti coinvolte; inoltre rafforza i processi ed assicura le decisioni fornendo risultati tecnicamente e socialmente robusti. È augurabile che il paradigma gestionale "Decidi-Annuncia-Difendi", che ha portato a risultati disastrosi in passato, sia alla fine completamente superato da un

progetto pluralistico di "Proponi-Apprendi-Condividi-Decidi" (PLSD, dall'acronimo dei termini in inglese Propose-Learn-Share-Decide).

Guidelines for comunication and information (ENGLISH VERSION)

1. Introduction

1.1 Motivation of the work

Worldwide, the long-term governance of radioactive waste (RWG) continues to be a major and yet unresolved issue of complex socio-technical decision making. Today, the consensus is that managing such a complex system requires an integrated perspective [5]. Much of the widespread blockage of effective governance in this sensitive policy area may be ascribed to the neglect of considering the various dimensions involved. During the 1990s international nuclear agencies recognized that it is not up to them alone to decide on such complex issues. Thus the Nuclear Energy Agency (NEA) stated in 1999: "Rather, an informed societal judgment is necessary" [6]. Accordingly, in line with efforts of the International Atomic Energy Agency [7][8], the NEA established a so-called *Forum on Stakeholder Confidence* "to facilitate the sharing of international experience in addressing the societal dimension of radioactive waste management" [9]. Coherently, the Sixth European Framework Programme for Research and Technological Development launched in 2002 conceded that research "alone cannot ensure societal acceptance; however, it is needed in order to … promote basic scientific understanding relating to safety and safety assessment methods, and to develop decision processes that are perceived as fair and equitable by the stakeholders involved" [10].
In summarizing the complex interconnected strings of argumentation arisen from several international experiences of radioactive waste management (RWM), the following issues emerge:

Radioactive waste governance: A "technical" or a "political" issue?

- As a recurrent theme the seeming juxtaposition of the "technical" (technically solved) and the "political" (*i.e.,* politically problematic) pervades all time periods. Implementers and authorities, on the one hand, have maintained that all technical issues be under control and the "reason for delay" be merely "political"; on the other hand, the actors mainly in the NGO-oriented sphere have asserted that not even the "technical" basics have been solved to date. This phenomenon is not unique to nuclear issues though: "The essence of politics is based on trading off technical options" [11].
- The radioactive waste issue is misused as a political vehicle by both opponents and proponents of nuclear energy use: "insolvability" as an "argument" for phasing out *versus* "solution" as a "proof" of the legitimacy of a prolonged use of nuclear power.

Attitude towards technological issues (risk debate, long-term phenomena)

- As with other complex socio-technical fields, especially with respect to technological constraints, the dimensions were often debated in reverse order: firstly, the technical and commercial aspects, followed by the political and economic, the social and, finally, the ethical aspects.
- Divergent attitudes towards technological issues become manifest in the differing attitudes towards safety and risk management. On the on hand, the nuclear waste community takes an inevitable "residual" risk for granted which is to be reduced by way of risk assessment and concurrent mitigating measures. On the other hand, sections of the opposition from the anti-nuclear movement demand "absolute safety", "best solutions possible" and "best sites".
- Long-term aspects were not taken into account before the mid-1970s. To that, the waste community came up with the concept of final disposal, parts of other experts and the public repeatedly responded with the quest for controllability and retrievability.
- The insight that a rigorous mathematical proof of long-term safety is not feasible has led to the special emphasis of a stepwise procedure. The needed "set of arguments" referred to above comprises technological approaches (such as diverse and graded safety indicators, test facilities) as well as institutional components (quality assurance, reviewing procedures).

Involvement of third parties and procedure

- Until 1980, "third parties", who did not belong to either implementers/proponents, regulators or hired experts, were not involved in the decision process. The linear model of "Decide–Announce–Defend (DAD)" [12] prevailed, in a seemingly contradictory mixture of Habermas's technocratic and decisionistic models [13]. The "nuclear establishment" [14] of industry, the regulatory body, and politics was a closed circle. This has gradually changed with the appointment of interest subgroups predominantly resourced with external experts.
- These aforementioned external bodies either acted as the initial impetus or encouraged others on decisive issues: criticism of programming, non-traceability of the siting process, extensive duty of publication, reviewing, participation of the public.
- In some instances, the broad public forcefully obtained their "involvement" in popular votes and referenda. Thus, they could exert pressure on change and concept modifications.
- Political considerations predominated the fact-based ones. In various Countries, many parties and stakeholder groups instrumentalised the waste issue in their energy politics. Procedural issues of

such a complex disposal programme were not duly followed, and if they were, they were dealt with as "political" issues.

Concept and evolution of the disposal programme, learning processes

- The concept, requirements and delays have often been changed – on some occasions considerably. Only recently, the corresponding revisions have been debated among a broader range of stakeholders.
- As mentioned, political considerations often overrule the fact-based ones. The waste issue has often been in some respects misused by all major stakeholder groups, as a political battlefield or platform.
- With regard to scheduling and factual issues there was an over optimism particularly in the 1980s. Initially, familiar and well-known structural engineering issues were prioritized whereas the critical issue of long-term safety was underestimated.
- Gaining a complete overview of the complex system of RWG is almost impossible for all players. Thus, proxies are defined. Examples in the technical field are controllability, retrievability, site exclusion criteria, safety indicators or traceability of reasoning. Separation of promotion and oversight, extensive publication of documents, stepwise and phased procedure, external reviewing serve as proxies for procedural issues.
- Regarding learning processes, the forms of "adaptive learning" and "trial and error" dominate in the complex and politically charged RWM arena. They are typically induced by programmatic impasses or political pressure like the rejection of applications as in the cases of the potential low-level waste site in Wellenberg (Switzerland) in 1995 and Scanzano (Italy) in 2003.
- The interaction of the stakeholder groups [15] suggests a partial convergence and gradual acquisition of values and notions such as controllability and retrievability or the expansion of the disposal concept.
- Resource exchange is hampered by the political instrumentalisation of the issue. Networks [16] typically exist among proponents and implementers as well as regulators (national supervisory bodies/NEA forum). Together with these networks, engineering experts, university institutes, and advisory committees constitute the nuclear community in a narrower sense (*e.g.,* forum of IAEA). During the implementation phase, the lack of a wholly connective network is fatal: nowledge transfer and technically as well as societally reinforced programming can only be sustainable if sufficient resources are provided.

The resolution of the above issues requires the development of an approach which allows verifying the robustness of the waste disposal solution by integration of all technical, societal and political views involved.

This entails the development of a comprehensible, stepwise and plausible process on the way to a consensual "end product", the "demonstration" of long-term safety. The procedure adopted should be traceable for non-specialists and free of dooming lack of knowledge and ghostly prejudices which build radioactivity terror.

1.2 Background

Černobyl' nuclear accident (April 1986) triggered a worldwide sort of "radiophobia" in the public perception to nuclear rise, generating distrust by non-governmental organizations towards all nuclear activities and initiating a strong international anti-nuclear movement which contributed to a significant slowdown of nuclear energy development [17]. After Černobyl', no serious accident has occurred in the nuclear industry for more than 20 years. Although, this has contributed to a much reduced opposition to the nuclear industry, many countries in the world have struggled to site a facility for radioactive waste, due to the strong opposition of the local communities [17]. Radioactive waste management and the location of a suitable place for the installation of a repository for the disposal of radioactive waste have arisen public controversy due to the social and political importance of health and environmental issues.

Public acceptance or rejection of the installation of a radioactive waste disposal is related to the way that the risk associated to its operation is perceived. Perception is a selective phenomenon by which, different people or social groups, perceive different things of the same reality by means of a subjective process [18]. Issues of public perception and confidence have been most critical in gaining approval for development of repositories for radioactive waste at specific sites, which raises the question of how best to achieve confidence regarding the ethical, economic, political and technical aspects of a waste management strategy, and disposal in particular [18].

Since the mid-1980s the topic of waste inventory, including definition and allocation to eventual facilities, has concerned interested parties in RWG. A consistent waste classification has been called for internationally: at the IAEA's 3rd Scientific Forum in 2000 it was complained in the official document that "[t]here is an air of mystery attached to radioactive waste, which is at least partly the result of the complex and sometimes obscure terminology used by specialists" [19]. Consistent with this is a recommendation by an International Regulatory Review Team (IRRT) to the Swiss safety authorities [20].

In conformity with international standards the nuclear community has, until recently, refrained from defining the inventory before the construction of a respective facility. While acknowledging the intrinsic complexity of giving conclusive evidence of long-term safety [21][22], it seems fundamental to augment the presentation of the safety case:

- The evidence of long-term safety of a deep geological disposal facility has to be supported by means of revised safety cases according to the state of the art.

- The strict protection goals of the regulatory guidelines evidently have to be complied with but, additional safety indicators may be developed to help reduce uncertainties and establish transparency.
- Single criteria such as the half-life period of radionuclides, their origin, *etc.*, are not commensurate with the complexity of the issue and should be substituted by a set of criteria of diverse indicators.
- The selection of criteria and sites proposed as well as the ensuing assessment and evaluation have to be continuously traceable and plausible.
- In the end, "robustness" of the disposal system solution adopted must be guaranteed from an integral viewpoint successfully addressing all technical, societal and political issues. Transparency and traceability are key attributes of the process as the robustness of the disposal system can only be tested and audited if its parameters are clearly defined and if it is ensured that the system rests within well-set boundaries [23].
- On a planet with limited resources, retrievability of a specific, technically processed material of goods such as nuclear waste, is an option that should be taken into account under a resource management perspective. Nuclear waste incorporates a potential of use for currently unknown purposes for future generations. Returning to the notion of the closed fuel cycle, this is a new perspective asking for new types of solution in RWG. Therefore, one has to be firmly aware of the implications of choosing such an option, with respect to the continuation of the nuclear path, investments into and commitment to nuclear research, *etc.*

In arguing for the extension of the safety case for the integration of all technical, societal and political aspects, the following reasons are put forth. In the past, typically all stakeholders, with the exception of the few existing performance assessment analysts, have been referred to "end products". On one of two levels, the technical level, the stakeholders are provided safety reports containing information about meeting the safety goals; on the other level, the legal one, they face the general license application, at best the application for the concession for a facility. In technical matters, the strategy selected according to legal requirements takes the safety of humans and the environment as a basis. In the legal procedure, the strategy facilitates participation even today and is, thus, process-related. It is granted that the decision here is "open" but the fundamentals to the decision are not presented prior to the final process phase.

On the contrary, an expanded procedure of integration that would be perceived as stepwise by the public, even in technical matters, would directly relate the waste and the siting discussions to each other via the criteria discussion, in a recursive manner. Paralleling these consensually achieved criteria in the scientific field, a set of criteria for inventory and waste classification ought to be developed. Such efforts regarding the diversification of safety indicators and the improvement of transparency as well as stakeholder involvement,

are in accord with international discussions of late [7][21][22][24][25][26][27][28][29][30][31] and the recent research endeavours of the European Union [10][32].

In the view of an integrated approach to robustness of radioactive waste management solutions, communication and information to the public is crucial to the successful building of a consensus-based decision regarding radioactive waste disposal and management. In general, the need for adequate information is basic in democratic countries where Society has every right to take part in decision-making processes. An active permanent communication policy, transparent and well coordinated among all the areas of an organization must be performed. Communication must be kept alive between Society and the legitimate national, provincial and municipal representatives, together with other opinion leaders such as non-governmental organizations, private companies, schools, professionals, neighbor associations and other live community forces [17]. Besides, any information gap left by the institutions in charge of radioactive waste management, can be filled by the opinions of those who overtly oppose nuclear activities or others who become spokespeople of fundamentalist-environmentalist groups, due to the lack of suitable objective information [17]. In this respect, the way mass media inform the issue and report research and studies on it can have great relevance due to the effect their opinion exerts on the public. To some extent, mass media can shape the image of social reality about a controversial issue, such as the siting of a repository for radioactive waste disposal.

Although it has proven difficult for an institution to have a consistent safety framework and communication platform across all radioactive waste management applications, ranging from waste disposal to the remediation of mine sites [17][33], any effective communication process must be based on informing the issue, discussing the alternatives and participating in the decisions, while recognizing that the risk perceived by the public is as important as the actual or scientifically derived risk. This entails that stakeholders be afforded opportunities to interact as early as possible in the process of repository development, that proposals be brought forward by a trustworthy procedure and the decisions be made with sensitivity to local concerns. Thus, an additional, specific issue for consideration is how to elicit more meaningful public involvement in the decision-making process as the needs of such stakeholders may not always be anticipated and can emerge only through dialogue with them.

In summary, nowadays it is mandatory to achieve societal and political consensus when siting new hazardous facilities. This entails a participatory process of communication, information and involvement for decision-making that goes beyond the technical risk to account for all stakeholder perceptions and concerns. On the other hand, institutions involved in radioactive waste management are facing rapidly evolving societal changes, including new information technology and new roles for the media. This is taking place at

the same time as some national programmes are moving from research and development to site selection and implementation, whilst others are reviewing and defining their policies in the waste management areas.

The necessities of sharing the relevant information and the demand for public participation in decision making are leading to a need for new integrated approaches to interacting with stakeholders [18]. Within these approaches, performance assessment continues to play a major role in addressing the technical issues related to the safety of the proposed radioactive waste disposal solutions. Due to the required longevity of the disposal system, "[t]he aim of the performance assessment is not to predict the behaviour of the disposal system in the long term, but rather to test the robustness of the concept as regards safety criteria" [26]. Appreciating this and society's requirement for control, a concept of "integral robustness" – technical and societal – must be introduced for effective RWG [34][35][36]. This entails an amplification of the safety concept for the integration of societal aspects into the defence-in-depth strategy familiar to the nuclear community [37]. As regards technical robustness, the NEA makes the following distinction [21]:

- Engineered robustness: "[i]ntentional design provisions that improve performance" such as over-building of barriers, waste conditioning in a stable matrix, and physical separation of waste into packages of limited size
- Intrinsic robustness: "[i]ntentional siting and design provisions that avoid detrimental phenomena and the sources of uncertainty" such as siting in sedimentary layers deep underground, with self-healing properties and an uneventful geological history, away from potential resources
- (Technical) system robustness: combination of siting and design provisions supplemented by peer-review and quality assurance procedures

This technical component of robustness, as envisaged by the international nuclear community, is depicted in Figure 4 in terms of the different barriers between the source, *i.e.,* the waste inventory, and the target, *e.g.,* a critical group affected by health impacts.

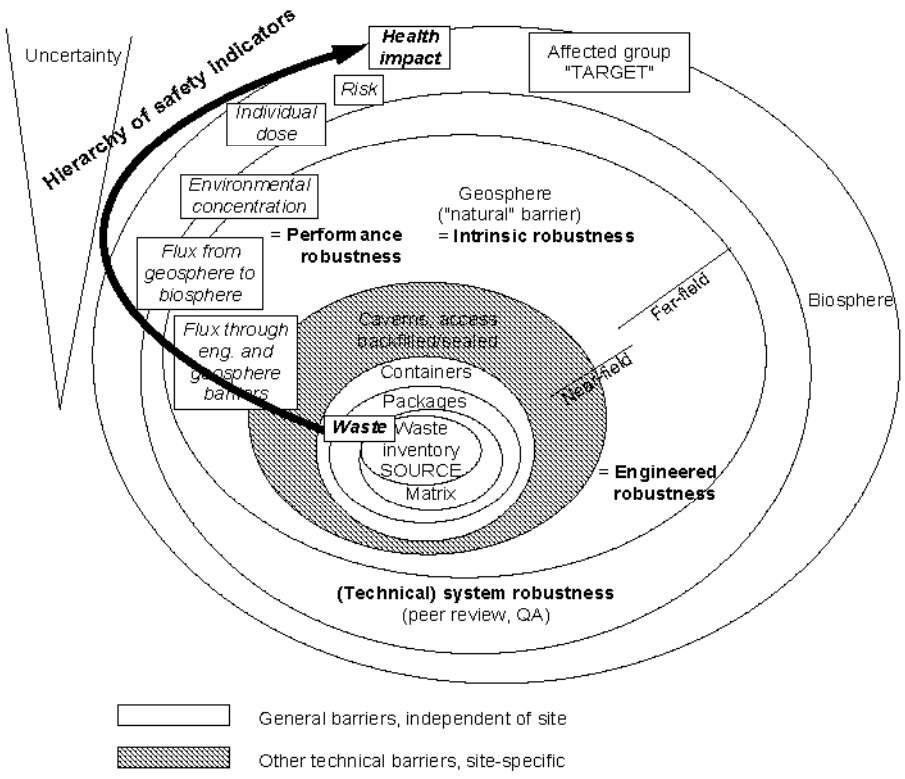

Figure 4: Technical robustness [38].

The technical systems approach takes into consideration the fact that the various project stages of a disposal site – from site selection, characterisation, design, construction, operation, to closure – take at least several decades. Besides the objective longevity of radioactive waste we, therefore, have to also deal with an institutional long-term dimension. Thus, managerial concepts and principles have to be integrated into a consistent and incremental decision-making path.

In this scenario, the decision-making process calls for multiple technical barriers against the release of radioactivity, as well as for phased societal checks to achieve and sustain confidence in technical assessments and, hence, acceptance or at least tolerability in Society (Figure 5).

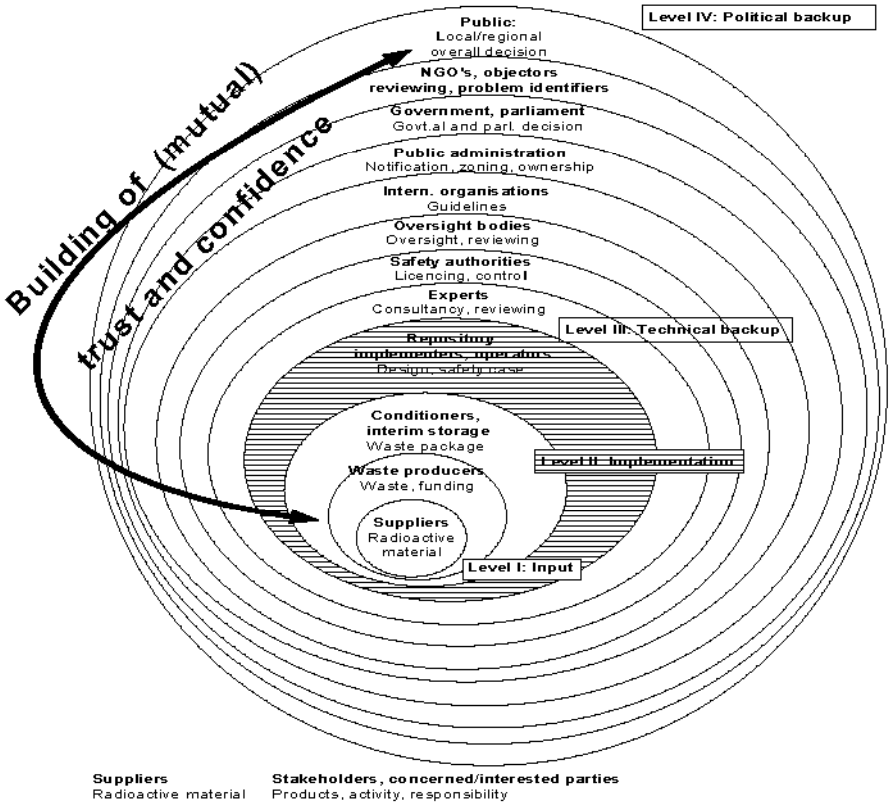

Figure 5: Societal/institutional robustness [38].

Figura 3 depicts the integration of technical and societal/institutional aspects into integral robustness. In the context of the Figure, the term robust or robustness is used in relation to technical and environmental risk analysis. In general, a system is robust if it is not sensitive to significant parameter changes. According to Rip it is "socially robust" if most arguments, evidence, social alignments, interests, and cultural values lead to a consistent option [39]. Therefore, the concerned and deciding stakeholders have to eventually achieve consent on some common interests. "Integral robustness", in a way, is a fuzzy notion but it recognizes the complex socio-technical character of the issue and has the potential to stepwise and iteratively integrate structural and procedural/dynamic elements – as well as various and diverse types of uncertainty – into RWG.

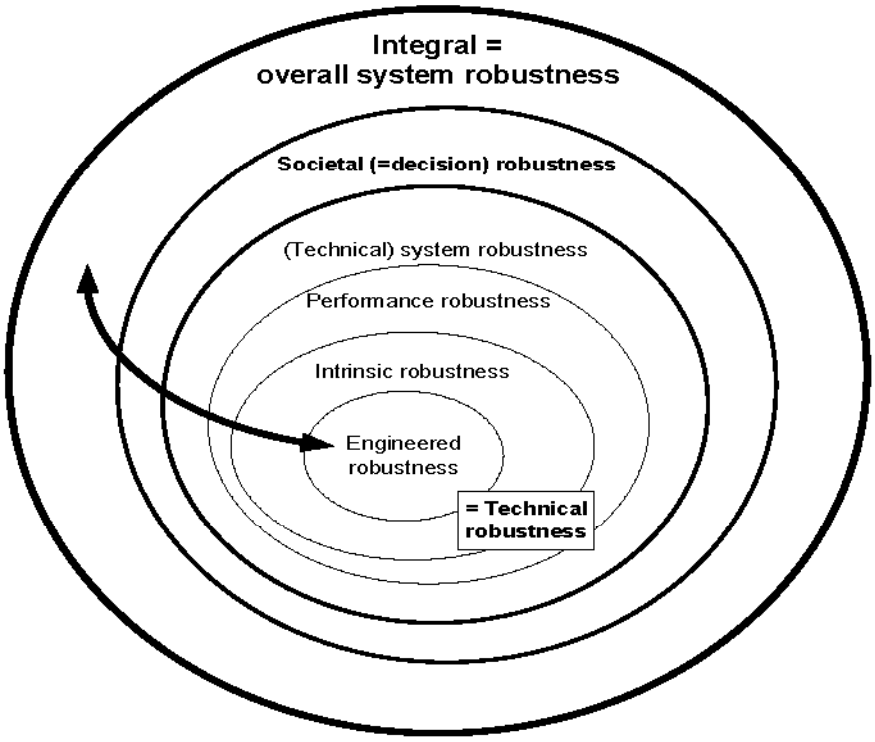

Figure 6: Integral robustness [38].

1.3 Objectives of the study

Through a synthesis and a critical analysis of risk communication practices in various Countries, the present work aims at contributing to the formation of a safety conscience for the participatory management of radioactive wastes in Italy.

In particular, the report illustrates studies and experiences by national and international Organizations, in the field of risk communication within the practice of surface disposal of radioactive wastes.

The work is framed within the Annual Plan of activities of the Collaboration Agreement between ENEA and CIRTEN, in the area of the MSE-ENEA Program Agreement, research theme no. 5.2.5.8 "New Nuclear from Fission: Activity in support to the characterization and selection of a site and the successive realization of a disposal deposit for radioactive wastes of Category II and of a medium-long term storage deposit for long-lived and high-radioactivity wastes.

The overall objective of the research activity is that of providing the basis for the development of a participatory strategy of communication and information, with the involvement of all stakeholders which have a role (active or passive) in the issues of radioactive waste management. The activity must contribute to recreate, update and/or consolidate the competences in Italy on the subject.

2. Building safety confidence in the public by communication and information

The need for involvement of all main stakeholders in the nuclear waste arena has lately been realized by the international nuclear community. In the course of this seeming paradigm shift, from a purely technocratic "Decide–Announce–Defend" approach to a more participatory approach, process aspects have come into focus [40].

Insights from risk perception research point at the fact that institutional decision-making anomalies of proponents and authorities may be diminished through an enlarged risk model which integrates the risk perception of concerned parties. In this view, risk modelling has to be expanded by widening the notion of risk, extending it to hazard properties and the social context.

On the other hand, insights from normative as well as from empirical decision science and systems engineering show that complex decision situations can only be adequately dealt with if certain preconditions are met which take into consideration the complexity of the issue at hand. These include:

- Understanding the system sufficiently
- Recognizing perception and communication aspects
- Avoiding biases and fallacies
- Considering and adapting problem structures
- Decomposing into subsystems and re-integrating
- Exploring target relations
- Treating different levels adequately
- Utilizing latency periods as a chance for learning

For example, a detailed analysis of the aspects considered and strategies taken in the history of Swiss radioactive waste management (RWM) shows the evident deadlock in radioactive waste management in Switzerland with the following conclusions [41]:

- The perspectives of the concerned/affected parties have not been adequately appreciated in risk management
- Both proponents for radioactive waste disposal and authorities have largely acted according to a restricted technical, natural-science based definitions of rationality and risk assessment procedures

- The decision process has been of a linear and not a multidimensional type, in particular with respect to problem complexity, *i.e.*, the multilayered nature of the history and uncertainty of the issue, was not appropriately acknowledged.

Coherently with the above observations, the Nuclear Energy Agency (NEA) Radioactive Waste Management Committee (RWMC) has identified public perception and confidence as one of the strategic areas in which progress would be most beneficial towards further development of radioactive waste management, and particularly disposal programmes. The Committee intends to promote common understanding amongst its institutional members and provide bases for enhanced dialogue amongst all interested parties. In this light, the RWMC launched the Forum on Stakeholder Confidence (FSC) [18]. The FSC considers that stakeholder involvement is an integral part of a stepwise process of decision making. According to FSC, the term "stakeholder" is a convenient label for any actor (institution, group or individual), with an interest or a role to play in the societal decision-making process around radioactive waste management [42].

In order to gain public confidence and trust on the safety of a radioactive waste repository, the involved regulatory authorities need a long-term strategy of public communication and of interaction with other stakeholders. This requires a proper set up for timely listening to their concerns and expectations. All social concerns must be listened to, understood and properly addressed, as in many cases they differ from those that the technical experts regard as the most relevant concerns [43].

A preliminary condition for building a constructive dialogue with the public is the development of the necessary base culture on the issue, through proper information which must be early, understandable, credible, consistent and related to all concerns of public interest. Means of distributed, easy access to information that are used by organizations are, for example, booklets, internet sites, information centers near the facilities, exhibitions in regions of interest, public meetings and debates, etc. [18].

Dialogue with the public must be based on a two-way communication policy rather than a one-way information system. Indeed, a primary goal of meetings, information centers and internet sites is to stimulate feedback from the public in order to identify issues of public and social interest to be further addressed.

Also, the communication process can only be effective if the parties are really motivated and willing to openly acknowledge the respective dignity, roles, interests and concerns. In this respect, one pitfall of earlier communication processes was the bias of waste management experts which emphasized only technical and scientific issues of sciences to the detriment of the social and political issues.

Some insights and operative suggestions on how to build safety confidence between the institutions and the public are provided in APPENDICE 1, as resulting from previous international experiences.

3. Approaches to public participation and stakeholder involvement

Radioactive waste management issues are embedded in broader societal issues related to environment protection, technological risk, energy policy and sustainability. The dimension of the problem inevitably demands for strong *stakeholder involvement*.

The answers of NEA RWMC member countries organizations to surveys on stakeholder involvement, practice and experience provide information and insights into the initiatives taken, their aims and approaches, as well as the responses outcomes. These are summarized in APPENDICE 2, according to different categories.

The experiences of the different member countries point at the fact that inclusive approaches for information gathering and deliberation are likely to enhance the credibility of the decision-making processes. This is not the only type of positive effect that may be expected from a well-run stakeholder involvement initiative. Three classes of effects may result from the application of consultation and deliberation techniques [44]:

- *Substantive effects*: more acceptable choices from the environmental, economic, and technical points of view.
- *Procedural effects*: better use of information; better conflict management; increased legitimacy of the decision making process, improvement of the effectiveness of the process in terms of cost and time, more dynamic processes.
- *Contextual effects*: better information to stakeholders and/or the public; improvement of strategic capacity of decision makers; reinforcement of democratic practices; increased confidence in institutional players.

Moreover, stakeholders' views may influence not only specific decisions, but even the decision-making practice and behavior of the responsible organizations.

On the other hand, problems are doomed to arise when there is a considerable difference in opinion among the various stakeholders: how can the decision maker take into consideration all different views? Research in this field indicates that the following four approaches or their combinations can be applied [45]:

- The *reconciling* approach, aimed at integrating the views of the parties.
- The *statistical* approach, aimed at aggregating the views of the parties by quantitative methods.
- The *compromising* approach, aimed at finding a compromise acceptable for each party.

- The *confronting* approach, aimed at finding a creative solution via direct confrontation of the different opinions.

As final, synthetic remarks on stakeholder involvement it seems worth mentioning that:

1) At different phases, involvement may take the form of sharing information, consulting, dialoguing, or deliberating on decisions. It should be seen always as a meaningful part of formulating and implementing good, robust decision-making policies. Stakeholder involvement techniques should not be viewed as convenient tools for "public relations", image-building, or winning acceptance for a decision taken behind closed doors [42].
2) In certain contexts the times and the means for involvement are specified by law, while in other contexts, a specific player may have to create the opportunity and the means for involving other stakeholders. Practitioners and scholars are developing, applying, and evaluating various techniques for stakeholder involvement. A vast range of approaches exists, as well as a great number of publications describing them [42].
3) Not all kinds of participation are alike. Different levels of stakeholder involvement are offered by different techniques. One approach may simply transmit information to a passive stakeholder audience; at the other extreme, a technique may significantly empower stakeholders within the decision-making process. Decision makers should be aware that stakeholders may desire, expect or be entitled to a particular level of involvement. Preliminary discussion, contact with or observation of target stakeholder groups, as well as review of statutory requirements, will help determine the appropriate level of involvement. How much involvement the organisation can – or wishes to – offer must be clearly defined and communicated to potential stakeholder participants, at the outset of the programme [42].

4. Regulator's evolving role

Generally speaking, the nuclear regulator's responsibility is (i) to define radiation protection and safety requirements, (ii) to issue guidance on safety assessment methodology and documentation, (iii) to review the implementer´s safety analysis as a basis for licensing of waste management and disposal activities and facilities, (iv) to inspect and review construction, operation and closure of nuclear facilities to ensure compliance with licensing conditions and (v) to provide information to political authorities, the public, and others as needed.

In doing this, regulators play a fundamental role in the overall decision-making process of national waste management programs; particularly, they must ensure its credibility and therefore favour confidence in it. Regulators need to act and be seen as independent overseers of the quality of the evaluation work and the integrity of the decision-making process. Ideally, and subject to any legal constraints, the regulators should be "guarantors" of safety and serve as the "peoples' expert", acting as an accessible resource to stakeholders, and to the public in general, addressing safety concerns [43].

The independence and public accountability of the regulators are vital to the public confidence in the national radioactive waste programmes. Especially in the phase of site selection, the issue arises of whether the regulators can take an active role with involvement in the community processes while maintaining independence for later licensing actions.

The traditional policy worldwide has been that the regulators should not be too intensely involved, if at all, since that might put their independence into question [18]. Actually, though, the regulators seem to take a more active role, although the approaches and the extent to which this is done vary. Some experiences have shown that active regulator involvement is needed and can be achieved without endangering independence and integrity as licensing body. An active role is important to gain trust and confidence in the communities that the regulator fulfils its protective function in the management process [18]. Open channels of communication should be maintained with the general public, implementers, government departments, parliament, concerned action groups and others. Appropriate mechanisms of dialogue must be found with the different stakeholders [43].

Public involvement in the regulatory process is a usual practice in some cases (e.g., the USNRC), and is being incorporated by other regulators (e.g., the CNSC, HSK, SKI and SSI). Approaches differ among countries varying from open public and stakeholders' comments to open licensing meetings and hearings. This is an area of continuing learning, where new experience may offer valuable lessons.

In conclusion, the success of public outreach programmes hinges, in large measures, on the extent to which regulators effectively make their presence and role known, and communicate their independence, showing capacity for their own evaluations and the integrity to put forward their requirements.

5. Analysis for the local acceptance of a radioactive waste repository

The analysis of the local acceptance of a LULU is a fundamental task which should be carried on during the siting phase, so as to able to disregard potential sites where the population's reaction would seriously compromise the facility construction, as well as in all following stages of the project, to identify proper compensations for the local population.

In this regard, many analyses have been conducted in order to anticipate the local acceptance of a radioactive waste repository. In [46] and [47] have compared the cost-benefit and risk perception models and asserted that the risk perception model is considerably more significant than the cost-benefit model. This might be the case in the Western countries, which have different cultural and social backgrounds from the Asian countries. A synthesis of a recent study conducted in Korea [48] is reported in APPENDICE 3.

The cost-benefit model is a common approach for analyzing a person's behavior. The central concept of the model is that "humans are more or less rational choosers, within the constraints of their capacity for reasoning and learning, the experiences to which they have access, and the context in which they live" [48]. Rational actor approaches have been understood as "expectancy-value models", where behavior is found to result from the assessment of the likelihood and severity of outcomes.

In the stages following the selection of the facility site, the use of compensation is a frequently cited method to increase the acceptance of LULUs facilities and to reimburse the affected parties for potential costs. In the view of the cost-benefit approach, "monetary compensation works if the amount of compensation is large enough to off-set the negative externalities of the proposed facilities" [48]. However, many researchers have asserted that compensation may not be viable in most cases due to the political environment in which siting decisions are made. In particular, for siting facilities that have potential environmental or health impacts, an emphasis on risk compensation rather than risk reduction may result in severe distrust rather than acceptance by residents. Evidence from siting of other nuclear waste facilities suggests that compensation will not increase the utility of the repository as long as the risk are perceived to be serious. Moreover, the introduction of the compensation may be viewed as a signal that the repository imposes a risk where before they thought it was non-existent [48].

As an alternative to direct compensation such as rebates, many researchers have suggested grants, which are less likely to be perceived as a bribe and can be used to reduce other risks faced by individuals if the funds are allocated to improving health services. Generally, various tax credits and funding for local cultural, education, medical and transportation facilities have been suggested as grant.

In conclusion, the analysis of the level of acceptance of a radioactive waste disposal system by the local population is a continuous process which should be performed from the earliest stages of the project and should last throughout the operative phase. Compensations to local communities should be foreseen and properly planned so as to balance the obvious benefits and the possibility of inducing more fear.

6. Conclusions

In general, changes in modern society demand new forms of risk governance when dealing with hazardous activities that require the involvement of the concerned stakeholders in the associated decision-making processes. In particular, the decision-making process in radioactive waste management and disposal should be seen in the context of a well structured dialogue/interaction between implementer, regulator, political decision maker and the general public. A necessary condition for a successful process is that institutions and decision makers gain and merit recognition as trustworthy and accountable.

Culture, politics, and history vary from country to country, providing differing contexts for establishing and maintaining public confidence. Therefore, what works in one country may not necessarily be effective in another. Nonetheless, there appear to be certain elements that may be common to programs that are successful in gaining public confidence. These are:

- A clear strategy for the long-term management solution and sound support by the government and policy makers, based on the recognition of responsibilities and needs.
- A flexible decision-making process, which allows the accommodation of public and stakeholder needs (smaller steps in implementation, retrievability, etc).
- The commitment of all involved parties, including affected municipalities and the appropriate regulatory authorities.
- A well-structured process of dialogue/interaction between implementer, regulators, political decision makers and the general public.

Among all the actors involved in the decision-making process, the sharpest change of role probably falls to the regulators. The traditional position worldwide has been that the regulators should not be too intensely involved with the waste management and disposal programme until the licensing process begins, since their independence might be legally compromised. This position is gradually changing toward a more active and visible role in the prelicensing steps. The regulatory authorities, representing the interest of the public safety, should be involved early in the siting process and collaborate with the potential host community/ies.

Regulators have a role both in developing safety standards and criteria to ensure public health and in evaluating whether these standards and criteria will be acceptably met by the proposed facilities, prior to their licensing phases. An open, stepwise regulatory process led by a respected regulator can give confidence that the implementer's proposals are subject to the needed detailed technical scrutiny on behalf of the public.

Keeping the public informed is considered a key function of regulators. The goals of a regulatory authority in communicating with the public are to foster public understanding of the regulatory role and activities, to gain public trust as well as provide national and local decision makers with the necessary information on relevant matters.

The regulatory process is a part of a broader decision making system, the practical application of which has still to be better defined in some cases or to be improved in other cases, taking proper account of the national institutional framework and culture.

Finally, a number of issues which have emerged from the analysis of past international experience on RWG and RWM are synthetically summarized.

Case-specific findings on radioactive waste governance:

- The dichotomy "political – technical" is an illegitimate problem reduction, particularly if the seemingly "disturbing" involvement of third parties is considered.
- The technical foundations and the rationale of decisions have to be considered in close interconnection with (political) decisions and side-effects.
- In the "transitional area" of this interrelationship there are aspects including the definition of criteria, transparency, the duty of publication, traceability, plausibility, reasonableness, the independence of reviewing processes, and the stepwise nature of the procedure.
- The multidimensionality of the issue requires an appropriate reference system. Normatively, the principle of sustainability seems to suggest itself, for two reasons. Firstly, it facilitates a stepwise analysis according to various dimensions. Secondly, it forces upon stakeholders, including decision makers, an examination of these dimensions and consequently it incorporates all parties' perspectives, needs, targets/goals, and knowledge systems.
- Sustainable political decisions in the socio-technical system of radioactive waste disposal are, consequently, based on solid technical grounds, which may only be built on corresponding pre-decisions that provide a sufficient framework (including resources).

The broadening of the "inner" circle of decision makers is being strengthened and professionalised in many Countries; the dialogue is characterised less by "pure political" arguments but is more and more "facts based". This increases the chances of implementing an option of "final disposal" of radioactive waste, with the primary objective being passive long-term safety but incorporating also control mechanisms so as to both validate the safety analyses and achieve broad political support.

Interdisciplinary convergences regarding processes in complex issues such as RWG allow for the conclusion that for the overall decision it is not only the results that are relevant but also the procedure for reaching them. In view of the sustainability goal relation "protection *vs.* control" and process- *vs.* outcome-orientation, it is understood that the RWG system has to be dynamic, adaptive, and even experimental in its instruments, but not in its ultimate goal, *i.e.,* the passive protection of present and future generations and environments.

General findings relating to decision making

Empirical data on radioactive waste management and governance support the assumption that to successfully deal with complex socio-technical systems one needs an integrated perspective. Systems characterised by objective and institutional longevity, a diversity of included dimensions, an intense risk and technology debate, and trust issues suggest a particular emphasis on the decision and communication processes. Consequently, "process-orientation" is not only an issue of involving formerly excluded stakeholders but a productive approach for integrating different aspects and perspectives and for expounding the associated problems.

A decision is more than the preference of an option. It involves the decision-making process with problem definition, judgement, choice and implementation [49]. "Good" decisions are always purposeful and goal-related ("good" with respect to what?). "Good" decisions require good processes (which, however, do not necessarily result in good decisions, although good processes increase the probability of ending up with intelligent decision making). A multitude of stakeholders and perspectives are involved. Therefore, particularly due to the complexity of the issue, the process and procedure, not only the result, are vital for the decisions to be taken. It is a stunning interaction to face. The following attributes of a "good" decision-making process can be suggested based on various international analyses [30][43][50]:

- *Stepwise planning:* planning phases with milestones
- Periodic orientation, reviewing and interim decisions: for technical and political backup
- Open and comprehensive option analysis
- *Iterative dealing with relevant issues, with opportunities for recourse:* allowing for mutual learning [51]
- *Reliable, accountable decision making:* unambiguous rules to be complied with (only modifiable by prior consent)
- *Consistent rationale minimising conflicts:* technical and non-technical sets of criteria
- *Coherent, continuous processes:* establishing sufficient trust in the RWG system

- *Traceable decision making:* arguments and reasoning have to be fully comprehended by interested parties
- *Transparent communication and inclusive participation:* aspects may be put up in broad discussion fora at early stages
- *"Fair" procedure and treatment* of the intra- and intergenerational equity issues

Following Carter [52], well-supported and robust decisions require an "informed consent", on the basis of a "common ground". This, in turn, calls for a demonstration of (most or, if possible, all) potential paths and consequences of actions. Credible and sustained compromise can only, if at all, be achieved if collective learning takes place and as many as possible concerned stakeholder views are considered in all relevant planning phases. All stakeholders have to realize that, in the end, effectively sustainable RWG only results from transdisciplinary "mutual learning" – learning from each other. "Transdisciplinarity aspires to make the change *from research for society to research with society*" as Scholz [51] puts it; "... mutual learning sessions ... should be regarded as a tool to establish an efficient transfer of knowledge both from science to society and from problem owners (*i.e.* from science, industry, politics *etc.*) to science" (p. 13). A corresponding decision is well supported if it integrates relevant parts of both the problem and solution ranges of the main stakeholders.

In complementing their knowledge framework and linking their relations, inclusive participation is an asset. It adds value to all stakeholders involved, strengthens the processes, secures decisions, and provides technically and socially robust outcomes. It is hoped that the managerial paradigm of "Decide–Announce–Defend (DAD)", proved to have all the makings of a disaster, be eventually superseded by a pluralistic design such as "Propose–Learn–Share–Decide (PLSD)".

APPENDICE 1

Building safety confidence in the public by communication and information

Stakeholder confidence and trust in institutions are seen as key conditions for a successful societal decision-making process concerning radioactive waste management. This falls within the tasks of the regulatory authorities as "guarantors" of public health and safety: to be fully effective in carrying out their mission, regulators need not only to be independent, competent and reliable, but should also strive to achieve the confidence and earn the trust of all stakeholders and the public at large.

The lack of confidence, fears and a collective attachment to the land are common denominators among the public participating in a debate when it comes to erecting a new hazardous facility in the vicinity, like a radioactive waste repository. The lack of confidence is linked to the feeling that the judgment of scientists and engineers is biased by their loyalty to the organization they belong to; fears are associated with the idea of life-long exposure to low-level radiation released by the waste disposed; collective attachment to the land as a deeply-rooted identity strengthens as society goes increasingly complex and globalizes [53].

Nuclear waste disposal in particular is such a complex issue that the general public cannot follow it in detail if they do not have the confidence that the best has been tried to address their concerns. Two concerns traditionally raised by the public are the fear of radioactivity and the timescales involved. People cannot understand how scientists and engineers can make a prognosis over those long timescales when even a weather forecast cannot extend beyond few days. The foremost issue is that the responsible regulators who are evaluating these things must be trustworthy and independent; society must be able to have trust and confidence in the independent nuclear regulators who do their best job.

Confidence in the safety of radioactive waste management can be built through a decision-making process made of successive and easily evaluated steps which allow the traceability of decisions and the feedback from stakeholders and the public. The stepwise process must be based on the clear division and definition of the roles and responsibilities of each stakeholder along the different steps, based on a legal framework. In order to build confidence in the process it is important that it can be explained and, even more important, that it can be acknowledged as being open, transparent, fair and broadly participatory. To achieve openness and transparency there must be appropriate procedures in which stakeholders and the public can participate and validate claims of trust, legitimacy and authenticity. It should be possible to obtain an understanding of what is expected at each step and of how facts, expert and value judgments interact to form the basis for a decision [42].

According to the Canadian Nuclear Safety Commission (CNSC), lack of credibility of waste management organizations and regulators seems to reflect a lack of credibility in governments and "big business" as a whole. For waste management implementers and regulators, this translates not to a lack of confidence in their competence, but to skepticism about their integrity and intentions. CNSC concludes that little can be done directly to change this attitude, other than to maintain a high degree of integrity in dealing with the public [18]. This means, inter alia, clearly defining where public opinion can affect decisions and what decisions public opinion cannot influence, showing the use of public opinion in the decision-making process, and honoring all commitments made to the public.

Public information, communication and participation is a way to ensure that public values and ethical understanding are represented, lending fairness, stability and legitimacy to decisions. It is of great importance to [53]:

- Improve the objectivity, quality and diversity of the information made available to the public;
- Encourage greater public awareness with a view to facilitating debate and allowing the public to express their views on issues such as radioactive waste management;
- Foster the development of diverse sources of expertise.

The public involvement in the consideration and examination of alternative options can serve as a means to increase the legitimacy of the decision-making process. An additional forum for weighing waste management options may be paired to the Environmental Impact Assessment (EIA) of a specific project. The EIA provides a useful framework for public and stakeholder involvement with regard to a specific project at a local level; for decisions on general policies and strategies, however, the concept of Strategic Environmental Assessment (SEA), as developed in the EU context, may be more appropriate. This involves a potentially broader spectrum of stakeholders at both national and international levels. In either case, each stakeholder needs to have a clearly defined and well-communicated role both at national and international levels.

Experience in radioactive waste repository implementation shows that progress in the works rests on [42]:

- A clear strategy for the long-term management solution and sound support by the government and policy makers, based on the recognition of responsibilities and needs.
- A flexible decision-making process, which allows the accommodation of public and stakeholder needs (smaller steps in implementation, reversibility, etc).

- The commitment of all involved parties, including affected municipalities and the appropriate regulatory authorities.
- A well-structured process of dialogue/interaction between implementer, regulators, political decision makers and the general public.

From the communication viewpoint, it is clear that relations with the mass media are also important in today's modern society. Openness and availability to media are always required. It is also useful to make acquaintance with journalists and media editors so that they can identify the face and the personal characteristics of the company spokesman as well as of the media interface officer.

Some organizations note that the Non-Governmental Organizations (NGOs) impact on the media and the public may create credibility problems for institutions. Information from operators and regulators is often mistrusted when the media and NGOs put forward alternative experts who dramatically dispute official information. Total openness and availability of communication are the only means to deal with such problems. Some communication means and information activities and general behavioural advices are summarized in Table 1 [18].

Table 1: Means of and suggestions for communication [18]

Organizational
• Local information and monitoring committees are very valuable to convey the information and to discuss and debate all related issues. They should be established at a very early stage, as soon as the project ideas are mature enough to be thoroughly explained. Local authorities, members of political parties and social organizations should be represented. • A structure of open and participative collaboration is indispensable. • Integration of technical-scientific aspects and social aspects must be sought. • Within the framework of the site selection procedure, care should be taken that the local population regards the project as its (own) project and not as an imposed (from outside) project. • Seminars, hearings and public interviews with high credibility personalities, leaders and university professors can convey solid and convincing messages to the general public through the media. • Visits to facilities are an important means for building knowledge and understanding. "A real 3-D image is worth more than one million words" [18]. • If a site is selected, local embedding of the implementing organization is a sign of institutional involvement. • No discrimination against "amateurs" – the concerned public's expertise and knowledge may lie elsewhere than in radioactive waste management, but they can still be valuable to the project. • Neutral mediation in case of conflict is recommandable. • "Focus Group" discussions and Local Liaison Committees.

Technical
• Information centres should be attractive, equipped with interactive models, suitable not only for students but for persons of all ages. • Web sites should be user-friendly and preferably in two modules: one designed for the broad public and one designed for children and youngsters. • Publications, CD-ROMs, videotapes, etc. must be easy to read and/or use, avoiding too many technical details.
JNC (Japan) advice for "face to face" communication [18]
• Walk don't run: work to a local time scale, don't push your schedule. • Make sure you understand whom you are facing: he might not be the person you think he is. • Speak to what they want to hear about, don't just tell what you want to say: in many cases what they want to know about disposal is "why dispose of the waste" instead of "how to". • Don't promise what you can't maintain: never choose a temporary solution to get out of a difficult spot. • Face them: a single contact with your counterpart provides more trust than preparing 100 responses to "frequently asked questions".

In Table 2 are summarized the respondents' views to a survey conducted in the NEA members countries, regarding what is required to foster and maintain credibility of waste management organizations or, on the contrary, harm credibility [18].

Table 2: Generic elements that may favour or harm credibility [18]

Elements that favour credibility	Elements that harm credibility
• The highest possible level of openness and transparency will eventually help to show that the implementer and the regulator have nothing to hide.	• Lack of transparency in the messages, secrecy, reactive approach.
• Procedural equity (acknowledgement and adequate representation of all viewpoints).	• Over-representation of particular viewpoints or interests.
• The decision-making processes should be highly accessible. Local governments and citizens should be involved in the processes from the beginning.	• Minimisation of the importance of public opinion and social movements.
• Credibility is based on confidence in institutions, which depends on their long-term behaviour and actual actions.	• Lack of designation of a spokesman per field of activity.
• Recognising that alternative views may be valid, that the organisation "does not have all the answers".	• Appearing arrogant or dismissive of stakeholder viewpoints, within a "we are the experts" attitude.
• In communicating the final decision, it is shown explicitly where and how stakeholder views have been taken into account.	• Limited consideration of the results of participation in the final decision.
• Objectivity (consideration of information from a variety of sources, with no apparent vested interest).	• Apparent lack of objectivity (seen to be too closely associated with interest groups).
• It is difficult, if not impossible, to heal early mistakes affecting credibility. These mistakes can only be corrected by going back to the point before the mistake was made.	• Accidents or incidents occurring anywhere in the world.
• Comprehensive and stringent disposal strategy, technical concepts and assessment methodology. Changes must be convincing and discussed prior to implementation.	• Unclear strategies and decision making processes.
• Leadership, and therefore involvement, of the national government is necessary.	• Lack of political consensus. Political use of the radioactive waste issue.
• Demonstrated technical competence of the implementer and the regulator.	• Unconvincing technical competence.
• National and international reviews by independent experts.	• Unwillingness to have one's own work subject to review.
• Clear separation of roles of the implementer and the regulator.	• Unclear roles – the public cannot separate implementer and regulator.
• Stay uninvolved in the more general debate concerning the energy choices and the place of the nuclear power.	• Mixing energy policy with waste management safety debates.
• Willingness to give the process time.	• Giving higher priority to deadlines than to communication.

Analysis of the criticisms voiced by the public

Trust is the basis for any dialogue strategy as it governs what is felt by the public, including fear. In this respect, it should be regarded as the prerequisite for any endeavour towards risk governance. Important factors for successfully building confidence are as follows:

- the management of time: rushing is detrimental to filling stakeholders with confidence;
- the sound structuring of all the parties involved, e.g. the set-up of bodies open to the public for discussing all safety issues;
- the availability of pluralistic expertise capable of providing the public with "stereoscopic" views on issues.

The price of truth is questioning, contesting and debate. The public starts trusting scientific statements only when they can be questioned and debated openly among people from distinct origins, e.g. persons in charge and experts belonging to various organizations, motivated by different stakes. Then, regardless of their degree of understanding, members of the public somehow manage to segregate what is wrong from what is right.

Public debate on radioactive waste management must neither be a referendum nor a survey. It must be built on a series of critical hearings on the project and its options, as well as a dialectic on the critical analyses and arguments advocated by those who back the project. The outcomes are a comprehensive round-up of the argumentation provided by all parties and proposals resulting from collective thinking that should not be disregarded by decision makers.

Time is a specific dimension of the nuclear waste issue, which often translates into strong criticism voiced by the public: the public cannot envision thousands of years and denies scientists or engineers any ability to do so. Throughout the world, the Earth is widely regarded as having rights mankind cannot disregard. Adding to this, the public's attitude towards science has changed: at the end of the 19th century, people's expectations towards science were very high; today, these expectations are mixed with distrust against uncontrolled "proliferation" of science. Conversely, confidence in society's maturity has been growing: the opinion is widely shared that, if society is aware of potential hazard, it will take care of it in depth, providing trustworthy solutions [53].

Furthermore, the traditional idea of public acceptance based on communication and public relations can be regarded as irrelevant, the public being rather ready to task fellow citizens who acquired deep knowledge on

the subject with asking questions and relying upon knowledgeable, independent experts to make their own opinion. This attitude shows that some knowledge pertaining to nuclear waste management is still poorly shared and that a constructive dialogue with the public must be part of a governance conducive to trust, equity and open-mindedness.

APPENDICE 2

Approaches to public participation and stakeholder involvement

Experience in RWM decision-making processes clearly discern a progressive widening and opening up of the debate: from the industry's expert organisation (*i.e.,* a "closed" expert) to an open expert community with so-called counter-experts. As a consequence thereof, the problem definition has extended from the internal technical problem of waste deposition in the 1960s and early 1970s to the conceptual debate (concerning issues ranging from final disposal to monitored long-term geological disposal) with the ensuing specification: things and aspects under discussion become clearer and more outspoken. For example, in Switzerland, initially the resources have been with the nuclear power utilities and, partly, with the regulatory body, but then mediation attempts have had to be started after the electorate's acceptance of a moratorium of nuclear power construction in 1990, although these proved to be futile. Following the – negative – referendum on the proponent's (GNW's) application for a repository at Wellenberg in Central Switzerland in 1995, the trials were expanded to negotiations and, from 1999 onwards, to pluralistic expert discussions.

In general, the decisional conditions have widened from the insular existence of the construction technologists all the way to a strategic and inter-expert discourse; the power of defining the issue and framing increasingly moved away from the industry to include additional stakeholders. The problem horizon initially was confined to construction technology, then developed to include long-term safety and, finally, has made RWG both a technically and institutionally complex, long-term issue and programme.

In summary, the progressive integration and generation of knowledge may be recognized as being characterized by an understanding of diverse perspectives, an openness in the ways of thinking and an exchange of ideas, which on the whole is appropriate for the complexity of the issue.

Techniques for stakeholder involvement

The Forum on Stakeholder Confidence (FSC) observes that involvement techniques are not best used for an isolated, "one-off" or "add-on" initiative [42]. In fact, appropriate involvement of relevant stakeholders is advisable throughout a management or decision-making process. Specific techniques will give best results for participants and for the institutions that organize dialogue, if they support a logical step in well-defined processes of management or of decision. This overall process justifies the use of a specific instrument at a

given time, in order to obtain a needed output. Within this process, different issues or problems take centre stage at different times. They will frame the choice of techniques, in order to elucidate, for example national or local considerations, or predominantly societal or technical choices. Experience shows that the success of a particular technique will depend also on external factors such as the phase of decision, the political and cultural context [42].

The technique suitable for a particular situation depends on the stakeholders to be engaged, and the aims and objectives of the consultation. The appropriate level of involvement is a fundamental criterion. It should be carefully set and communicated to potential participants. In the following, a list of techniques is given; increasing order of involvement, based on two-way, deliberative dialogues and compatible with decision-making models that integrate both analytic and deliberative processes [42]:

- *Public hearings*: formal arrangements for times and places at which members of the general public and other types of stakeholders can give evidence or question public authorities about decisions under consideration.
- *Deliberative polling*: collects views after persons have been introduced to the issue and have thought about it; includes a feedback session, sometimes with a high media profile (e.g. broadcast by television along with documentary inserts).
- *Focus groups*: small groups of invited or recruited persons discuss a theme or proposal; provides insight on their reactions, values, concerns and perspectives, and an indication of how group dynamics influence opinions.
- *Citizen advisory groups*: small groups of persons who represent various interests or expertise (e.g. community leaders) meet on a regular or ad hoc basis to discuss concerns and provide informed input.
- *Consultative groups*: forums that call together key representatives of civil society (NGOs and CSOs), economic and political spheres, to make policy recommendations and to improve the ongoing dialogue between these actors.
- *Nominal group process*: a structured group interaction technique designed to generate a prioritized list of high-quality ideas, typically within two hours or less. It is particularly helpful for setting goals, defining obstacles, and gathering creative responses to a particular question.
- *Multi-actor policy workshops*: small groups mixing key stakeholders and technical experts, aimed at collecting a range of viewpoints on what are the important questions raised by the dialogue issue.
- *Charette*: from 20 to 60 persons work co-operatively to find solutions to a given problem within a set time period (usually one day); an experienced facilitator is needed.

- *Delphi process*: persons with different expertise or interests relevant to a problem participate in a series of planned, facilitated discussions (either face-to-face or by correspondence); it is used to develop fact-based decisions and strategies reflecting expert opinion on well-defined issues.
- *Round tables*: representatives of different views or interests come together to make decisions on an equal footing; may last for several days; most valuable when used at the beginning of a process to set broad policy orientations.
- *Citizen task forces*: persons with some special knowledge or representing some interest of the community may be appointed to a temporary task force, organised to consider in depth some issue on which decision is required; the group meets a number of times, often in the company of organising entity representatives, to consider information and formulate recommendations.
- *Study circles*: 5 to 20 people agree to meet together 3-5 times to discuss a specific topic (or, meetings are scheduled on a weekly or monthly basis for more complex topics); information materials are provided over time; a study group may call on different modes of participation (e.g., electronic) from a wider group of participants, and does not track change over time in regard to new information and learning.
- *Scenario workshop*: a local meeting where scenarios are used to stimulate vision making and dialogue between policy makers, experts, business and concerned citizens; it is a technique of technology assessment in which the workshop participants carry out the assessments and develop visions and proposals for technological needs and possibilities; allows the exploration of different possible future technological strategies and at the same time facilitates actual cooperation in the direction of the strategy chosen.
- *Referendum*: for reasons of cost, the only very large-scale public decision format is the popular vote; setting up such a procedure can be an efficient way of attracting citizens' attention to the issue at hand and allowing citizens to collect information about the different positions taken by public figures.
- *Consensus conferences*: these are organized at a national level, usually by a "neutral" organization; a small group of volunteer citizens is chosen to be representative of the public at large, or, to represent a spectrum of viewpoints.
- *Citizens' juries*: participants are recruited by lottery to serve their community by taking part in deliberations on a planning decision that will affect a geographically situated population: e.g., to designate a site for a (conventional) waste management installation.
- *Citizens' panels*: citizens' panels are similar to juries, except that they also develop a range of options before deciding upon one.

- *Participatory site selection*: committees grouping citizen representatives and various types of technical experts work together over a significant period of months or years to develop solutions acceptable from both a technical and societal point of view.
- *Local monitoring, oversight and information committees*: instated at the time of site (pre-) selection, or created when a risk-producing installation is built, such committees are a mechanism for ongoing involvement and dialogue among stakeholders and with the general public; in some countries these committees are required by law; in other contexts, they may be created to improve relationships between the community and institutional personnel and contribute to better risk management; they typically include representatives from elected bodies and from civil society organizations, and they may be of small or very large size (6 to 90 persons, depending on the definition given to "affected public" and the system of representation that is chosen).

Stakeholder involvement techniques may be focused on any suitable dialogue issue. In the given case, the dialogue issue could be radioactive waste management overall, or any of the specific decisions, options, steps, or issues (ethical, economic, etc.) that make up part of radioactive waste management. Clearly, not every technique on the list can be used by every type of organization, nor be applied to every type of policy issue or every decision stage [42].

Furthermore, the above list is by no means exhaustive. Also, the short generic description offered here may not correspond exactly to specific examples: this is because, under a single technique label, field practitioners may design slightly different implementations.

In the following, techniques for "alternative dispute resolution" are mentioned, which offer an alternative to going to court, or make it less likely that the parties will need to go to court later [42]:

- *Policy dialogues*: a small group is created to facilitate informal but structured dialogue between a range of stakeholder representatives and policy actors, often in the aim of generating useful suggestions or options for consideration by political decision makers.
- *Regulatory negotiation or negotiated rule making*: representatives of interested and affected parties work together with regulating government agency personnel to draft proposed rules; participants are mandated by the group they represent, or are chosen because of some recognised expertise; participants need negotiation skills; the function of such negotiation is to fine-tune regulation before its application, so as to avoid legal or other challenges, and to improve its responsiveness to the needs of affected parties.

Levels of stakeholder involvement

In what follows, a list of the main practical insights from the FSC experience is presented, with reference to the need of clarifying the level of involvement and the degree of two-way communication that can be expected by participants [42]:

- Consulting the public when the legal scope for them, to influence the decision, is small causes anger; so it is important to be clear on what issues reasonably can be influenced.
- The basis for the decision must be clearly understood.
- It is important to be clear about the information sought and the feedback to be provided by the decision maker.
- People want to see that they have influenced the process and have had a meaningful impact on the outcome.

For example, Health Canada has proposed a public involvement continuum [54]: the different activities summarized in Table 3 below are blended into each other, with no strict separation line between them.

Table 3: A public involvement continuum [54]

Low level of public involvement or influence		**Mid level**	**High level of public involvement or influence**	
Inform, educate, share or disseminate information	Gather information, views	Discuss through two-way dialogue	Fully engage on complex issues	Partner in the implementation of solutions

In Table 4 is gives some practical guidance on how to fit different levels of public involvement to the needs of the situation.

Table 4: Guidance on choosing different levels of public involvement [42][54]

In what cases may it be appropriate to involve the public?	In matters of health, safety, local impacts of radioactive waste management activities; development and implementation of legislation and regulations; development of policies, statutes and new programmes; preparation of business plan; issues with social, economic, cultural or ethical implications; sharing or disseminating information; resolving questions that revolve around conflicting values.
When to inform/educate?	Factual information is needed to describe a policy, programme or process; a decision has already been made (no decision is required); the public needs to know the results of a process; there is no opportunity to influence the final outcome; there is need for acceptance of a proposal before a decision may be made; an emergency or crisis requires immediate action; information is necessary to abate concerns or prepare for involvement; the issue is relatively simple.
When to gather information/views?	The purpose is primarily to listen and gather information; policy decisions are still being shaped and discretion is required; there may not be a firm commitment to do anything with the views collected – in this case, advise participants from the outset.
When to discuss or involve?	Two-way information exchange is needed; individuals and groups have an interest in the issue and will likely be affected by the outcome; there is an opportunity to influence the final outcome; organizer wishes to encourage discussion among and with stakeholders; input may shape policy directions and programme delivery.
When to engage?	It is necessary for stakeholders to talk to each other regarding complex, value-laden decisions; there is a capacity for stakeholders to shape policies that affect them; there is opportunity for shared agenda setting and open time frames for deliberation on issues; options generated together will be respected.
When to partner?	Institutions want to empower stakeholders to manage the process; stakeholders have accepted the challenge of developing solutions themselves; institutions are ready to assume the role of enabler; there is an agreement to implement solutions generated by stakeholders.

From a more theoretical viewpoint, frameworks of risk perception and decision science allow criteria related to stakeholder involvement, such as perceivability or credibility, to be subsumed and illustrated by means of indicators and anchor statements [55][56]. From risk perception research, three subdivisions are introduced [57]:

- *"Risk notion"* with the categories "risk definition", "risk analysis", "risk 'target'"
- *"Hazard"* with the categories "damage potential", "emergence"/ "onset of impacts", "scientific uncertainties"/ "controversies", "experience with hazard", "voluntariness"/ "inevitability", "controllability"/ "damage defence", "reversibility", "'commonplace' character"/ "familiarity", "perceivability"
- *"Social context"* with the categories "profit", "risk distribution"/ "concern"/ "participation in procedures", "degree of information"/ "risk understanding", "confidence"/ "trust"

From decision science (assessed and reviewed according to Flüeler, [41]) reference is made to research on "system understanding":

i. "recognition of perception and communication problems" (see the above set of variables regarding risk perception)
ii. "avoidance of biases and fallacies" (*e.g.,* the assumption that a technical solution leads to the solution of the entire problem)
iii. "consideration and adaptation of problem structures" (*e.g.*, ill-structured: not all elements are known, no clearly determinable "optimum" solution)
iv. "decomposition into subsystems and re-integration" (*e.g.,* technical risk assessment/comprehensive long-term safety demonstration)
v. "exploration of target relations" (*e.g.,* analysis of aspects of "sustainability" as a complex goal)
vi. "adequate treatment of diverse levels" (*e.g.,* incorporation of stakeholder interests)
vii. "decisions under uncertainty" (decisions are future-oriented and are, thus, always taken with incomplete information)
viii. "cooperation problem" (environmental action as a problem of cooperation of the prisoner's dilemma type: individually rational strategy leads to a collectively inefficient balance)
ix. "behaviour in case of delays" (*e.g.,* utilisation of latency periods as an opportunity for learning)

As theoretical constructs, these categories reflect the rationality concept in risk perception research and the complexity concept of decision science to which the risk assessment framework is added for handling the technical and scientific reasons.

To identify the stakeholders for involvement in the integrated decision making process, the above categories can be sorted according to the actor model [58]. Since considerations and decisions in RWM are taken by organizations, institutional aspects receive special attention; these can be analyzed according to the resource concept in administration science (legislation, knowledge, time spent, human resources, organisation, financing, strategy, see [59]).

Further, to explore inter-individual rationalities, the concept of institutional anomalies can be applied [60]. Finally, the phase model of political science as a principle of order can be utilised for political processes as outlined by Windhoff-Héritier [61][62]. In this context, the concept of sustainability provides the central normative idea.

With the exception of risk perception, all above invoked theoretical constructs of stakeholder involvement share the ability of being system- and process-oriented applicable [40] and thus can be merged on the grounds of risk assessment and system science to reach the decision objectives in a participatory manner which integrates all technical, societal and political issues under a common framework of analysis and decision-making. This accommodates the approach of "integral robustness" of the selected waste disposal solution, thereby making it particularly fruitful.

Addressing divergent stakeholder views

The essence of the *reconciling* approach is that it does not try to remove the divergences between the views, ideas, values of various stakeholders, but attempts to integrate them [45]. An example of this approach is the development of an assessment framework for evaluating and comparing radioactive waste management options in Canada, by integrating the values elicited from a number of stakeholders [63]. Another example is the identification of possible impacts to be considered in Finnish and Swedish EIA processes [64][65]. In all these cases, ideas of various stakeholders were integrated in a joint framework, without the need for reaching a consensus on the relevance of various concerns and values.

Also the *statistical* approach does not try to remove divergences, but aggregates different views by using mathematical methods (e.g., statistical procedures, decision analysis) [45]. An example for this approach is the statistical analysis of views elicited via public opinion surveys in the Japanese siting process [66]. Measuring local and national acceptance via local government vote and Parliament vote in the Finnish case and public referenda organized in the Czech Republic are other examples [67].

An innovative tool is the UK decision analytic procedure, which tries to assess the level and depth of public concern and include this as a criterion for weighing up options [68]. In case of the *compromising* approach, a decision is reached which is a deliberate compromise between the various stakeholders. This approach assumes that the views of the stakeholders may come closer to each other [45]. The UK experiments to involve members of the public in risk assessment with the expectation that a compromise can be reached among them, is an example for this approach [68].

In contrast to the former three approaches, the *confronting* approach focuses on the differences between the problem representations of various stakeholders. It is based on the assumption that revealing and confronting different opinions may help exploring the sources of conflicts and thus may facilitate the finding of creative and mutually acceptable solutions [45]. An example is the introduction of the concept of "stretching" and the

use of hearings in Swedish decision processes [65]. Confronting the stakeholders' claims of truth, legitimacy and authenticity is likely to bring underlying knowledge, beliefs, values, preferences, etc. to the surface. This process will help testing the arguments of all parties, as well as testing the authenticity of stakeholders and experts.

International requirements for public involvement: some examples

In general, a license for a radioactive waste repository needs not only a technical or regulatory decision but also a political decision, which in turn requires broad public consent. In most countries, members of the public have the opportunity to respond or object to a proposed nuclear installation at certain phases in the decision process. Gaining public acceptance is, therefore, a prerequisite for implementing the final disposal solution.

In Germany, for instance, any person has two opportunities to object to a project during the general licensing procedure: one at the moment of the request itself and one when the statements by the States (Länder) and federal offices and the expert reports have been published.

In some countries, e.g. Finland and Sweden, it is stipulated that the local municipality council has a right of veto over a siting proposal (although in Sweden a veto may in principle be overruled by the government under certain conditions). In Sweden, the siting process is based on voluntary participation and the feasibility studies take place only in municipalities that have given their consent. There often also exist explicit requirements for consultations with affected parts of the public, especially those living close to a potential repository [18].

In Canada, the Nuclear Safety and Control Act that established the Canadian Nuclear Safety Commission (CNSC) imposes requirements for public notification and participation. Following in the footsteps of its predecessor, the Atomic Energy Control Board (AECB), the CNSC has maintained an active public participation programme, especially with respect to public hearings and the provision of opportunities for public comment [18].

In France, a 1999 decree authorizes the implementation of a Local Information and Monitoring Committee to be chaired by the Prefect of Department where an underground research laboratory (URL) project is implemented. That committee shall be responsible for ensuring that all information concerning the evolution of the URL project is freely accessible. In particular, it shall be entitled to commission hearings or

independent audits by certified laboratories. Furthermore, its members shall be granted full access at all times to the installations of the underground laboratory [18].

Switzerland, with its federalist structure, has a long tradition of involvement of the public in decision making at all political levels. The public decides in a binding fashion on factual questions through communal, cantonal and federal referenda. The licensing procedure for each license (even for exploratory drillings, shafts or galleries) includes two public consultations, which give opportunity for the public to comment on or object to the project applied for. In other countries referenda at the local level are also used even if they are not always obligatory [18].

An interesting form of public participation is in place in the Czech Republic, where representatives of the public sit on the Radioactive Waste Repository Authority (RAWRA) Board. These representatives supervise RAWRA activities and approve plans, budget, etc. In this way, representatives of the public participate directly in the decision making process [18].

In the U.S., the Nuclear Waste Policy Act (NWPA) of 1982 directs that the U.S. Department of Energy (DOE) study Yucca Mountain, Nevada, as the single site to be characterised for a repository for deep geologic disposal. The NWPA also requires interaction with, and financial assistance to, the various States, local governments, and Native American tribes. Furthermore, the NWPA requires an open, public process for the establishment of standards and regulations [18].

Regulator's evolving role

Attributes of regulators for building confidence and earning public trust

In general, public trust is based both on track record and on perceived morality and values. A good track record would suggest, from experience or evidence, that certain future events would occur as expected. A perception of reliability, honesty, veracity, fairness, strength, etc. of a person or institution, would further allow a certain degree of delegation to be given. Public trust is thus necessary to further legitimate the mission and role of the regulators, in the eye of the public.

A number of organisational and behavioural features appear essential to building confidence and meriting public trust; among these are [43]:

- *Openness*: being active in providing information about decisions, policies and questions related to safety; openness is also a matter of being prepared to answer questions, to discuss and to exchange views with the public or organizations; communications need to be open and honest; open channels of communication must be maintained.
- *Clarity*: regulators demonstrate their commitment to openness through their efforts to communicate in ways that are clear and understandable to the broader public they serve; use of plain language to explain safety, institutional and procedural concepts is essential for fostering the understanding and transparency necessary for building trust.
- *Accountability*: regulators must be prepared to have their actions and decisions probed and questioned in public fora.
- *Independence*: regulators need to be independent of organizations of the nuclear energy industry in regard to licensing decisions, and of any other organizations likely to be affected by such decisions; independence has to be demonstrated by visible actions.
- *Competence*: competence is both statutory and effective; statutory competence is granted by the mandate defined for regulators in the national programme; it is a prerequisite for legitimacy and action; effective competence relies on the training of regulatory staff and the resources of their institution; the regulatory staff must have the required expertise and sufficient resources for careful scrutiny of the implementer's proposals and arguments; achieving and maintaining adequate effective competence within regulatory authorities means they must be able to attract and retain capable staff.

Gradual process of public involvement

A stepwise decision-making and implementation process implies a stepwise regulatory process. From a regulatory point of view, the stepwise approach for implementation of repository programmes is essential since, at each step, it allows for the evaluation of the steps taken so far and the verification of the appropriateness of the next step. This kind of process facilitates the development of regulations in a gradual way, starting from very general principles and ending with the guidance applicable to a licensing review. In this way, the job of regulating is intrinsically one of gradual learning and refinement. Accordingly, rules set at one step may be modified or updated at later stages, although regulators must clarify the reasons and basis for changing regulations at later stages of repository development [43].

In order to preserve flexibility within a decision-making process that could last decades, regulators should strive to avoid overly prescriptive rules too early. This attitude implies, in turn, a well-structured and

formalised interaction process between implementers and regulatory authorities that secures societal trust as described above. At present, there are a wide variety of regulations in the OECD (Organisation for Economic Co-operation and Development) countries in terms of scope and criteria specified and level of detail set down in regulation.

Two philosophies can be distinguished; each of them may have advantages and disadvantages as follow [43]:

- Detailed requirements:
  - provide clear messages to both the implementer and the general public;
  - if unduly restrictive may hamper the development of techniques and procedures within the radioactive waste management system.
- No detailed requirements:
  - provide more opportunity for a constructive dialogue between regulator and implementer; could be beneficial for the development of technical procedures;
  - leave too much to interpretation and perhaps give the impression of insufficient control by the authorities.

A potential issue that could emerge is whether the level of knowledge is adequate to provide the necessary input for the technical and societal decision at each stage in the stepwise development process. Measured participation in this type of long-term process demands that regulators have a good overview of the whole decision-making process as well as a clear definition of what is required or expected at each step.

Involvement of the public when the "rules of the game" are defined is of great importance, especially in the process of rule making and its application to facility site selection and licensing should be transparent and comprehensible [18]. This implies an open process in which the public and other stakeholders can comment on the approaches used by the regulators. Accordingly,

- the "rules of the game" for the regulatory process should be known as soon as possible and in any case in advance of a licensing application;
- ideally the general public should perceive the overall system of regulation, including the formulation of relevant policy by government, as being impartial and equitable.

However, since there are issues that are the exclusive responsibility of the regulatory authorities, the FSC recognises that regulators should determine and inform in advance when, where and how public and other stakeholders input can be accommodated. At a minimum, they should communicate the basis of their decisions.

Experiences and initiatives for public involvement in different Countries

As already emphasised, the approaches of the regulatory organizations are very important for credibility and success of nuclear waste management programmes. Table 5 summarises the specific activities reported in the survey by NEA [18].

Table 5: Regulatory approaches [18]

Organisation(s)	Event or activity	Experience
CNSC, Canada	– Modified licensing procedures, including open licensing meetings, active participation of staff in public meetings.	– Little response from the "general public". Public confidence or apathy?
	– Workshop for potential licensees of legacy uranium mine sites that must be brought under licence control as a result of the implementation of the Nuclear Safety and Control Act in 2000.	– The workshop was considered a success by the attendees: familiarizing the potential licensees with their legal requirements under the Act; establishing a dialogue and working relationship with the CNSC and with each other; enhancing the credibility of the CNSC with these stakeholders as a fair and open regulator; and encouraging them to work with the CNSC to voluntarily move forward with licensing the legacy uranium mine sites.
SKB, SKI and SSI, Sweden	– Reviews of the SKB research and development plans. Comments from about 45 organisations.	– This process is much appreciated by communities and organisations that otherwise do not take an active part in the nuclear waste programme.
	– Regulations of radiation protection (SSI) and safety (SKI) for disposal of nuclear waste. New activities, such as focus groups, to get public input.	– The initiative has been much appreciated. Although it is too early to evaluate, early experience indicates that public input will give substance to the regulations.
HSK, Switzerland	– Guideline on the Protection Objectives for the Disposal or Radioactive Waste. Information meetings, e.g. with opponent organization. Initiatives to enhance knowledge on existence of HSK and of its functions: broadly distributed publications (annual report, information brochures), internet site, press releases and conferences, public information meetings.	– The guideline has been well accepted by the stakeholders, including some opponents.

Organisation(s)	Event or activity	Experience
U.S. NRC, USA	– Enhancement of public outreach with measures such as risk communication training to technical staff, plain language posters, flyers and fact sheets, restructured format for public meetings.	– Positive local reactions, better press coverage, greater satisfaction in the NRC staff.
CSN, SPAIN	– Strategic Plans since 1995 have given strong preferences to promote a closer contact with the general public, the media and other key stakeholders by a proactive attitude increasing the presence of CSN in public forums and widening the dissemination of information.	– Better interaction with key stakeholders e.g., media and local representatives, including municipalities. A set of tools to increase public interest and knowledge on nuclear safety matters.

An important phase in any waste management programme is site selection. A wide range of public interaction experiences exist related to site selection. A summary is offered in Table 6.

Table 6: Site selection experiences [18]

Organisation(s)	Event or Activity	Experiences
POSIVA, Finland	– The EIA process in 1997-1999. Interaction on the local level between the implementers, residents, entrepreneurs, politicians, officials of the municipal government, members of associations.	– A major break-through in bringing about discussion of merits and disadvantages of alternatives in nuclear waste management.
BMU, Germany	– Gorleben experiences. Lectures by scientists and technicians. Meetings to allow for controversial discussions under broad participation. – Konrad experiences. Public inquiry to ensure that all public interests were considered.	– Extended controversial discussions between the "officials" and the audiences. No real participation – decision on next step of investigation was not open. – Opponents trusted the licensing procedure. Confirmation of the applicant's plan.
HAEA, Hungary	– Site selection for a LLW/ILW repository. The public was asked whether they would agree or disagree to exploration activities.	– A majority of the local public is supporting the site selection process.

Organisation(s)	Event or Activity	Experiences
SKB, SKI, SSI, Sweden	– The EIA process in Kalmar County and the municipality of Oskarshamn. Laymen among the politicians, the municipality employees and citizens take part in the work. The competent authorities are visible throughout the process.	– Considerable impact on the siting studies (which issues should be given emphasis). Influence on the programme to meet municipality conditions and to ensure the local perspective. The local competence has increased to a considerable degree. The process is now being adjusted to handle the site investigations.
	– SKB's proposal for three candidate sites for surface based investigation using deep bore-holes has been reviewed by SKI with major input from SSI and other organisations.	– The proposal has been endorsed by the Government based on SKI's recommendations. Two municipalities have agreed to site investigations while the third declined.
NAGRA, HSK, Switzerland	– Site selection for the repository for low and intermediate level waste. Licensing process for the Wellenberg repository project.	– Acceptance of the Wellenberg site selection. Then rejection of the mining concession in view of a repository, by referendum in June 1995.
	– Actions to restart the politically blocked Wellenberg project. Fulfilment of the conditions set by the Federal and Cantonal Governments. Communication of the actions taken (public reports, media conference, information brochure, etc.).	– A mining concession for an exploratory gallery was granted by the Cantonal Government. This decision was however rejected in a public referendum on 22 September 2002, putting a complete end to the Wellenberg project.
	– Swiss/German information meetings for officials from both sides of the border related to concerns on a possible repository for high level waste close to the German border. Independent appraisal of the site selection procedure by German experts (AkEnd).	– The information meetings are appreciated, but the concerns are not yet satisfied.
Statens Stralevern, Norway	– Himdalen waste repository. Process following the Planning and Building Act.	– The public acceptance is high.
	– Spent fuel storage at the research reactors.	– Renewal of the license for the operation of the research reactors.

Organisation(s)	Event or Activity	Experiences
CSN, ENRESA, Spain	– Underground research laboratory – IPES. The project was accepted by the central and regional governments.	– Social rejection and abandonment of the project.
	– Dismantling of lightning rods. Negotiations with many municipalities. A few of them agreed to host the storage.	– Opposition to the project. The strategy was changed to recycling the americium sources abroad.
	– El Cabril LILW repository. Three year of dedicated communication including meetings with the Andalusian Government and Parliament, meetings with local authorities, information campaigns, technical visits etc.	– Local acceptance and construction permit.
	– Vandellos I decommissioning project and Andujar uranium mill decommissioning project. Local information and monitoring committees with labour unions, NGO's neighbourhood associations, political parties, etc., and chaired by a university professor.	– A firm proactive attitude was adopted towards all range of authorities, political parties and the media.
NIREX, UK	– Nirex Liaison Group (1991-1995). Preparation of documents in response to issues raised; discussions with officers and scientific consultants of local government body; records of all information exchanges placed on public record.	– Valuable discussion of technical information and ideas; adverse criticisms in reports by scientific consultants; approvals of borehole planning permissions; refusal of Rock Characterisation Facility
ANDRA, France	– Selection of the underground laboratory site in Meuse. Installation of the CLIS.	– The CLIS is a new part in the process which must demonstrate its capacity for managing the debate and influencing the process – its success or its unsuccess will influence the future of the project.
	– Site selection for a granite site.	– Local refusal of the project.
	– Centre de stockage de l'Aube for LLW.	– Good relations maintained with the local elected representatives and population

Organisation(s)	Event or Activity	Experiences
ONDRA/NIRAS, Belgium	– In the beginning of the nineties ONDRAF/NIRAS carried out studies aimed to assess the technical feasibility of the construction of a surface repository on various types of favourable geological formations. A site selection approach based on purely technical criteria. – ONDRAF/NIRAS has developed the idea of local partnerships. Any party that could be directly affected by a collective decision, should have a say in it. Independent (University/ research – based) mediators work with local stakeholders in the development of increased understanding. Another innovative aspect of this new methodology is that of integration: an integration at the local level enabling the development of draft repository projects creating new perspectives for the regions concerned.	– The report caused a general outcry and was rejected unanimously by all the local councils concerned by the 98 zones that had been identified. – So far two partnerships have been formed: in the local communities of Dessel and Mol.There are currently four working groups in each partnership. Although, it is too soon to draw conclusions, it is felt that the concept is highly appreciated by the local politicians as well as the interested local associations. There is a high level of participation. Public consultation

Some additional reported consultation activities, which have no direct connection with site selection, are summarised in Table 7.

Table 7: Public consultation initiatives [18]

Organisation(s)	Activity	Experiences
Department of Industry, Science and Resources, Australia	– Communication with local community including Aboriginal groups. Briefings, site inspections, discussion papers, reports, newsletter circulated in the central north region of South Austria.	– Diverse opinions, from accepting to opposing. Aboriginal groups continue to refuse waste disposal facilities.
RAWRA, Czech Republic	– Early communication initiatives towards local population and media.	– The outcome seems positive, especially repository visits are useful. About 20 articles and radio reports.
NAGRA and HSK, Switzerland	– Consensus discussions on radioactive waste management. – Setting of requirements on radioactive waste management and disposal according to internationally agreed principles and to the recommendations of expert groups in the new Nuclear Energy Law.	– Conclusions and recommendations had a good response in the media. – The debate on the law in the Parliament is still ongoing. The technical requirements on disposal have been well accepted.

Organisation(s)	Activity	Experiences
SKI and SSI, Sweden	– The Dialogue Project. Seminars were held on critical issues in order to build a common knowledge base between participants. A hearing was arranged for a simulated license application.	– A successful effort for improving stakeholders' pre-understanding of how issues will arise in a real licensing process.
	– A model for enhancing transparency in decision making has been developed through the RISCOM pilot project and the on-going RISCOM II project.	– The RISCOM model has been tested both with the EIA-process in Oskarshamn and when designing the public hearings which were part of the regulatory review of SKB's proposal for site investigations.
U.S. DOE U.S. NRC	– A large number of activities including meetings with counties and State of Nevada, tours to Yucca Mountain, exhibits and conferences, co-operative scientific research, media packets, information centres, web site, public hearings and meetings, interaction with tribes.	– The DOE's responsiveness has resulted in enhanced credibility. However, the Yucca Mountain project continues to be seen as controversial.
	– Enhancement of outreach activities concerning public input into regulation. Public meetings, hearings, individualized follow-up; staff training in risk communication; checking and revamping of information materials.	– Improvements in the accuracy and tone of press coverage, positive reactions from local government officials, and greater satisfaction on the part of the NRC staff.

APPENDICE 3

Analysis for the local acceptance of radioactive waste repository

In [48] an analysis of local acceptance of a radioactive waste facility was conducted. The objective of the analysis was to verify the Gyeongju (Korea) citizens' average level of risk perception of a radioactive waste disposal facility. The cost-benefit and the risk perception models were compared in order to anticipate the local residents' siting decision making, including also political process variables to generate a best-fit model of local acceptance. The analysis allows assessing the ability of the variables used in each model to predict acceptance. To this aim the multiple linear regression method was used to identify the bivariate relationships among variables. First, the Pearson correlation coefficients among all the variables used in the regression analysis (cost-benefit variables, risk perception variables, political variables, demographic variables, and so on) were calculated. The outcome of the analysis was the confirmation of the significant correlation between the degree of acceptance and most of the other important variables identified in previous researches. In the risk perception model, the perceived risk is assessed by global evaluations of risk severity and by subjective factors (dread, trust, etc) that might influence these evaluations, and not by explicit measures of probability and consequences. Some of the variables used in the model evaluation were: risk being familiar or new, trust in central or local government, trust in private sector, risk giving rise to anxiety and dread. Both cases show that the acceptance of the facility decreases with an increase in the possibility of an accident as perceived by the residents.

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