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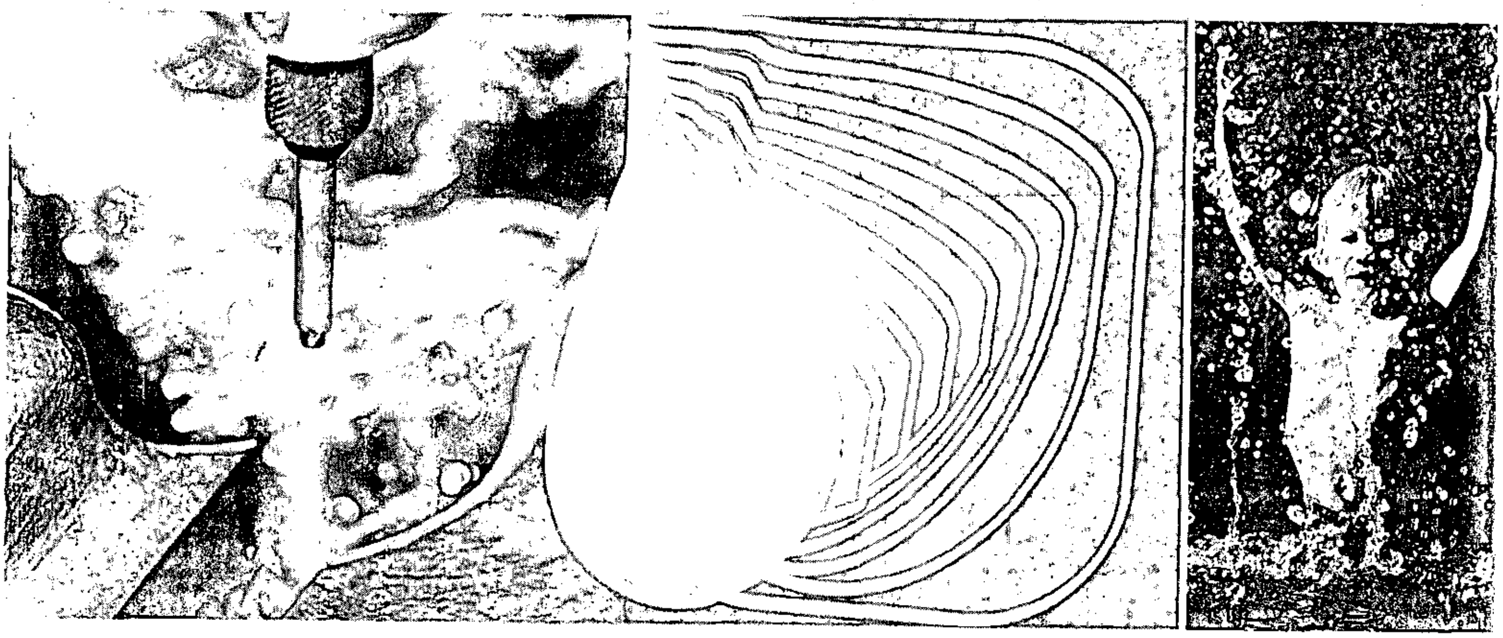
WORKBOOK



# TECHNOLOGY FORESIGHT SUMMIT 2007



Budapest, Hungary
27-29 September 2007

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

WORKBOOK

# TECHNOLOGY FORESIGHT SUMMIT 2007

Budapest, Hungary
27-29 September 2007

*Organized by*
*UNIDO in cooperation with the Government of Hungary*

*Co-financed by*
*the Governments of Austria, Czech Republic and Slovenia*

**UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION**
**Vienna, 2007**

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| Plenary session | Fair of the Future | **Exh. Present.** / **Retreat** | Water Symposium | TF Panels | Fair of the Future | **Exh. Present.** / **Retreat** | Ministerial Round Table | Fair of the future | **Retreat** |
| **Koppenhaga** | **Nizza & Amsterdam** | **Brusszel** | **Koppenhaga** | **Maastricht** | **Nizza & Amsterdam** | **Brusszel** | **Koppenhaga** | **Nizza & Amsterdam** | **Brusszel** |
| | | 9.00 Retreat | 9:00 – 10:30 W1: Saving water and increasing industrial water productivity | 9:00 – 12:00 TF1: Experiences and good practices of TF in the CEE/NIS (national and regional levels) | 9:30 – 18:00 Exhibitions by companies and R&D institutes | Presentations by exhibitors | 9:00 –10:00: Presentation of conclusions and recommendations of the Summit | 9:30 – 15:00 Exhibitions by companies and R&D institutes | |
| | | | 10:30 – 12:00 W2: Matching water quality to use requirements | | | | | | |
| | 13:00 – 14:00 Opening ceremony of the Fair | | 12:00 – 13:30 Lunch | | | | 12:00 – 13:30 Working Lunch | | Retreat working lunch |
| | | 3.30 Retreat | 13:30 – 15:00 W3: Water recycling and on-site reuse | 13:30 – 16:10 TF2: Priority setting for future critical and key industrial technologies as driving forces for economic development | | | 13:30 – 14:00 Rapport on resolutions | | |
| 14:00 – 15:00 Press conference | 14:00 – 18:00 Exhibitions by companies and R&D institutes | | | | | | 14:00 – 14:30 Closing ceremony | | |
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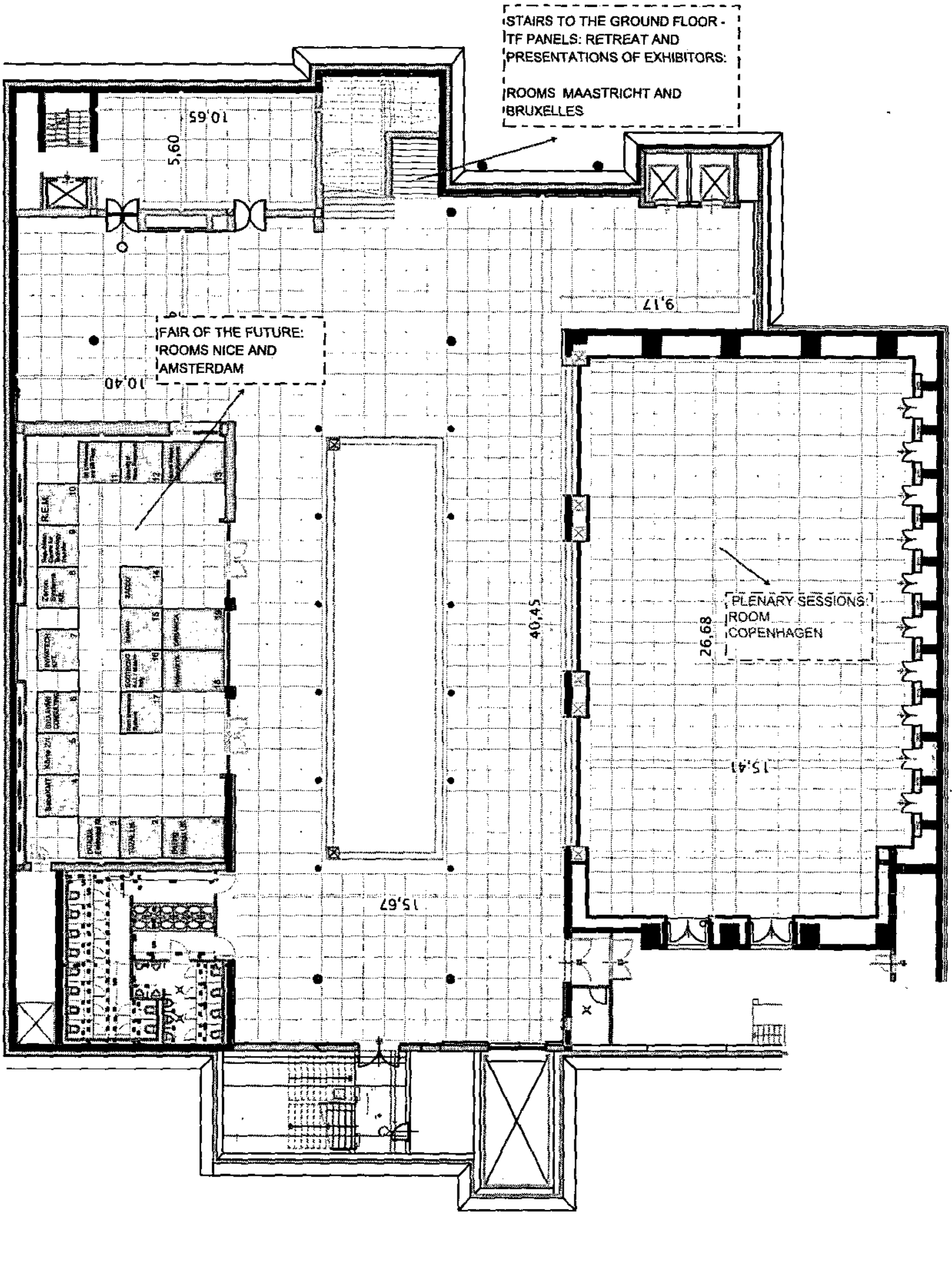
| 16:00 – 17:30 Plenary session | | 7.30 Retreat | 16:45 – 18:00 Plenary: Foresight exercise on zero discharge | | | | 17:00 Closing reception | | |
| 18:00 – 20:00 Welcome reception | | | | | | 18.00 Retreat | | | |

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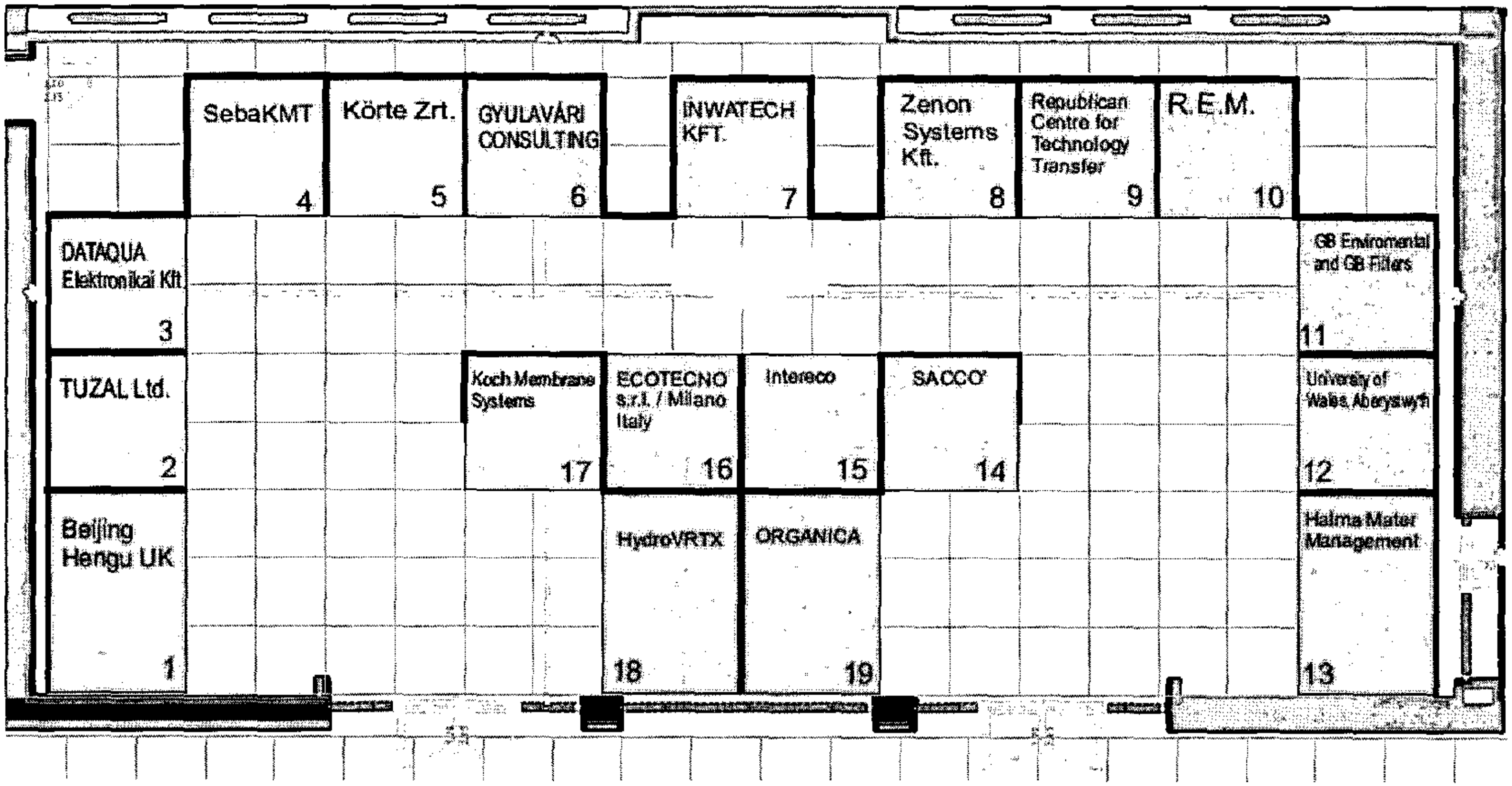
## Layout of the Fair of the Future



# AGENDA

## Day 1: 27 September 2007

**14.00-15.00** **Press conference**

PLENARY SESSION

**15:00 – 15:30** **Opening ceremony of the Summit**
Keynote speakers:
János Kóka, Minister of Economy and Transport, Hungary
Kandeh K. Yumkella, Director General, UNIDO

**16:00 – 18:00** **Plenary session: Summit's Scope**
Chairperson:
Dmitri Piskounov, Managing Director, UNIDO

**Future of using water in industry**
Key speaker:
Anna Grobicka, Research Policy and Cooperation, World Health Organization (WHO), Geneva, Switzerland

**Foresighting for economic development**
Key speaker:
Luke Georghiou, Director, PREST, University of Manchester, UK
Rapporteur:
Michael Keenan, PREST, University of Manchester, UK

FAIR OF THE FUTURE

**13:00 – 14:00** **Opening ceremony of the Fair**
Chairperson: Ferenc Paratos, National Office for Research and Technology (NKTH), Hungary

**14:00 – 18:00** **Exhibitions and presentations by companies and R&D institutes**

**19:00** **Welcome reception**

## Day 2 – 28 September 2007

SYMPOSIUM ON WATER PRODUCTIVITY IN THE INDUSTRY OF THE FUTURE

**9:00 – 10:30** **W1: Saving water and increasing industrial water productivity**

Chairperson: Thomas Jakl, Ministry for the Environment, Austria
Key speaker: Jerzy A. Kopytowski, Industrial Chemistry Research Institute, Poland
Commentator: Mark Macklin, Institute of Geography & Earth Sciences, University of Wales, UK

Rapporteur: Dmytro Rushchak, Director of Ukrainian Water Management Centre and Rabmer Ukraine Ltd., Ukraine

**10:30 – 12:00** **W2: Matching water quality to use requirements**

-

Chairperson: Peter Kovacs, Ministry of Environment and Water, Hungary
Key speaker: John Payne, SNC Lavalin, Assessment – Risk – Remediation General Engineering & Environment, Canada
Commentator: Professor Mark Macklin, Institute of Geography & Earth Sciences, University of Wales, UK
Rapporteur: Dmytro Rushchak, Director of Ukrainian Water Management Centre and Rabmer Ukraine Ltd., Ukraine

**12:00 – 13:30** **Lunch**

**13:30 – 15:00** **W3: Water recycling and on-site reuse**

-

Chairperson: Dimitrij Grcar, Ministry of Economic Affairs, Slovenia

Key speaker: Giuseppe Genon, Politecnico Di Torino, Italy
Commentator: Dr. Stephen Mudge, Biogeochemistry & Environmental Forensics School of Ocean Sciences, University of Wales, UK
Rapporteur: Viera Fecková, Slovak Cleaner Production Centre, Slovakia

**15:00 – 16:30** **W4: Using reclaimed water**

Chairperson: Pavel Puncochar, Ministry of Agriculture, Czech Republic
Key speaker: Marek J. Gromiec, Chairman, Polish National Council on Water Management, Poland
Commentator: Dr. Stephen Mudge, Biogeochemistry & Environmental Forensics School of Ocean Sciences, University of Wales, UK
Rapporteur: Viera Fecková, Slovak Cleaner Production Centre, Slovakia

## TECHNOLOGY FORESIGHT PANELS

**9:00 – 12:00** **TF1: Experiences and recent practices of TF in the European Region (multi-country, national and regional levels)**

Issues:
- *Application of TF process at different levels to promote technology and innovation.*
- *Impact of TF in the decision-making process for technology/ innovation promotion*
- *Methodologies and outcomes from selected experiences*

Chairperson: Norbert Kroo, Hungarian Academy of Sciences (HUS)
Key speakers: Karl Matthias Weber, ARC, Austria, and
Attila Havas, HUS, Hungary

Case presenters:

1. **Multi-country foresight** –Ana Morato, OPTI, Spain and Ricardo Seidl da Fonseca, UNIDO
2. **Regions foresight in Europe** – Francoise Warrant, Destrée Institute, Walonien Region, Belgium, and Alexander Sokolov, Institute for

Statistical Studies and Economics of Knowledge, HSE, Russian Federation

**3. Foresight for national STI strategy** – Adrian Curaj, ROST, Romania

**4. Corporate foresight** – Frank Ruff, DaimlerChrysler, Germany

Rapporteurs: Michael Keenan, PREST, UK, and Ricardo Seidl da Fonseca, UNIDO

**12:00 – 13:30 Lunch**

**13:30 – 16:10 TF2: Priority setting for future critical and key industrial technologies as driving forces for economic development and competitiveness**

*Issues: According to existing TF exercises to discuss:*

- *technology development trends and critical technologies*
- *sectors that need critical technology change and*
- *main directives for setting RTDI priorities for funding and implementing dedicated programmes.*

Chairperson: Fabiana Scapolo, JRC-IPTS, DG Research, EC, Spain

Key speaker: Ron Johnston, Australian Centre for Innovation, University of Sydney, Australia

Case presenters:

1. **Critical technologies**: Karel Klusacek, TC, Czech Republic
2. **Scenarios and Road mapping for key technologies**: Ian Miles, PREST, UK
3. **RTDI priorities**: Elie Faroult, DG Research, European Commission

Rapporteur: Michael Keenan, PREST, UK, and Ricardo Seidl da Fonseca, UNIDO

### FAIR OF THE FUTURE

**9:30 – 18:00 Exhibitions and presentations by companies and R&D institutes**

### PLENARY SESSION

**16:45 – 18:00 Foresight exercise on zero discharge**

*Issues: Presentation of the results and recommendations of the study*

Chairperson: Laszlo Somlyody , Budapest University of Technology and Economics, Hungary

Speaker: Henning Banthien, IFOK, Germany

Rapporteur: Ferenc Kovats and Gabriella Eglesz, NKTH, Hungary

## Day 3 – 29 September 2007

### MINISTERIAL ROUND TABLE

**9:00 –10:00 Presentation of conclusions and recommendations of the Summit**

| | | |
|---|---|---|
| | Speaker (main rapporteur): Lajos Nyiri, Hungary |
| **10:00 – 12:00** | **Ministerial consultations**<br>Chairperson: Maria Rauch-Kallat, former Minister of Health, Austria<br>Rapporteur: Grzegorz Donocik, UNIDO |
| **12:00 – 13:30** | **Working Lunch** |
| **13:30 – 14:00** | **Rapport on resolutions**<br>Speaker (MRT Rapporteur): Grzegorz Donocik, UNIDO |
| **14:00 – 14:30** | **Closing ceremony**<br>Chairperson: János Kóka, Minister of Economy and Transport, Hungary |
| **17:00** | **Closing reception** |

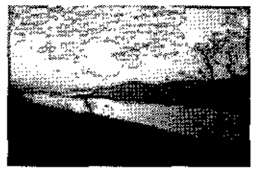
**FAIR FOR THE FUTURE**

| | |
|---|---|
| **9:30 – 15:00** | **Exhibitions and presentations by companies and R&D institutes** |


# THE FUTURE OF WATER USE IN INDUSTRY

**an overview of global trends and technological possibilities**

**Dr Anna Grobicka**





## OVERVIEW

- **The global challenge : water management for human security**
- **Trends in industrial water use and water productivity**
- **Opportunities for the future**
  **Opportunity #1 : increasing industrial water productivity**
  - ➤Water auditing
  - ➤Matching water quality to use requirements
  - ➤Water recycling on site
  - ➤Using reclaimed water

  **Opportunity #2 : closing the loop with zero discharge**
  - ➤Stream separation
  - ➤Materials recovery and waste reuse
- **Policy instruments and economic incentives**

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## EARTH IS A WORLD OF WATER . . .

Yet we hear of conflicts over water, water stress, water scarcity . . . Why?

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Slide 3

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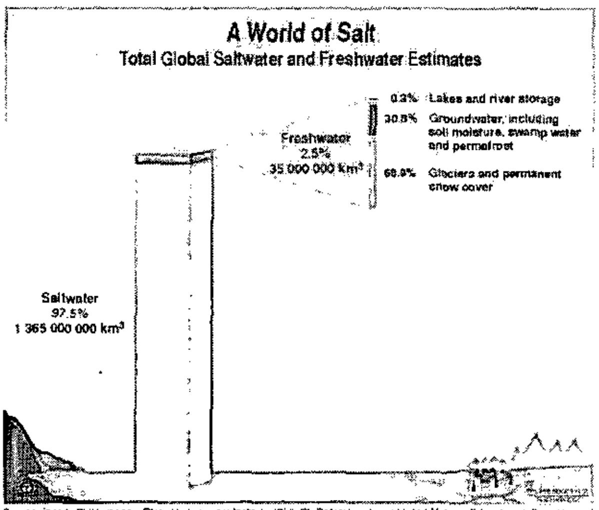


Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999

Desalination ?
Trade-off against energy supply

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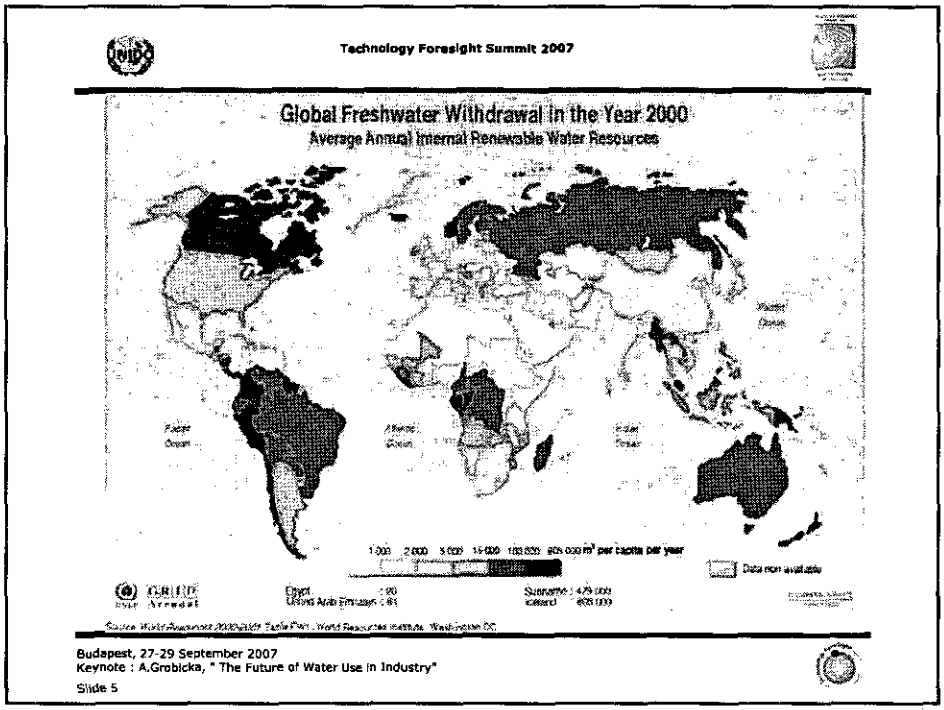
Slide 4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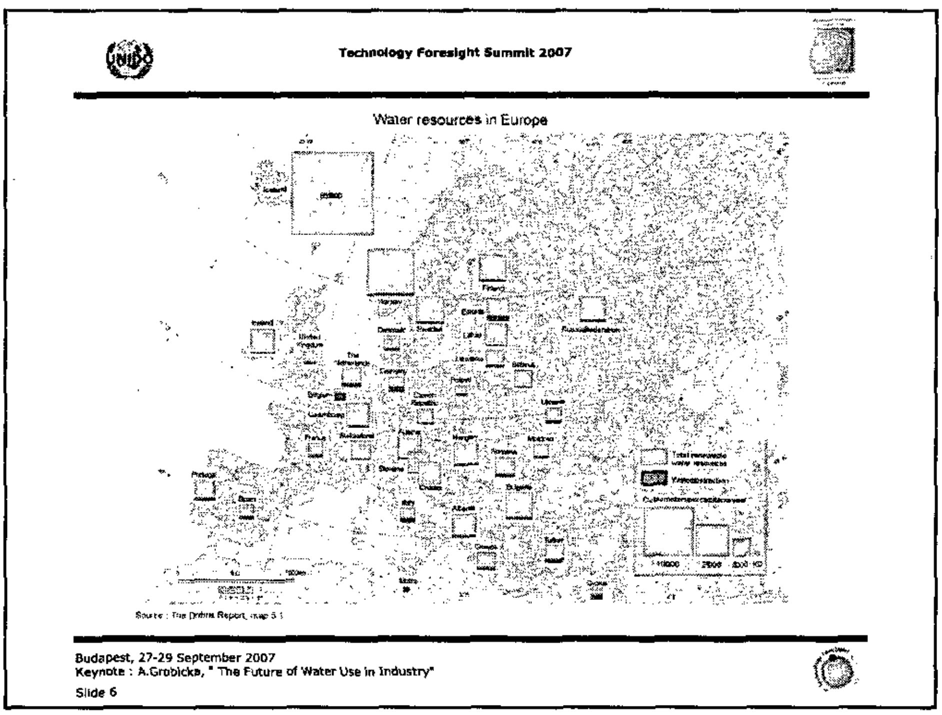
Global Freshwater Withdrawal in the Year 2000
Average Annual Internal Renewable Water Resources
m³ per capita per year
Data non available
Budapest, 27-29 September 2007
Keynote : A.Grobicka, " The Future of Water Use in Industry"
Slide 5


Technology Foresight Summit 2007
Water resources in Europe
Budapest, 27-29 September 2007
Keynote : A.Grobicka, " The Future of Water Use in Industry"
Slide 6

## WATER SECURITY : A HUMAN IMPERATIVE

- The world's population is growing . . .
  - from 6 billion in 2005 to a projected 9 billion in 2050
  
  . . . and urbanising
  - May 23, 2007 : transition day !
    - ❖ global urban population : 3,303,992,253
      exceeds rural population : 3,303,866,404

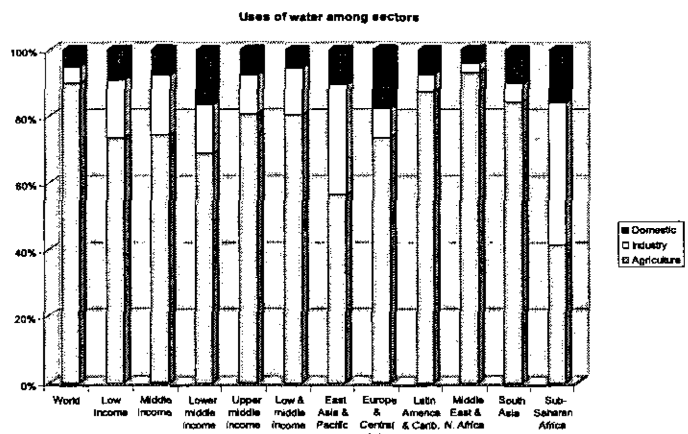
- Climate change is causing increased instability in water supply
  - Increased frequency of floods, droughts and hurricanes

- Competition for freshwater among different users is increasing: Slide 9
  - –Domestic use (drinking water supply and sanitation)
  - –Agriculture
  - –Industry
  - –Environment



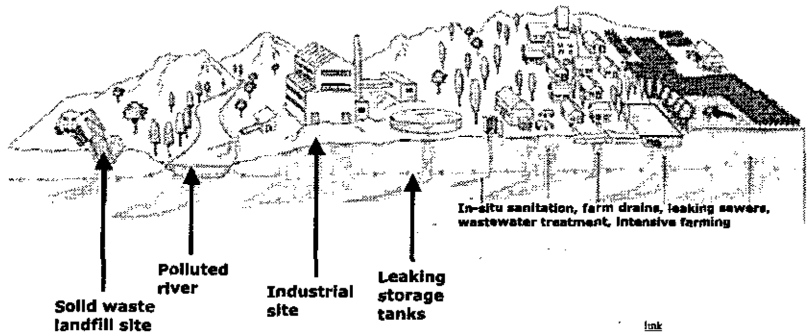


## Sectoral water use (excluding environmental flow requirements)




back

# Primary sources of groundwater pollution

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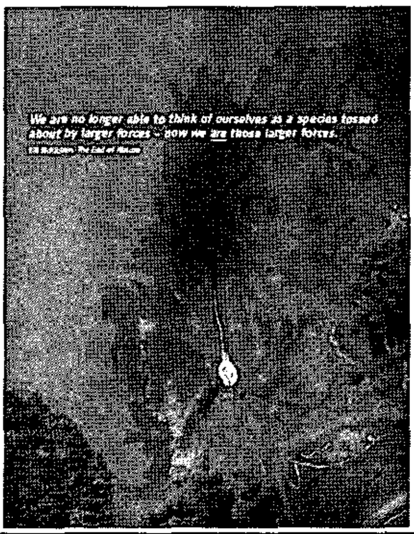

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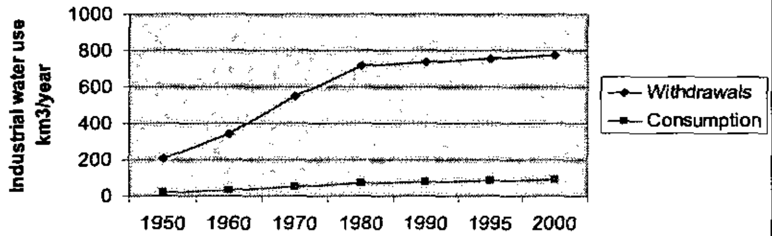
## World industrial water withdrawals and *consumption over the last 50 years*




**INDUSTRIAL WATER WITHDRAWALS = CONSUMPTION + EFFLUENT DISCHARGE**

$$W_i = C_i + E_i$$



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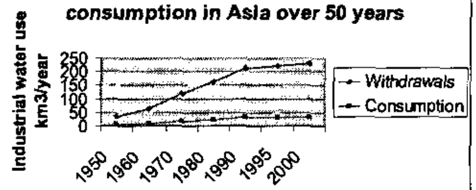
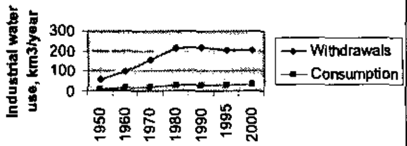
**Industrial water withdrawals and *consumption in Asia over 50 years***




$$W_i\uparrow = C_i\uparrow + E_i\uparrow$$

**Industrial water withdrawals and consumption in Europe over 50 years**




$$W_i\downarrow = C_i\uparrow + E_i\downarrow$$

- Increasing industrial water **consumption** goes hand in hand with economic and industrial **growth**
- BUT industrial water withdrawals (from freshwater sources) do not need to increase in proportion with economic and industrial growth
- By reducing effluent generation, and recycling effluent, industrial production can continue to increase without putting more pressure on scarce water resources

WORKING PRINCIPLE 1 :
The trend in water **withdrawals** can be delinked from industrial growth and industrial water **consumption**

- At the limit, withdrawals equal consumption (**$W_i$ = $C_i$** when **$E_i$ = 0**)





**INDUSTRIAL WATER PRODUCTIVITY**

If we regard water as a scarce and strategic resource, vitally necessary for industrial growth and economic development, it is worth considering how much value can be extracted from each cubic metre of water used:

**INDUSTRIAL WATER PRODUCTIVITY ($/m³)**

$$= \frac{\textbf{INDUSTRIAL VALUE ADDED (\$/year)}}{\textbf{INDUSTRIAL WATER WITHDRAWALS (cubic metres of water/year)}}$$

| Country | Industry, value added (IVA) (billions, constant 1995 US$ per year) Year : 2001 (some 2000) Source :World Bank | Industrial water use (km3 per year) Year : 2000 Source : AQUASTAT, FAO | Population (millions) Year : 2003 Source : AQUASTAT | Industrial water productivity ($ IVA per m3 of water) Year : 2000 Calculation |
|---|---|---|---|---|
| Denmark | 44.90 | 0.32 | 5.32 | 138.59 |
| Japan | 1889.94 | 15.80 | 127.10 | 119.62 |
| USA | 2147.80 | 220.69 | 283.23 | 9.73 |
| Canada | 205.98 | 31.57 | 30.76 | 6.52 |
| Austria | 82.15 | 1.3 | 58.08 | 60.85 |
| Belarus | 5.76 | 1.30 | 10.19 | 4.44 |
| Bulgaria | 3.48 | 8.21 | 7.95 | 0.42 |
| Czech Rep. | 20.97 | 1.471 | 0.27 | 14.31 |
| Estonia | 1.72 | 0.06 | 1.39 | 26.80 |
| Hungary | 17.26 | 4.48 | 9.97 | 3.85 |
| Kazakhstan | 8.39 | 5.78 | 16.17 | 1.45 |
| Kyrgyz Rep. | 0.36 | 0.31 | 4.92 | 1.17 |
| Latvia | 1.88 | 0.10 | 2.42 | 19.60 |
| Lithuania | 2.48 | 0.04 | 3.70 | 60.34 |
| Poland | 50.65 | 12.75 | 38.61 | 3.97 |
| Romania | 12.32 | 7.97 | 22.44 | 1.55 |
| Russia | 139.79 | 48.66 | 145.49 | 2.87 |
| Ukraine | 21.62 | 13.28 | 49.57 | 1.63 |





## WATER SECURITY II

From thinking in terms of water quantity,
let's make a shift towards water quality

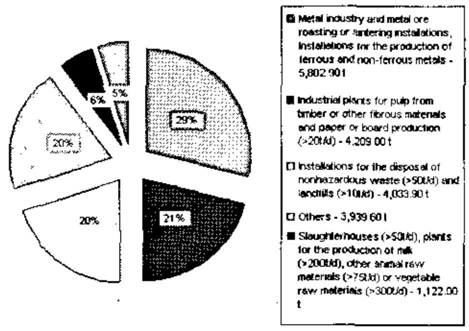
- Water pollution threatens freshwater resources (rivers, lakes and groundwater)
- Water that is too salty or too polluted is not available for to be used or is actively harmful and toxic – to people, to industry, to agriculture, or to the environment

WORKING PRINCIPLE 2 :
Different **uses** require different **levels** of water quality

- Treatment technologies exist for nearly all levels of water quality -but we can also use water more intelligently, as a reactant rather than as a medium; as a process input rather than as a utility

## Emissions direct to water per industrial activity – **Italy 2004**
## **Total TOC emissions direct to water = 20,061 tons in 2004**

Total Organic Carbon (TOC)



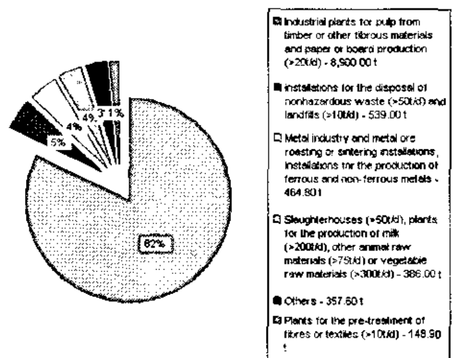

Source : European Pollutant Emission Register (EPER)





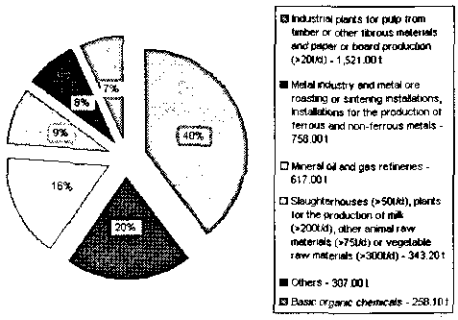
## Emissions direct to water per industrial activity – **Austria 2004**
## **Total TOC emissions direct to water = 10,796 tons in 2004**

Total Organic Carbon (TOC)



## Emissions direct to water per industrial activity – **Hungary 2004**
## **Total TOC emissions direct to water = 3,804 tons in 2004**

Total Organic Carbon (TOC)

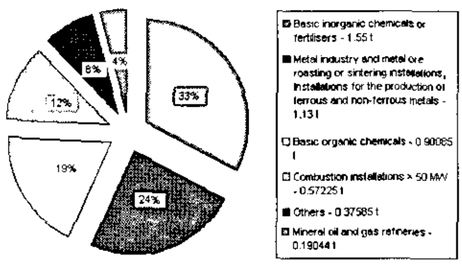







## Emissions of mercury per industrial activity **(total EU 25)**
## **Total mercury emissions direct to water = 4.72 tons in 2004**

Mercury and its compounds



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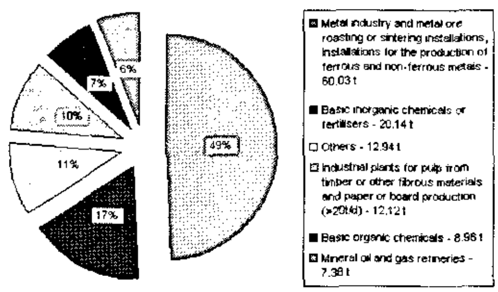
## Emissions of lead per industrial activity **(total EU 25)**
## **Total lead emissions direct to water = 121.57 tons in 2004**

Lead and its compounds

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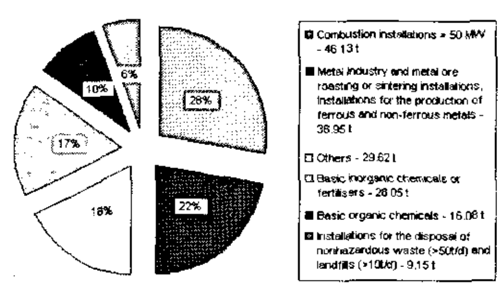
## Emissions of copper per industrial activity **(total EU 25)**
## **Total copper emissions direct to water = 165.98 tons in 2004**

Copper and its compounds

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## OPPORTUNITIES FOR THE FUTURE

### Stage #1 : increasing industrial water productivity

AT ENTERPRISE LEVEL :

- Water auditing - think outside the envelope; assess exactly where and how water is used, and how much water enters and leaves the site (incl. rainwater)
- Matching water quality to use requirements - use lower quality water for applications such as process cooling (heating/quenching/washdown/site irrigation); avoid using water simply for transportation (moving solid material) but switch to pneumatic or mechanical systems
- Water recycling on site - increase the "recycle ratio"; balance treatment costs against the benefits of increased water security and lower discharge volumes





## OPPORTUNITIES FOR THE FUTURE

### Stage #1 : increasing industrial water productivity

AT DISTRICT/LOCAL LEVEL :

Using reclaimed water - recycling water on a district level; pooling treatment costs among a number of industrial users; extend to agricultural and urban use

AT NATIONAL LEVEL :

The virtual water trade - shift to encouraging production of less water-intensive products ($m^3$ water/tonne; $m^3$/$)

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## OPPORTUNITIES FOR THE FUTURE

### Stage #2 : closing the loop with zero discharge

AT ENTERPRISE LEVEL :

- Process redesign, eg. stream separation – by keeping individual effluent streams separate, treatment costs are lowered and materials recovery can be enhanced
- Materials and energy recovery from waste – where a chemical or a heavy metal can be recovered from the waste stream, it can be reused; waste can be digested or incinerated for energy production
- Waste reuse – identifying marketable byproducts which can be manufactured from "waste" material, eg. whey in cheesemaking

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## OPPORTUNITIES FOR THE FUTURE

### Stage #2 : closing the loop with zero discharge

AT INDUSTRY LEVEL :

- Product redesign and innovative supply arrangements – chemicals leasing; moving away from "cradle to grave" thinking towards "cradle to cradle" thinking

AT LOCAL, REGIONAL AND NATIONAL LEVEL :

- Policy instruments and economic incentives – grouping of industries; water charges; effluent charges; tax incentives; introducing a cap-and-trade mechanism for industrial discharges (analogous to the carbon ETS)
- Communicating and making the case – moving to zero effluent discharge maximises industrial water productivity (for a given portfolio of products and industrial sectors)

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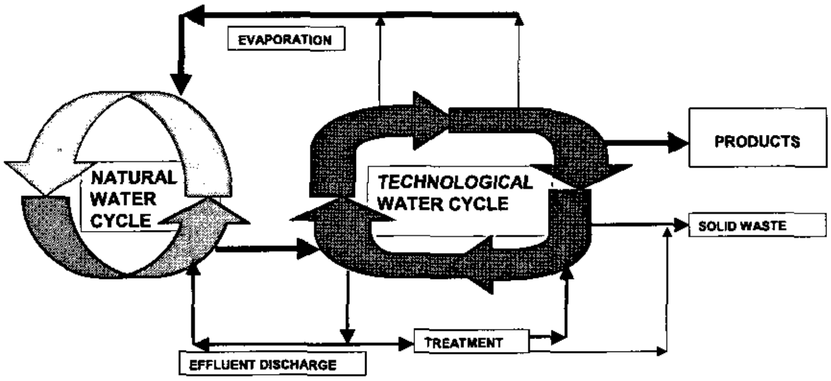
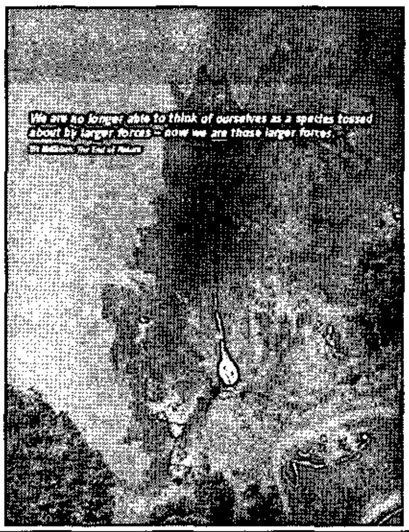
THE NATURAL WATER CYCLE AND THE TECHNOLOGICAL WATER CYCLE




From effluent discharge to zero discharge







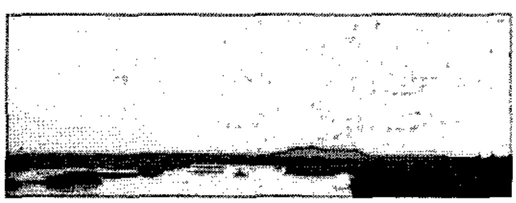
## TOWARDS ZERO DISCHARGE

- Keeping effluent within the technological cycle and away from the natural cycle
- Simultaneously :
  - Protecting the environment
  - Ensuring future water security for industry
  - **Maximising industrial water productivity**





**Through technology foresight we can choose our future.**



**Thank you!**

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# Future of Foresighting for Economic Development

Luke Georghiou
MIoIR, Manchester Business School
University of Manchester
http://www.mbs.ac.uk/PREST

1

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## Status of foresight

- Multiple activities and purposes sharing a name
- Content focus
  - Priority setting
  - Identifying ways in which future science and technology could address future challenges for society and identifying potential opportunities
- Structural focus (increasing tendency)
  - Reorienting Science & Innovation system
  - Demonstrating vitality of S & I system
  - Bringing new actors into the strategic debate
  - Building new networks and linkages across fields, sectors & markets or around problems
- Content and Structural Goals may be addressed simultaneously
  - All above may be at organisational, local, regional, national or supranational levels
- Also foresight carrying input from S&T futures into wider policy domains

2

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## Context of move to open innovation

- Convergence of innovation and industrial policy in the context of knowledge economy
- Concept of innovation ecosystem
- Foresight role in creating shared strategic vision
- Emerging reorientation of innovation policy with new emphasis upon demand-side policies
  - Also an industrial policy based upon fostering clusters, platforms and supply chains
  - Key driver of development is linkage between local capabilities and effective demand

3

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## Existing experience – in public policy

- Large body of experience logged by EFMN
- Multiple engagement but adaptation and experimentation rather than repetition
- Families of approach
  - Critical technologies; Delphi; Horizon scanning; Accession/transition

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## International Collaboration

- Gains from
  - Cost reduction through shared efforts
  - Accessing foresight expertise, training and experience
  - *Accessing broader &/or complementary domain* expertise
  - Addressing transnational problems
- For developing countries multi-country foresight can create space for dialogue about linkage between long-term problems and here-and-now and build community of practice

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## Policy Transfer & Learning in Foresight

- Failure can result from:
  - Uninformed transfer
    - borrowing country has insufficient information about the policy that is being transferred with the result the policy is imperfectly implemented.
  - Incomplete transfer
    - crucial elements of a policy or programme that made the policy or programme a success are not transferred.
  - Inappropriate transfer
    - insufficient consideration given to social, economic, political and ideological differences between the borrowings and the transferring country leading to programme failure

- All issues that become more important still when transfer is from developed economy to emerging, transition or developing

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## Existing experience - corporate

- Foresight in business vs Foresight for business
- Functions include anticipatory intelligence, direction setting, priority setting, strategy formulation and innovation catalysis
- Trend to "open foresight" in terms of participation, scope and delineation
- In developing countries particular challenge to build capability and to connect to wider environments (and markets)

7

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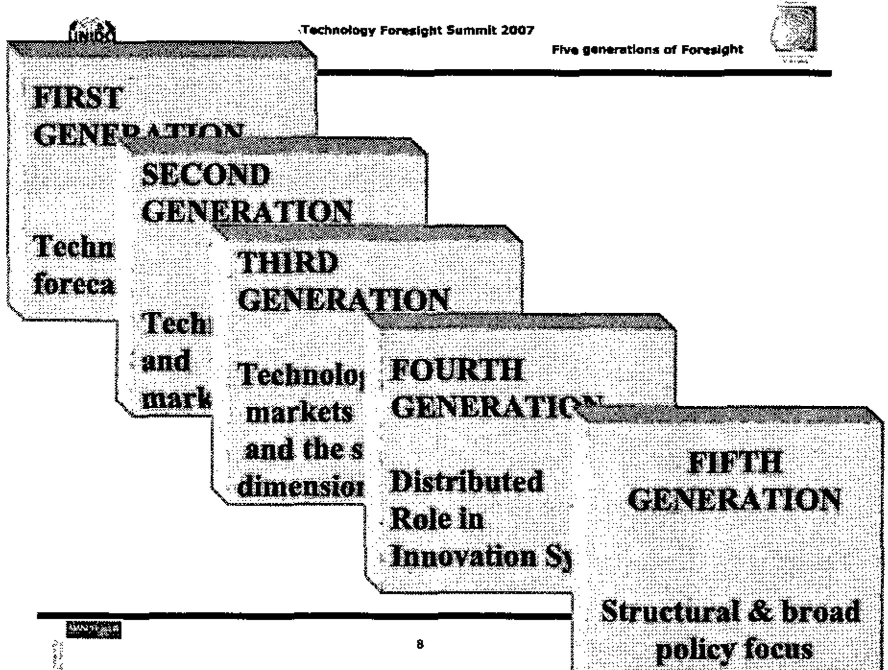
Five generations of Foresight

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## Extending the mandate to Innovation Foresight – structural focus

- *Overcoming market and system failures*
- Microeconomic climate for innovation
- Addressing deficiencies in firms
  - Resources
  - Incentives
  - Capabilities
  - Opportunities
- Also use foresight to address deficiencies in system capacity for strategic development
- Foresight as balancing and linking mechanism

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## A taxonomy of research and innovation policies

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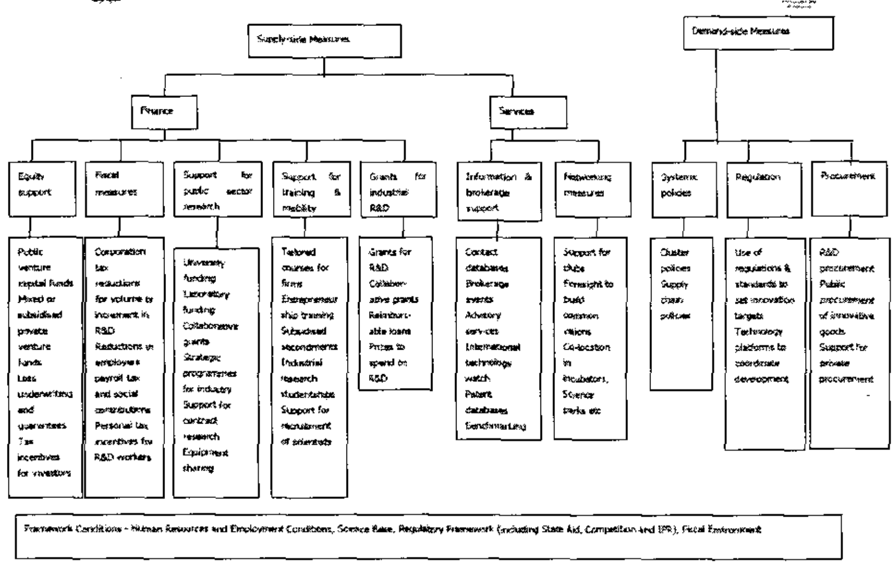


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## Foresight for policy vs Foresight as policy

- For policy
  - Use as a tool to *inform and develop* policy in any area
  - Also for "joining up" policy across domains
  - In our domain normally areas of policy with a strong science/ research input
- As policy
  - Use as an instrument to *implement* budgetary, structural or cultural changes
  - In our domain as an instrument of research and/or innovation policy





## For developing & transition economies

- May be deficiencies in system capacity for strategic development
  - Lack of integrated policy framework
  - Short-term reactive thinking
  - Inflexible scientific institutions disconnected from socio-economic problems
  - Low innovation intensity in industry
  - Resource deficiencies (human and capital)
- Diverse circumstances of developing countries and regions
- For poorest countries complex combination of factors forms problematique of underdevelopment
- Foresight can be part of solution but no one-size-fits all prescription

## Engaging foresight with development goals

- Key characteristics of foresight are provision of systematic combination of:
  - Long-term perspectives
  - Wide participation
  - Effective policy/strategy formulation and implementation
- Key benefits are:
  - Raising awareness of impending problems & opportunities
  - Diagnosing weaknesses and indicating strengths
  - Informing priorities and planning
  - Building networks
- In addition:
  - *Where there is high political polarisation foresight has* important role in seeking common ground beyond short-term concerns





## Conclusions

- Revisit initial theme of shift from technology to innovation foresight
- Open up to wider implications of knowledge economy and society & the forces & trends that drive innovation
  - Role in innovation & industrial policy
  - Promotion of foresight at corporate level

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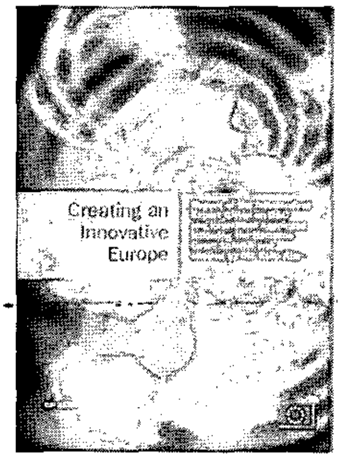
## Innovation & Industrial Policy

- Emerging role for foresight in New Wave Demand-side innovation policy
- Need to understand foresight in context of range of tools for innovation policy and how it can interact with, strengthen and be strengthened by combinations with other policies
- Particular opportunities in demand-oriented innovation policies
  - Clusters and technology platforms built on base of common visions
  - Public procurement for innovative goods and services again driven by shared visions

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## Developing country context for innovation foresight

- Fast-track development of open innovation system and new industrial eco-system
- Improve chance of success at innovation and channel more towards goals of sustainable development
- Creating pro-innovation culture in government
- Combining elements of 4th and 5th generation foresight to multiple embedment
- More use of foresight on structural issues connected to innovation system
- Space for difficult issues of present to be "shifted" to future
- Means of transition to join global networks that otherwise threaten exclusion

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## Corporate foresight

- Close connection to proposed changes in innovation environment but also need specific actions
- Build corporate culture and capability to sustain foresight in enterprises that are locked into traditional thinking and markets and day-to-day survival
- Key lessons from major firms
  - Ensure engagement of principal stakeholders in company
  - Match open innovation with open foresight

**And the future...**

- Foresight will continue to adapt and reinvent itself to keep pace with the changes which it helped to induce

# HOW TO INCREASE INDUSTRIAL WATER PRODUCTIVITY

J. A. KOPYTOWSKI (M. Sc. Ph.D)
Industrial Chemistry Research Institute (ICRI), Warsaw, Poland





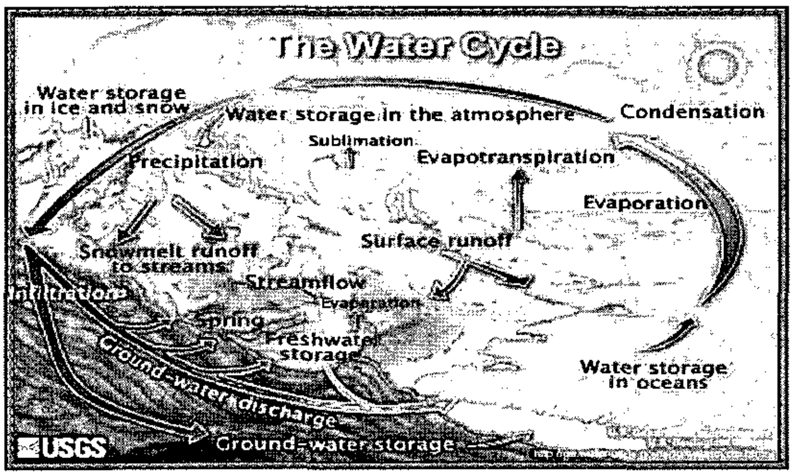
## CONTENS OF THIS PRESENTATION

- DATA OF PRODUCTIVITY
- SELECTED BRANCHES OF INDUSTRY
- PRICE AND VALUE OF WATER
- PRODUCTIVITY INCREASE BY CIRCULATION
- WASTE WATER ("0" EFFLUENTS)
- POLICY / MEASURES
- DEFINITIONS / MEASURES

# DEFINITIONS / MEASURES







# BASIC DEFINITIONS

**Total Actual Water Renewable Resources (AWRR)**
gives the maximum theoretical water amount actually available for each country being the sum of:

- **Internal Renewable Water Resources (IRWR)**
and
- **External Renewable Water Resources (ERWR)**
which is inflow from up stream countries and border lakes or rivers.

**ERWR** may be positive or negative depending on the flows.
The value is given in **km3/year** or **$10^9$ $m^3$/year.**





# BASIC DEFINITIONS,cont.

**Water Productivity (WP)** represents the ratio of value of withdrawal of water expressed in **$m^3$** (or in $m^3$ per capita) to the value of output from the industrial activities using this water expressed in monetary terms (or reverse). Value of output may be measured in industrial value added or GDP per capita (when macroeconomic patterns are discussed).
The amount of water used by a given industrial process is understood as:

**Direct Water Productivity**. In case when consumption of water is related to the complete industrial process from the raw material to the consumers product then this water productivity is understood as **extended (cumulative) water productivity** (or sometimes **technological water productivity).**

**Waste Waters** are the part of waters from withdrawal which are polluted by the industrial utilization and before reaching the water sources must be treated to the level accepted by law.

# Regional water withdrawal and use [6)]

| Region | Total withdrawal km³/year | Domestic withdrawal km³/year | Industrial withdrawal km³/year | Agricultural withdrawal km³/year | Withdrawal as % of IRWR |
|---|---|---|---|---|---|
| Africa | 215 | 21 | 9 | 184 | 5.5 |
| Asia | 2 378 | 172 | 270 | 1 936 | 20.5 |
| Latin America | 252 | 47 | 26 | 78 | 1.9 |
| Caribbean | 13 | 3 | 1 | 9 | 14.4 |
| North America | 525 | 70 | 252 | 203 | 8.4 |
| Oceania | 26 | 5 | 3 | 19 | 1.5 |
| Europe | 418 | 63 | 223 | 132 | 6.3 |
| **World total** | **3 830** | **381** | **785** | **2 264** | **8.8** |





# Comparison of the direct and cumulative water consumption

| Petrochemicals | Direct $m^3/t$ | Cumulative $m^3/t$ |
|---|---|---|
| LLDPE | 160 | 446 |
| HDPE | 157 | 472 |
| PCV | 30 | 668 |
| PS | 78 | 110 |
| **Fertilizers** | **Direct $m^3/t$** | **Cumulative $m^3/t$** |
| Urea | 80 | 124 |
| AN | 6 | 137 |
| DAP | 10 | 165 |

# INDUSTRIAL WATER CONSUMPTION

Water consumption is assed from two different aspects:

a. macroeconomic aspect which considers the water withdrawal by industries in a given country in amounts as well as in percentage from the total water withdrawal,

b. microeconomic aspect which considers the water use in given industrial production branch.



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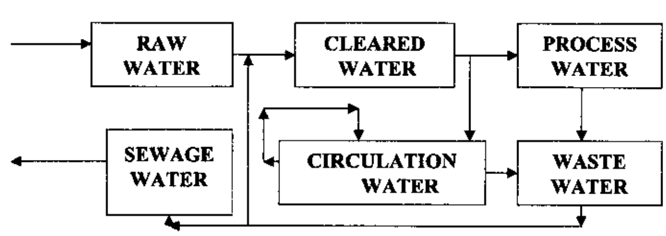
# SIMPLIFIED INDUSTRIAL WATER SYSTEM



## The macroeconomic information on use of water by countries in Europe, cont.

These **differences in ratio of withdrawal of the water** for the industrial purposes should be dependent of the *existing industrial structure in each country.*

For purpose of qualitative measure this should have obvious impact on the relationship between the MVA and water withdrawal.

**However this relationship is not strictly quantitative.**





# HOW TO INCREASE INDUSTRIAL WATER PRODUCTIVITY

**J. A. KOPYTOWSKI (M. Sc. Ph.D)**
**Industrial Chemistry Research Institute (ICRI), Warsaw, Poland**
**US/RER /06/A11**

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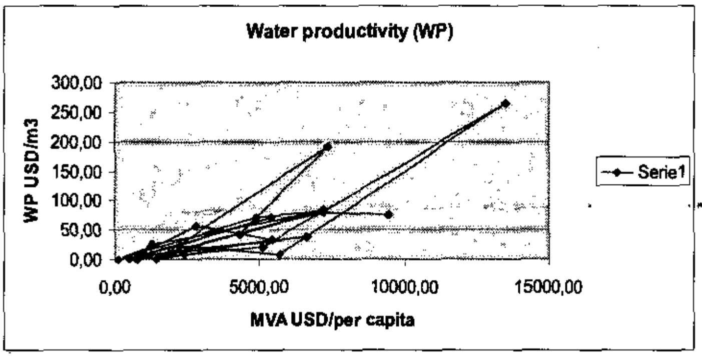
## Water productivity in selected branches of chemical industry

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## Consumption of water by the petrochemical industry in Europe in year 2005

| Product/Variables | Production t/year | Unit water use $m^3/t$ | Total water use $km^3/year$ |
|---|---|---|---|
| LDPE | 7 116 000 | 447 | 3.18 |
| HDPE | 5 110 000 | 472 | 2.41 |
| PS +ABS | 2 459 000 | 110 | 0.27 |
| PCV | 6 050 000 | 668 | 4.04 |
| EO | 2 397 000 | 306 | 0.73 |
| EG | 1 637 000 | 436 | 0.71 |
| Other | 2 476 900 | 407 | 1.01 |

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# Ethylene branch water productivity

| Product/Variable | Units | LLDPE + LDPE | HDPE | PCW | PS | EO | EG |
|---|---|---|---|---|---|---|---|
| Water use | $m^3/t$ | 447 | 472 | 668 | 110 | 306 | 436 |
| MVA , industrial case C | €/t | 338 | 1020 | 744 | 176 | 253 | 343 |
| Price, industrial case C | €/t | 2183 | 2400 | 4323 | 3059 | 2333 | 1947 |
| Productivity brut | €/$m^3$ | 4.89 | 5.09 | 6.73 | 27.72 | 5.47 | 4.57 |
| Productivity net | €/$m^3$ | 0.76 | 2.16 | 1.11 | 1.6 | 0.59 | 0.81 |
| Profit (water at 0.05 €/$m^3$) | €/t | 235 | 257 | 178 | 176 | 267 | 280 |





# Impact of water prices on profitability of the petrochemical industry

| Produkt | Water use $m^3/t$ | No charge for water | Profit at 0.05 €/$m^3$ | Profit at 0.25 €/$m^3$ | Profit at 0.5 €/$m^3$ |
|---|---|---|---|---|---|
| LDPE | 447 | 257 | 235 | 146 | 34 |
| HDPE | 472 | 281 | 257 | 163 | 45 |
| PS +ABS | 110 | 184 | 178 | 156 | 129 |
| PCV | 668 | 209 | 176 | 42 | -125 |
| EO | 306 | 282 | 267 | 206 | 129 |
| EG | 436 | 302 | 280 | 193 | 84 |
| Other | 407 | 252 | 232 | 151 | 49 |

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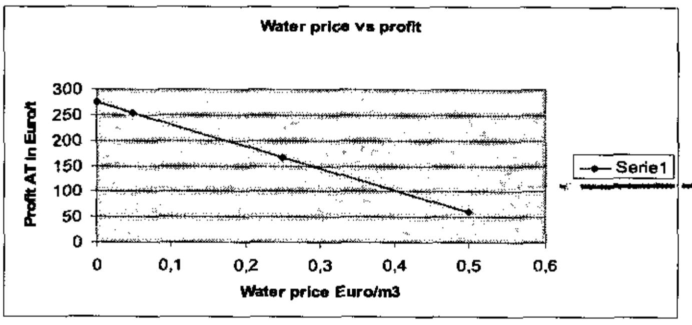
## Impact of water prices on profitability of the petrochemical industry, cont.

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## Price and value of water

Value of water is a multi-faceted variable.
It has several aspects like:

- **social**
- **economic**
- **environmental.**

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# Price and value of water, cont.

Such a case is denoted **in Spain** where respective charges were established by the **Agencia Catalona de l'Aigua** [14].
The price composition **in Catalonia** is therefore a sum of charges:

**-general charge: 0.1091 €/m³**
**-specific charge: 0.4276 €/m³**
**- fresh water cost: 0.5367 €/m³**

Pollutants charges added to the water price (e.g.):

- **suspended matters 0.3095 €/kg**
- **oxidable matters 0.6190 €/kg**
- **nitrogen 0.4699 €/kg**
- **phosphorus 0.9400 €/kg**





# Prices of water in case studies [19] in €/m³

in €/m³

| Water class | Industrial case A | Industrial case B | Industrial case C | Industrial case D |
|---|---|---|---|---|
| Raw water | 0.2 | 0.38 | 0.1 | 0.37 |
| Decarbonized water | 0.54 | 2.59 | 0.32 | 0.55 |
| Circulating water | 0.10 (93% recycle) | 0.18 (90% recycle) | 0.03 (95% recycle) | 0.06 |
| Process water | 1.16 (85% recycle) | 2.9 (60% recycle) | 1.55 (75% recycle) | 2.16 ? |

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# PRODUCTIVITY INCREASE BY CIRCULATION

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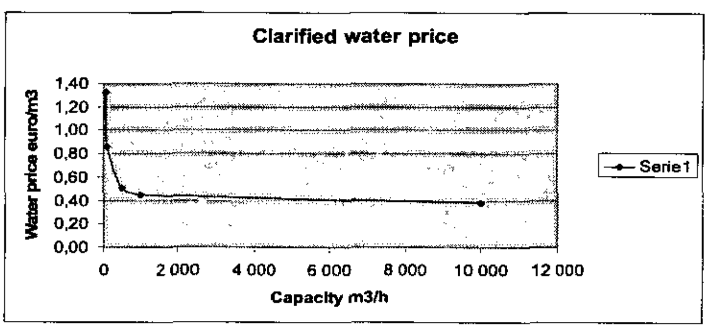
## Clarified water price at the cost of raw water 0.1 €/m³

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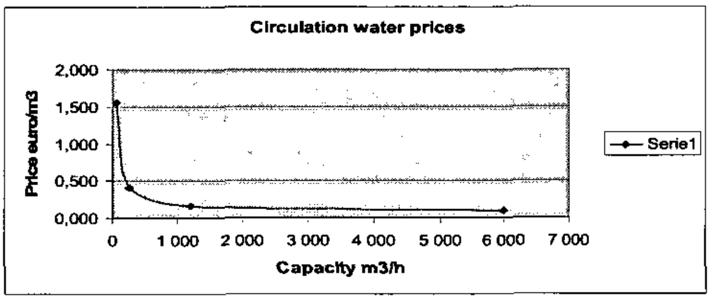
# Price of the circulation water based on technological profiles, cont.



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# INDUSTRIAL WASTE WATER SOURCES

The sources of industrial waste waters are numerous [20)] and differentiated in time, unit amounts and composition.

The easy identified are as flows:

a. waste water from system of the industrial water supply
b. waste water from system of industrial water circulation
c. waste water from direct use of industrial water
d. waste water from process waters
e. waste water from rain harvesting by sewage system

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## INDUSTRIAL WASTE WATER SOURCES cont.

- In Europe exists **over 2400** waste water treatment plants and numerous small size treatment facilities for small and medium size industries.
- Every one has certain particularities related to the properties of waste incorporated in water.
- According to the EU regulations the standards for waste waters of **40 industrial categories** are established and limits regulating discharge of **120 pollutants.**

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## Water productivity increasing. <u>High income countries strategy</u>

For high income countries the consumption function is streaming to

**the Kuznets form,**

due to the outsourcing the industries consuming the large amount of water and development of the secondary industrial structure

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# Water productivity increasing. <u>Low and medium income countries strategy</u>

1. In principle only new advanced alternatives of technologies are transferred, which are lower than historical use in high income count.

2. The water treatment technologies are much more advanced than they were during the industrialization boom in 70-ties.
   In fact the technological level achieved allows full reuse of industrial water, again except the physical features of use.





# Water productivity increasing. <u>The command measures applied</u>

- **Establishment of the water quota (targets)**
- **Establishment of the waste water quotas**
- **Effluents standards**
- **Establishment of the rate of circulation**
- **R@D support in the field of water management**
- **Licensing of the water management system**

# Water productivity increasing. The economic measures applied

**Tariffs on water supply from all sources.**

- **the universal charge (monetary units/$m^3$)**
- **the specific charge (monetary units/$m^3$)**
- **the pollution charge dependent on the waste water pollution composition (monetary unit/ pollutant unit).**

**Charges on the waste waters**

- **the waste waters leaving industrial estate are cleaner than withdrawn waters quality**
- **the water is used in the closed circle**



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# Water Management Systems Management systems based on semi - public assets property

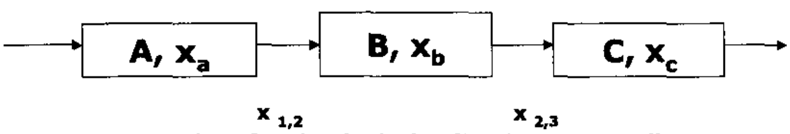
| System | Advantages | Disadvantages |
|---|---|---|
| Service contracts | Transparency of operational cost | Local budget responsibility for assets |
| Management contracts | Short term responsibility of contractor for operation of the system | Lack of improvements and modernization of technology |
| Lease agreements | Long term contracts ensuring renovation of assets | Difficulty in establishing of the price formula |

# Water Management Systems
## Management systems based on change of assets property

| System | Advantage | Disadvantages |
|---|---|---|
| Built, operate, transfer | The technology is selected by administrative authority | Long periods of construction; *budgetary difficulties* |
| Built, operate, own | The investment cost is under control of administrative authority | Long term difficulties in establishment of price formula |
| *Joint-venture* between contractor and authority | Continuous control of the water operational cost | *Participation in* renovation cost of assets |
| Outright sale | Full responsibility of contractor at the investment recovery cost | Possibility of monopolistic actions |








**A,.....Z capacities of technological units t/year at condition $B \times x_{1,2} > A$ and $C \times x_{2,3} >$**

**$x_{1,2}$...$x_{2,3}$....$x_{n,\,n+1}$ direct material consumption coefficient t/t**
**$x_a$,....$x_z$ - direct water consumption $m^3/t$**
**$y_a \dots y_n$ - cumulative material consumption coefficient t/t**
**$y_a = x_{1,2} \times x_{2,3}$**
**$y_b = x_{2,3}$**
**$Y_A \dots Y_N$ *technological unit cumulative water consumption* $m^3/t$**
**$Y_a = x_a\, y_a$**
**Z - total network cumulative water consumption $m^3/t$**
**$Z = Y_a + Y_b + \dots Y_n$**

## The macroeconomic information on use of water by countries in Europe [7)]

| Country | ARWR km³ | Withdrawal km³/year | % of industrial withdrawal |
|---|---|---|---|
| Albania | 41.7 | 1.71 | 11 |
| Austria | 77.7 | 2.11 | 64 |
| Belarus | 58 | 2.79 | 47 |
| Belgium | 18.3 | 9.03 | 86 |
| Bulgaria | 21.3 | 10.5 | 78 |
| Czech Republic | 13.2 | 2.58 | 57 |
| Denmark | 6.0 | 0.017 | 25 |
| Estonia | 12.8 | 0.158 | 38 |
| Finland | 110.0 | 2.476 | 84 |
| France | 203.7 | 39.69 | 74 |





## The macroeconomic information on use of water by countries in Europe, cont.

| Country | ARWR km³ | Withdrawal km³/year | % of industrial withdrawal |
|---|---|---|---|
| Germany | 154.0 | 47.05 | 68 |
| Greece | 74.3 | 7.77 | 3 |
| Hungary | 104.0 | 7.64 | 59 |
| Ireland | 52.0 | 1,13 | 77 |
| Italy | 191.3 | 44.37 | 37 |
| Latvia | 35.4 | 0.30 | 33 |
| Lithuania | 24.9 | 0.27 | 15 |
| Moldova | 11.7 | 2.31 | 58 |
| Netherlands | 91.0 | 7.94 | 60 |
| Norway | 382.0 | 2.19 | 67 |

# The macroeconomic information on use of water by countries in Europe, cont.

| Country | ARWR km³ | Withdrawal km³/year | % of industrial withdrawal |
|---|---|---|---|
| Poland | 61.6 | 16,20 | 79 |
| Portugal | 68.7 | 11.26 | 12 |
| Romania | 24.9 | 23.18 | 34 |
| Russia | 4507.3 | 76.68 | 63 |
| Spain | 111.5 | 35.63 | 19 |
| Sweden | 174.0 | 1.04 | 54 |
| Switzerland | 53.5 | 2.57 | 74 |
| UK | 147.0 | 9.54 | 75 |
| **Europe** | **7771.3** | **418.325** | **53** |





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# Matching Water Quality to Use Requirements

**Technology Foresight Summit – Water Productivity in Industry Budapest, Hungary 27 - 29 September, 2007**

**John Payne**
**SNC-Lavalin Engineers & Constructors Inc.**
**Toronto, Ontario, Canada**

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## Prologue

**"Water, water everywhere / Nor any drop to drink"**


*From "The Rime of the Ancient Mariner" by Samuel Taylor Coleridge*

2

# Topics

- Sources of Water
- Uses of Water
- Industry's Relationship to Water
- Industry's Effect on Water Quality
- Industry's Requirements for Water Quality
- Matching Quality and Use
- Treatment
- Planning and Implementation
- Summary
- Actions
- The Way Forward





# Sources of Water

**Natural**

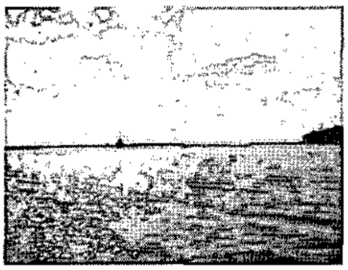
Groundwater Aquifers; Spring Water; Thermal Water; Surface Water; Rivers; Lakes; Ice Caps and Icebergs; Sea Water; Rain Water

**Municipal**

Stormwater; Sewage Water

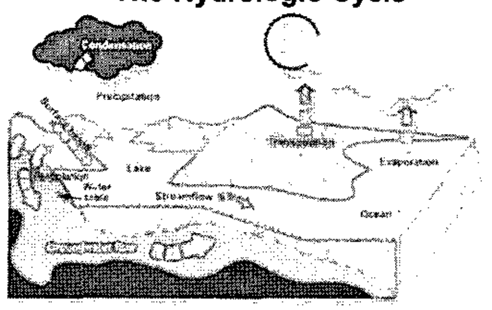
**Industrial**

Non-Contact, e.g, Cooling/Heating
Contact, e.g., Process Effluent



## Sources of Water

### The Hydrologic Cycle



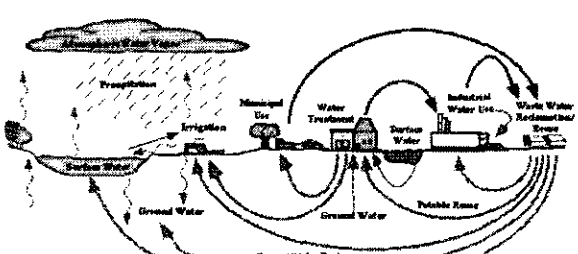
*From: Environment Canada Freshwater Website: Properties of Water: http://www.ec.gc.ca/water/en/nature/ prop/e_ cycle.htm*





## Sources of Water

### The Role of Engineered Treatment, Reclamation and Reuse Facilities in the Cycling of Water Through the Hydrologic Cycle (Asano 1998)



*From: Australian Academy of Technological Sciences and Engineering, 2004*

## Uses of Water

**Consumptive**

- Municipal - Potable
- Municipal – Non-Potable
- Agriculture
- Industrial – Manufacturing Needs
- Industrial – Product Needs

**Non-Consumptive**

- Hydroelectric Power
- Geo - Cooling/Heating
- Fishing
- Recreation
- Navigation

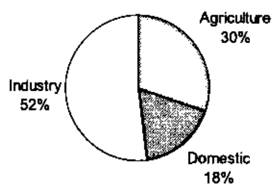




## Uses of Water

**Water Withdrawal in Ukraine (AQUASTAT FAO)**

**Figure 3 : Water Withdrawal in Ukraine (AQUASTAT FAO)**
**Total 25.991 $km^3$ in 1992**



## Industry's Relationship to Water

**Optimum Scenario for Water Supply and Use ...**

- *to have the right quality of water ...*
- *in the right quantity ...*
- *in the right place ...*
- *for the right use ...*
- *at the right time.*



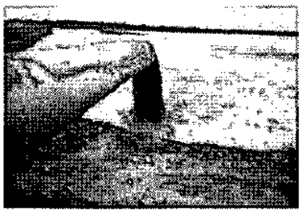


## Industry's Effect on Water Quality

- **Industrial water use** – essentially linear
- **Industry** – pollutes primary water supply
- **Pollutants** – many routes in hydrological cycle

## Industry's Effect on Water Quality

- Discharges not adequately treated
- "Dilution Effect"
- Groundwater







## Industry's Requirements for Water Quality

**Agriculture** – majority of World's water use

**Thermal Cooling** – 39% US withdrawals

**Drinking Water** – high quality

**Food Processing** – highest quality

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## Industry's Requirements for Water Quality

**Typical Industrial Water Quality Problems**

- Scaling
- Corrosion
- Biological Growth
- Foaming
- Pathogenic Organisms

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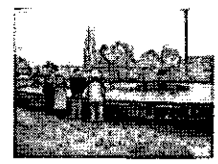
## Matching Quality and Use

**Productive Reuse**

- Additional service from a given amount of water
- Avoid discharge after one application
- Put back into service economically



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# Matching Quality and Use

## Possible Water Use versus Sources and Quality

| Table 19 National Water Quality Guidelines - Current Situation and Future Requirements (Rathjen et al. 2003) | | | Water Sources | | | | Quality of Recycled Water | | |
|---|---|---|---|---|---|---|---|---|---|
| | Functional Use Areas | | Potable Water | Rain Water | Stormwater | Greywater | Highly Treated | Medium Treatment | Low Treatment |
| Portable Substitution Uses | Residential / Commercial Indoor | Toilet Flushing | | | | | | | |
| | | Clothes Washing | | | | | | | |
| | | Showering / Bathing | | | | | | | |
| | | Hot water System | | | | | | | |
| | | Drinking / Food Preparation | | | | | | | |
| | Residential / Commercial Outdoor | Residential irrigation and other urban outdoor uses | | | | | | | |
| | Municipal Controlled Access | Parks & Sportsgrounds and Recreational Activities | | | | | | | |
| | Municipal Uncontrolled Access | Parks & Sportsgrounds and Recreational Activities | | | | | | | |
| | Fire Protection Systems | | | | | | | | |
| | Industrial Process Waters | Open Systems | | | | | | | |
| | | Closed Loop Systems | | | | | | | |
| New Water Uses | Agriculture | Food eaten unprocessed and in direct contact with recycled water | | | | | | | |
| | | Food processed and not in direct contact with recycled water | | | | | | | |
| | | Pastures | | | | | | | |
| | | Non Food Crops | | | | | | | |

| | |
|---|---|
| (dark shading) | Guidelines Non Existent or Require Major Work |
| (no shading) | Guidelines Exist - Require Work |
| (light shading) | Guidelines Well Established and Accepted |

*From: Australian Academy of Technological Sciences and Engineering (2004)*

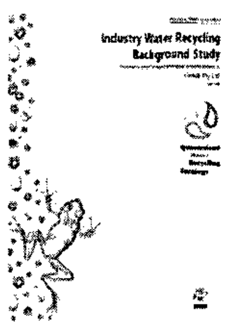




# Matching Quality and Use

**Viability**

- Proximity to reuse application
- Water quality
- Volume/consistency
- Cost reused versus cost potable
- Pretreatment requirements
- Health risk




**Compatibility**

- Similarity between process water outputs & inputs

*Kinhill Pty Ltd., 1999, Industry Water Recycling Background Study. Queensland Water Recycling Strategy, Department of Natural Resources, Brisbane.*

## Matching Quality and Use

| | Viability | Compatibility |
|---|---|---|
| Internal Process Water | 1 | 3 |
| Treated Municipal Water | 2 | 2 |
| External Process Water | 3 | 1 |

**Combined Results = Viability + Compatibility – little difference**

**Treated Municipal Effluent** – best potential

**Internal & External Process Water** – similar potential





## Matching Quality and Use

**Practical Aspects**

- Water Blending
- Water Quality Exchange
- Dual Reticulation

## Matching Quality and Use

**Cleaner Production**

- Stream Separation
- Recovery of Raw Material and Energy
- Reuse of Waste and Wastewater
- Product Transportation



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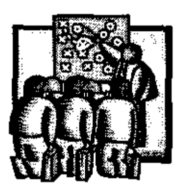
## Matching Quality and Use

**Water Management Strategies**



- Water recycling and reuse policies
- Grouping of industry
- Budgeting or allocating water use
- *Economic incentives or penalties*
- Water demand management and payment

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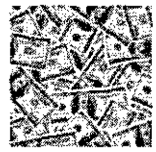
## Treatment

***"A view has been expressed that any water can be made safely potable if strained through enough money." (AATSE, 2004)***



**Constraint on treatment – cost not technology**

**Simpler treatment approaches – solve many problems**

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## Planning and Implementation

**Environmental Governance**

- Policy Planning → Implementation
- Legislation → Regulation
- Public/Community Consultation → Fear

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## Planning and Implementation

**International**

- Agreements
- Conventions
- BEPs
- ISO 14001

**Country**

- Water Demand Management
- Charges
- Compliance
- Incentives

**Local/ Plant**

- Cleaner Production Assessment





## Planning and Implementation

**Cost - $$**

**Average prices in Canada per Litre**

- Water $0.086
- Gasoline/Petrol $1.00
- Beer $3.00

***"When the well's dry, we know the worth of water"***

***Benjamin Franklin***

## Summary

### General Truths

- **Use/reuse of water** – very dependent on quality
- **Water wasted** – if quality does not match use
- **Quality** – base on standards related to use
- **Good monitoring** – essential
- **Drivers for quality** – decreased environmental impacts
  – reduced costs



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## Summary

### Practical Realities

- **Industrial location** – based on quantity
- **Cooling & process water** – significant water use
- **Match location to sewage treatment facilities**

## Summary

### Obstacles

- **Major impediments** – low cost & alternatives
- **Use of reclaimed water still limited** – non-food crops
- **Wastewater, stormwater and rainwater** – resources
- **Water management** – full hydrological cycle



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## Summary

### Directions

- **Focus for reuse** – reduce demand in base resource
- **Water reuse** – cost effective
- **Stricter criteria** – increasing quality
- **Treatment technology** – increasing reliability
  – reducing costs

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## Actions – Management, Planning, Regulation

**Broader Initiatives**

- **Institutional Strengthening projects**
- **Management of water and wastewater** – combined or separated
- **Resolving conflicts of mandates** – between government levels
- **Streamlining approval processes**

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## Actions – Management, Planning, Regulation

**Technical Requirements**

- **Water withdrawal & reuse policies**
- **Mandatory and Voluntary Standards**
- **Water quality monitoring requirements**

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## Actions – Management, Planning, Regulation

**Financial Incentives**

- Economic incentives or penalties
- Budgeting or allocating water use
- Water demand management and payment

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## Actions – Research

- Simple guidelines for reuse
- Climate Change
- Effluent and stormwater reuse
- Treatment processes to improve cost and efficiency
- Long-term impacts of reclaimed water
- Surrogate parameters for water quality monitoring
- Incorporating rainwater into supply
- Integrated water cycle management

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## Actions – Zero Discharge

- Key concept in matching water quality to use
- Linked to the "cradle-to-cradle" concept
- Withdrawal will decrease to meet consumption
- Zero Discharge = water stays in technological cycle for ever






## The Way Forward

**Where is the incentive to do anything?**

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## The Way Forward


### Good News

- Problem recognized
- Consequences recognized
- Ability to measure and track status
- Technical know-how

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## The Way Forward

### FORESIGHT

**Thoughtful & Robust Management, Planning & Regulation**
**+**
**Will Power and Persistence**

- ✓ Motivate Innovative Thought and Solutions
- ✓ Stimulate Action
- ✓ Move Quickly
- ✓ Maintain the Momentum and Sustainability

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Budapest, 27-29 September 2007

# Water recycling and on site reuse

**Giuseppe Genon**

***TURIN POLYTECHNIC***

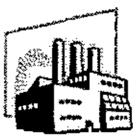


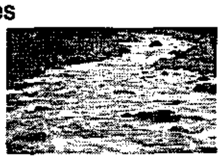


## Origin of opportunity of water recycle

*General considerations:*

- The natural water resources section and the industrial compartment cannot be longer considered different independent entities with end-of-pipe solutions defined on the basis of independent parameters of the two compartments
- There is an increasing cost connected to modified situations, the water resource cannot be considered an unlimited good
- The alternative is a recycling and reuse technology intervention; by this intervention a lower load is applied to the receiving bodies, and there is a lower weight on the external water resources





## Quality of discharge water from different origins

- It is possible to establish a direct correlation between the quality of the raw materials that are employed in an industrial operation, and the transfer of part of these materials and secondary components (solvents, chemicals) to receiving sewer systems
- For many industrial activities there are indications as Emission Factors, able to correlate in terms of flow rate and quality industrial activity and wastewater flows
- It is quite easy to find indications about macrocomponents (COD from sugar industry), more difficult to identify secondary pollutants (heavy metals in slaughterhouse wastewater)
- A direct analytical campaign is in many cases, together with industrial process review and technical literature comparison, the basis to evaluate initial wastewater quality and quantity





## Emission factors

Untreated Effluent Loads from Pulp and Paper Manufacture

| Effluent | lb/ton of product | |
|---|---|---|
| | Suspended solids, range of design values* | 5-day BOD, range of design values* |
| Pulps: | | |
| Unbleached sulfite | 20–40 | 400–700 |
| Bleached sulfite | 25–60 | 450–800 |
| Unbleached kraft and soda | 20–30 | 25–50 |
| Bleached kraft and soda | 25–55 | 45–80 |
| Unbleached groundwood | 30–80 | 15–25 |
| Bleached groundwood | 45–85 | 25–60 |
| Neutral sulfite semichemical | 80–180 | 250–500 |
| Textile fiber | 300–500 | 200–300 |
| Straw | 400–500 | 400–500 |
| Deinked | 400–800 | 60–100 |
| Fine papers: | | |
| Bond—mimeo | 50–100 | 15–40 |
| Glassine | 10–15 | 15–25 |
| Book or publication papers | 50–100 | 20–50 |
| Tissue papers | 30–100 | 10–30 |
| Coarse papers: | | |
| Boxboard | 50–70 | 20–40 |
| Corrugating board | 50–70 | 25–60 |
| Kraft wrapping | 15–25 | 5–15 |
| Newsprint | 20–60 | 10–20 |
| Insulating board | 50–100 | 150–250 |
| Specialty papers: | | |
| Asbestos | 300–400 | 20–40 |
| Roofing felt | 50–100 | 40–60 |
| Cigarette papers | 100–800 | 20–30 |

* *Design value is dependent upon yield.*

## Process revision directed to improve the recycle feasibility

*Besides to different flow separations, other process modifications can be realized in order to improve recycle feasibility; among them:*

- raw material selection, with elimination of refractory components
- careful verification of characteristics of wastewater
- process modification to improve water concentration and treatment
- separate management of different wastes
- the separation of different wastewater fluxes can have important consequences as concerns sewer system, and in some cases it is impossible to be performed a-posteriori; an initial plant construction devoted to wastewater segregation must be suggested





## Recycle, reuse and multiple use

*Two conceptually different solutions can be envisaged with the same objective, to reduce withdrawal and discharge, namely:*

- reuse solution: the same volume of wastewater after suitable treatment is re-employed in the same apparatus (many examples in galvanic industry, mechanical industry)
- multiple use: a wastewater discharge, with or without treatment, is subsequently sent to different technological operations

# Direct reuse
## advantages and limits

*The direct closed (or semi-closed cycle) presents advantages and limits:*

| *advantages* | *limits* |
| --- | --- |
| • ***conceptual simplicity***<br>• ***rational hydraulic scheme***<br>• ***possibility of automatic control***<br>• ***limited infrastructural interventions on the water network*** | • ***possibility of accumulation phenomena, and to avoid this aspect frequent necessity of extraction and re-filling***<br>• ***limited quality for the reused water***<br>• ***impossibility to obtain a secondary valorisation of discharged water*** |



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# Multiple use
## advantages and limits

*There are different positive and negative aspects in multiple use:*

| *advantages* | *limits* |
| --- | --- |
| • ***absence of accumulation phenomena***<br>• ***possibility in some cases to directly reuse water without intermediate treatment***<br>• ***wide technological possibilities*** | • ***necessity of hydraulic flow rates balancing***<br>• ***heavy structural transformations to allow the water transfer***<br>• ***presence in the final discharge of different pollutants from different technological stages*** |

## Example of multiple use

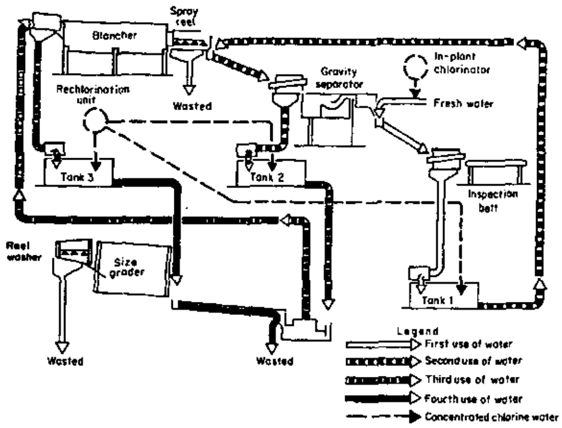


Fig. 1 Diagram of four-stage counterflow system for reuse of water in a pea cannery.



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## Characteristics of water to be reused

*In order to be reused, the quality of recycled water must be verified in accordance to different criteria:*

- take into account the effect of water quality on obtained product, define the minimum removal yield for a wanted product quality, establish a cost-benefit between recycle increase and lower product value, or higher costs;
- damages to the plant structures where the recycled water is used: scaling, corrosion, dirtying, deposition, deriving from lower quality in comparison with waterwork or well water, with reference to the specific plant;
- the possible transfer of pollutants towards the production workers can seriously limit the recycle possibility; it is very difficult to verify this aspect with a multimedia transfer, and to define for it acceptability limits (only epidemiological analysis are possible); impossibility to find for it technological counteractions

## Industrial costs for recycle

*In order to evaluate from the industry point of view the economic advantages of e recycle systems, the elements to be compared are from one side:*

- avoided cost of primary water withdrawal
- avoided cost of wastewater discharge (or at least its high decrease)

*and from the other side:*

- realization cost of intermediate treatment plant
- operation cost for the plant
- cost of treatment residuals disposal (if utilization cannot be obtained)
- cost of water network modification (sewers separation, multiple – use water transfer, connection)





## Public policies for water quality and resources conservation

*The public authorities must consider the task of guaranteeing the best destination of the water, by using normative, financial or planning instruments, as it is indicated:*

- in some extreme cases of particular criticity quantitative limits of withdrawal or discharge can be fixed, with a normative approach
- a planning function can be obtained by fixing for many areas strict limits for discharge, and requiring at the same time suitable end-of-pipe treatment systems
- *in order to support recycle systems economic-financial* instruments can be used, by using heavy taxation on withdrawal or/and financial assistance for reuse systems

## Knowledge of environmental phenomena involved in water use

*It is necessary to evaluate the effects of different water use on the condition of water resources:*

- for a determined water quantity the use of hydraulic balances and dynamic phenomena evaluations in receiving bodies permits to estimate modification of quality and quantity in account of connection system (open use, recycle)
- the concentration of pollutants in the receiving body can be established as a consequence of quantity of discharge
- water availability can be established on the basis of removal practices for withdrawal



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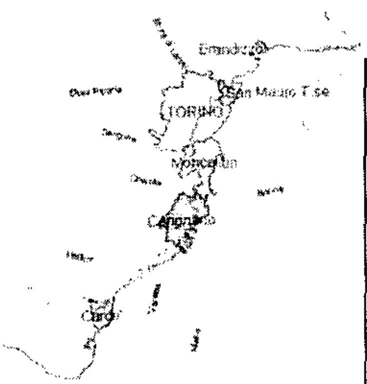
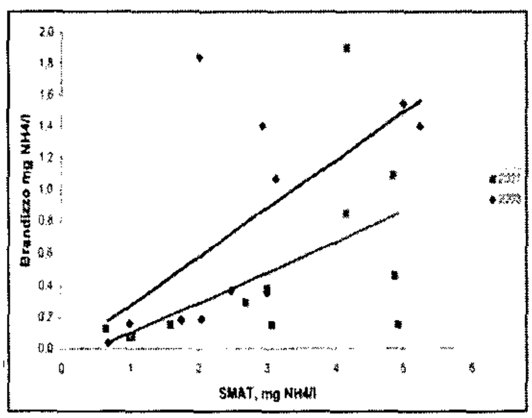
## Examples of hydraulic balance




Comparison between the ammoniacal nitrogen concentrations in output of SMAT plant and those measured to Brandizzo

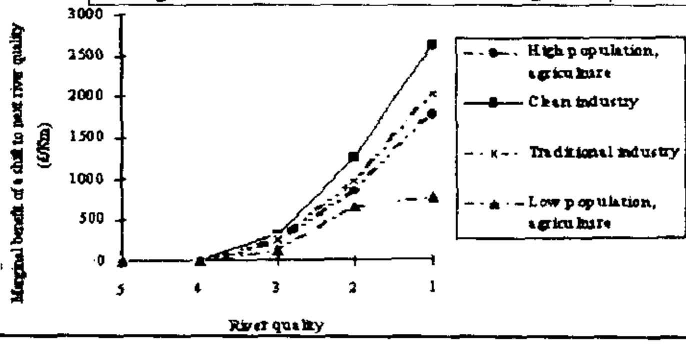


## Definition of externalities produced or avoided

It is possible to transform the quality level of the water resource in an externality value, i.e. an external cost of the natural system

The evaluation is quite difficult and uncertain as concerns numerical values, but it is important to estimate differences in values as a consequences of different qualities of natural water:

Marginal benefit curves for non - migratory trout

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## Fixation of economic instruments

*It is possible for the public authorities to transfer the externality calculation in:*

- fixation of a compensatory tax for a greater withdrawal
- establishment of an economic encouragement for reuse

*As opposite to fixation of quantitative or localization limits:*

- **prohibition of removal of water for industrial use from deep water tables**
- **maximum load to be introduced in a surface water body**

## European experiences

*The practice of water direct reuse in European industrial districts shows interesting aspects:*

- in some sectors (galvanic, siderurgic, thermoelectricity) there has been an important diffusion of practices, in account of the high cost of the resource and of the strict discharge limits
- some sectors (textile, food industry) demonstrated a lower tendency to adoption in account of problems of micro-pollutants accumulation and suspects about diminishing of final product acceptance
- a contiguous territorial localization (as in the case of area of Prato, textile district) has favored the spread of reuse systems, by creating a complete reuse industrial waterwork





## The example of Prato

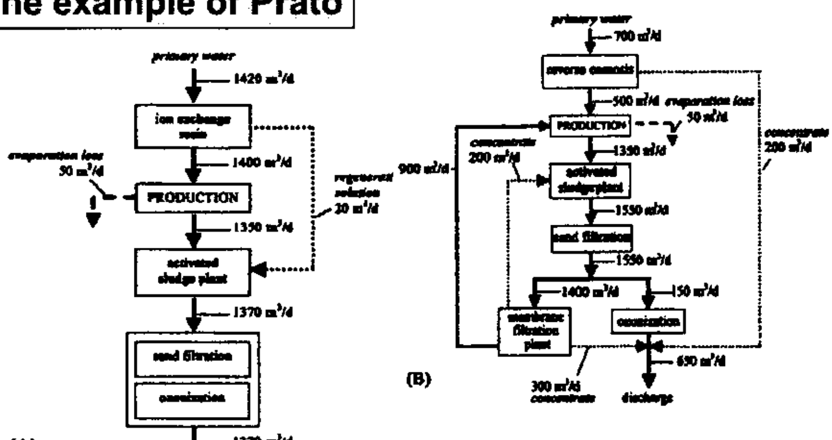


Fig. 3. Present (A) and proposed (B) water management in the case study.

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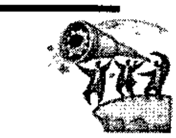
## Actual and future prospects for Europe



*Some elements can be considered in Europe:*

- the general reason behind the adoption of reuse systems seems to be more a discharging difficulty rather than resource scarcity
- a concern of public authorities about resource quality has been translated in normative and economic instruments directed to improve reuse
- the advantage of reuse in terms of overcoming of emergencies and avoiding of incidents encouraged to adopt water reuse systems
- the IPPC Directive seems to have a great importance in the orientation towards reuse policies: between the required best practices, also taking into account economical acceptability, water reuse is an important item

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## Conclusions (1)

- **the technological basis for water on-site reuse is absolutely developed, and its application can be compared with many positive applicative situations**
- **an important pre-condition for a positive application of water reuse systems is an initial separation of differently polluted wastewater streams**
- **a situation of traces of pollutants or other substances accumulation in recycle systems is quite common, and this aspect necessarily leads to a partial discharge and refilling in a semi-closed cycle**
- **the quality level of recycled water suitable to be re-employed must take into account productive aspects, that can be verified from different qualities of products, damage to apparatus, that can be forecast from fundamental materials studies, and impact on workers, quite difficult to be directly estimated**

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## Conclusions (2)

- a system of multi-use of water can be an interesting different approach to water saving, also if the important sewer system transformation involved seems to be an important obstacle
- an economic advantage for the industrial activity can arise from reuse system, in account of avoided connection to exterior water system costs, but initial transformation cost can be a negative aspect
- the public authority must evaluate the advantage in terms of avoided externalities of recycle systems, and translate this aspect in economic, planning or normative instruments
- the normative interventions, corresponding to limits to connections to aquifers or prohibitions of discharge, can only be taken into account in very critical cases





## Conclusions (3)

- voluntary operators choices can be oriented by economic-financial instruments, but it is important that these instruments are based ion reliable evaluation of modified externality situation
- economic instruments can correspond to taxation on water withdrawal or incentives and financing technical interventions directed to realise reuse systems
- it is necessary to carry out specific evaluations and studies about optimal definition of water quality for different reuse opportunities, about technological systems for integral recycle, about right definition of economic instruments
- as in may cases the network reconstruction is an important obstacle for realisation of systems for reuse or multiple use, the assistance and financing of public authorities of these interventions could be an important support to diffusion of these practices

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# Water recycling and on site reuse

**More information at...**

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# Experiences and Practices of Technology Foresight in the European Region

Attila Havas, Doris Schartinger & Matthias Weber

 



## Outline

Motivation

Policy challenges: why to conduct foresight

From Technology Foresight to integrated policy strategies

Innovation policy and foresight

The impact of foresight on policy

Conclusions and recommendations

 

## Motivation

**Apparent success of F: widely used to underpin public policies and business strategies**

**BUT: 'hype – disappointment cycle' for F, too?!?**

- initial enthusiasm → scepticism in several countries
- more realistic assessment of the strengths and the weaknesses of various types of prospective analyses

**Thus, a close look at the actual and expected impact of F, with a particular emphasis on policy impacts**





## Policy challenges: why to conduct foresight

**Complex, inter-related challenges** (quality of life, HR, social gaps, globalisation, environment, etc.)
⇒ **new approaches, methods**

**Change attitudes and norms**

**Develop new skills**

**Speed of technological changes vs. ability to devise appropriate policies**

**Cut budget deficits**

**Improve accountability**

**Ease social concerns about new technologies**

**Facilitate co-operation, networking**

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Thematic Panels

# From TF to integrated policy strategies

## 'Timeline' of policy approaches

- picking winners (top-down)
- limitations of gov't abilities: focus on framework conditions
- systems approach
- strategic decision-making (areas of specialisation set via dialogues with the major stakeholders)

## Understanding of policy processes

- technocratic, linear models (planning – implementation – evaluation)
- cycle models
- policy learning, interactive processes, distributed policy-*making and intelligence*



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# From TF to integrated policy strat (2)

## Principles of good governance

participation, accountability, openness, effectiveness, coherence

## Types of policy co-ordination

- horizontal: between different policy areas;
- vertical: between different administrative layers;
- multi-level: between different levels of governance;
- temporal: between different phases of policy-making processes

## The role of F

- strategy formation
- improving governance
- policy learning and co-ordination

© IE HAS and systems research

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## Functions of foresight in the policy-making process

**Adding a „second cycle" of interaction between „informing" and „facilitating" cycles, targeted at individual actor strategies**

**Embedded in the full policy cycle and its iterations („policy proces improving")**


- **Discourse**
- **Joint visions/scenarios**
- **Mobilisation**

- **Interpretation**
- **Individual strategies**

- **Concrete follow up**
- **Collective actions**
- **Coordination & networks**





## Application of foresight

**Geographical territories**
- local/regional
- national
- transnational (regions, countries)

**Socio-economic domains**
- industrial sectors or clusters
- types of firms, e.g. SMEs

**Policy fields**
- transport policy, innovation policy, etc.

**Specific issues/ challenges**
- women entrepreneurship
- crime prevention, etc.

## Application of F: emerging economies

### Policy Challenges

**General pressures: even stronger**

**Loss of former markets, and hence the need to fi… ones**

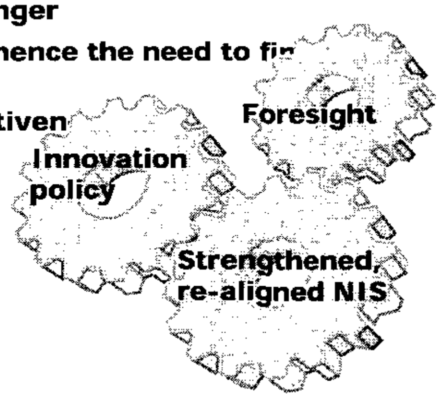
**Fragile international competitiven…**

**Poor quality of life**

**Brain drain → circulation**

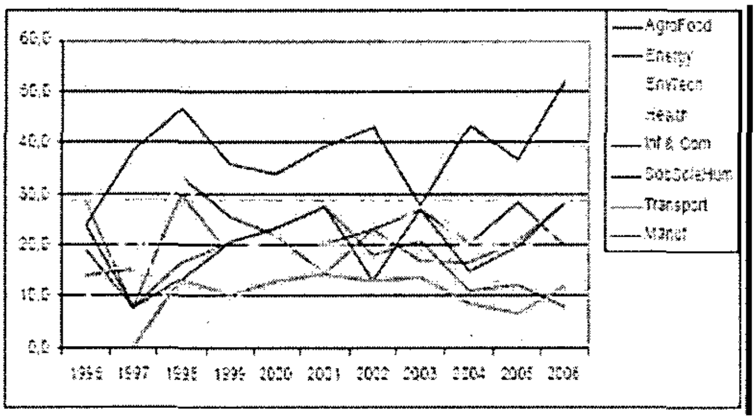
**Short ↔ long-term issues**

**Raise the profile of STI issues in politics and devising economic policies**






## Evolution of the different thematic areas 1996-2006




Source: Keenan et al. (2006)

## Innovation policy and Foresight: A large potential for synergies...

Innovation is a horizontal, cross-cutting policy matter
- Growing interdependence of policy-areas, most notably energy, environment, transport, regional development

The formation of innovation policy strategies is a continuous interactive learning process
- Not only between policies, but with various actors in RTI as well as in thematic policies

Innovation policy-makers are not perfectly informed social planners
- More problematic in innovation policy than in other areas

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## Innovation policy and Foresight: A large potential for synergies (2)

Innovation policy foresight as a 'meta' policy co-ordination mechanism
- mediates between different policy actors, different stakeholder communities, different policy areas
- creates a culture of long-term strategic thinking
- helps create an infrastructure of "distributed policy intelligence"

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# Innovation policy and Foresight: the context

## Governance culture

- Elaborated strategic intelligence instruments in place: the impact of F depends on its position in the hierarchy of instruments, windows of opportunity, etc.
- Without elaborated strategic intelligence instruments: catching-up processes may be structured through highly inclusive, integrative and consensus-oriented F

## Policy attention

- May increase the leverage of F in countries with a well-developed range of policy support mechanisms

## Socio-economic dynamics

- Expected major structural changes may speed up policy learning through F compared to countries in stable phases

## Resource availability

- The availability of resources facilitates their allocation to future-oriented and new activities resulting from FS




# Impacts of foresight: a framework

| Function | Time lag | Targeted and/or unintended impact |
|---|---|---|
| Informing | Immediate | • Increased recognition of topic area<br>• Awareness of science and technology among players, creating debate<br>• Awareness of systemic character<br>• Training of participants in foresight matters<br>• New combinations of experts and stakeholders, shared understanding (knowledge network) |
| | Intermediate | • Articulation of joint visions of the future, establishing longer-term perspectives |
| | Ultimate | • Integrate able new actors in the community |
| Counselling | Immediate | • Make hidden agendas and objectives explicit |
| | Intermediate | • Formulation of recommendations and options for action<br>• Activate and support fast policy learning and policy unlearning processes<br>• Identify hidden obstacles to the introduction of more informed, transparent, open participatory processes to governance |
| | Ultimate | • Influence on research/policy agendas of actors, both public and private (as revealed, for instance, in policy strategies and programmes)<br>• Incorporate forward-looking elements in organisations' internal procedures |
| Facilitating | Immediate | • Effective actions taken |
| | Intermediate | • Formation of action networks<br>• Creation of follow-up activities |
| | Ultimate | • Adoption of foresight contents in the research and teaching agenda of organisations (e.g. University of Malta); Foresight spin-off activities in various disciplines (see Malta)<br>• Improvement of coherence of policies<br>• Cultural changes towards longer-term holistic and systemic thinking |

**Source: ARC sys, based on Cassingena Harper and Georghiou (2005), PREST (2006) and ForSociety (2007)**

## Impacts of Foresight: Innovation policy

**Functions of F to be assessed**
- policy informing
- policy advisory/ strategic counselling
- policy facilitating

**The cases considered: national F programmes evaluated**
- UK
- eForesee in Malta (international programme)
- Hungary
- Sweden




## First results from the evaluation reports

**Policy informing**
- Results of F: a 'reservoir' of knowledge
- Uneven way as active inputs into the political process
- Quality and trustworthiness of the reports: of value in decision-making processes

**Strategic counselling**
- Time lag between F and the use of F results in policy-making ⇒ extremely difficult to evaluate the impacts

**Policy facilitating**
- „Soft" evidence of the sustainable creation of new linkages and of networks of major stakeholders

## Impacts of Foresight on policy: Critical issues

### Enrolment of able new actors and formation of actor networks

- Network-building is at least as important as the 'tangible products' of F
- The added-value of F increases when it is possible to overcome traditional sectoral/ disciplinary barriers
- Engaging able, new actors forges novel linkages within the innovation system and increases the recognition of F results

### Interested customers with absorptive capacities

- Lack of resources to 'digest' and absorb F results naturally inhibits their implementation




## Impacts of Foresight on policy: Critical issues (2)

### Ownership of results

- The more path-breaking the results of F, the more likely their implementation is beyond the scope of individuals, departments or even ministries

### The congruence of actors in FS and political advice

- Actors who advice ministries are often the same that take a lead part in FS ⇒ especially hard to isolate impacts

### Time horizon

- The longer the time horizon of F ⇒ the more revolutionary the results and the more wide-ranging the implications

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## Conclusions and recommendations

**Complexities of economically, socially and environmentally sustainable development**

**The role of *STI policies* in tackling them**

**Foresight processes can assist decision-makers facing these complex, demanding tasks**

**Use F to underpin STI policies and *beyond***

**F is a policy tool (not a scientific project!)**

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## Conclusions and recommendations (2)

**Embedding foresight in the decision-making processes is a far from trivial task**

**The requirements from the new application domains of F are different from STI policies**

**It is crucial to evaluate F programmes, but new methods are needed**

**Difficulties of evaluating impact are intrinsic to the role of F**

- **Isolating the effects of single FS activities on a complex and continuous process like policy–making is the more difficult, the closer the inter-action between foresight and policy-making**

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TECHNOLOGY FORESIGHT SUMMIT 2007

# MULTI-COUNTRY FORESIGHT

*by Ana Morato, OPTI and Ricardo Seidl da Fonseca, UNIDO*

1

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## UNIDO Technology Foresight Programme

- Starting date: 2000
- Aim: Disseminate the foresight as a tool for technology policies and carry out foresights exercises in various countries with common interest.
- Concept: Regional Dimension.

2

**From regional dimension to multi-country scope – UNIDO foresight approach**

Regional concept ⟺ Geographical and political space formed by:

1. More than one country belonging a common macro-region
2. Areas extending over more than one national border





- **Multi-country aproach:**

| | |
|---|---|
| Provides guidelines for cooperative research programmes in the private and the public sector | Facilitates less developed countries and small countries to be aware of global and regional trends |
| Improves national and international collaboration and networking | Facilitates a process of joint reflection |
| Networks into regional iniciatives for common awarenes building and training | Key issues that may affect several countries and extract consequences for national exercises in strategic decision processes |
| Helps to overcome potendial difficulties and excessive costs | National and supra-national levels of the foresight exercise constitutes an effective mechanism of international collaboration |

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**The application of foresight methods for production chains involves**

- Modelling the production chain as an industrial system
- Analysis of the institutional and organizational environment
- Identification of needs and expectations of each segment and the whole chain and identification of the critical factors
- Prognostics of the future behaviour of the critical factors
- Creation of future scenarios and visions
- Identification of actions and key technologies

*As a result* ⟹ **Technological and Non-technological demands**

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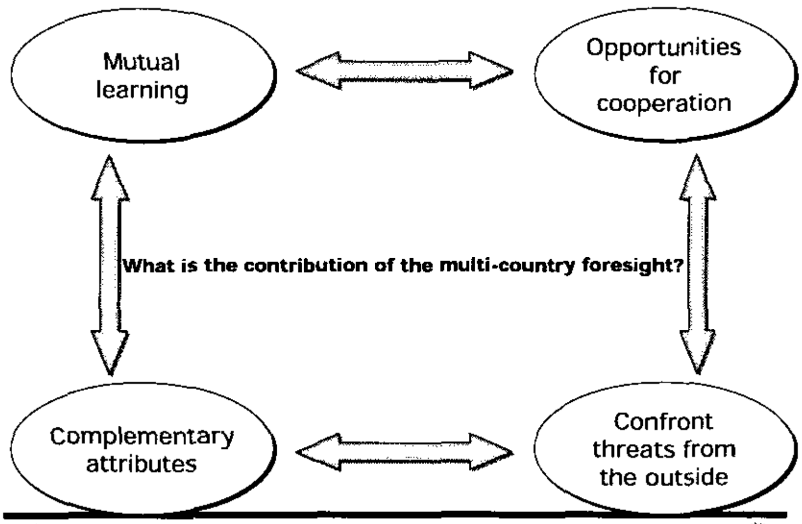
Thematic Panels




6

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## Motives of the participating countries

1. Existence of structural deficiencies
2. Foresight acts in the structural fields

KEY ASPECTS:

- Previous analysis of the regional situation
- Identification of appropiate contacts
- Regional offices of the multilateral bodies

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## How is the foresight exercise focused?

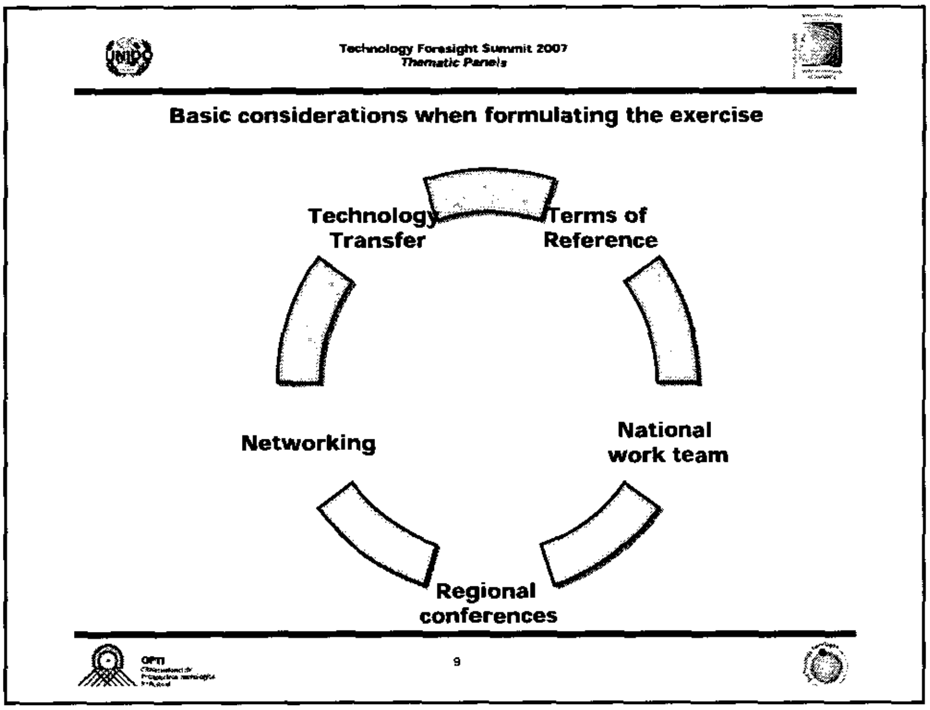
Formulating

→ The metothodology and *the execution process*

→ "Ad hoc" participation mechanisms at two levels:

- POLITICAL LEVEL
- OPERATING LEVEL

8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Basic considerations when formulating the exercise
Technology Transfer
Terms of Reference
National work team
Regional conferences
Networking
OPTI
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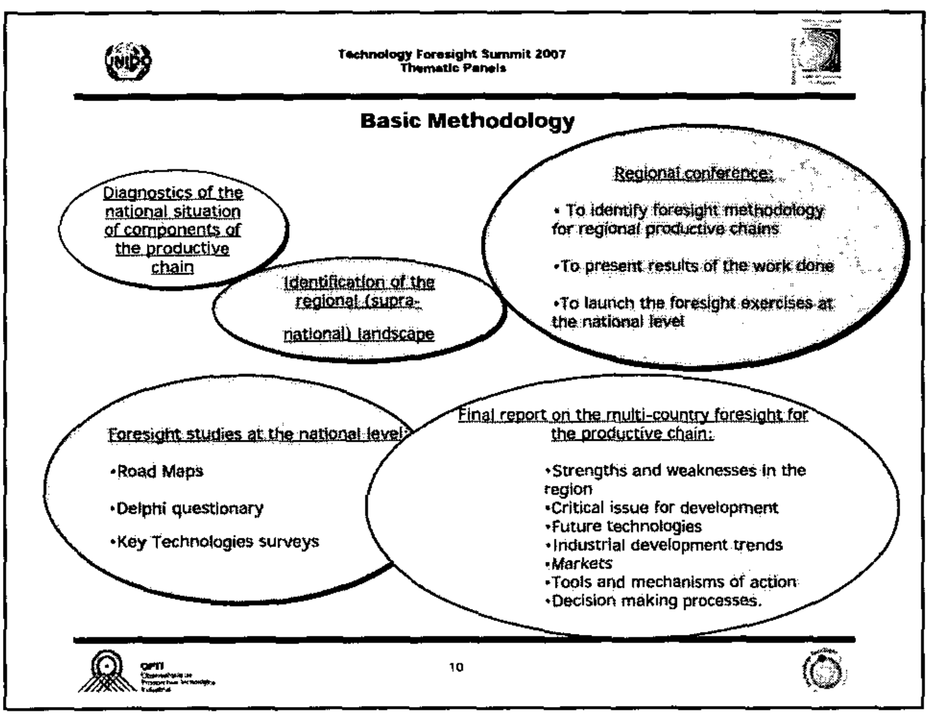
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Basic Methodology
Diagnostics of the national situation of components of the productive chain
Identification of the regional (supra-national) landscape
Regional conference:
• To identify foresight methodology for regional productive chains
•To present results of the work done
•To launch the foresight exercises at the national level
Foresight studies at the national level:
•Road Maps
•Delphi questionary
•Key Technologies surveys
Final report on the multi-country foresight for the productive chain:
•Strengths and weaknesses in the region
•Critical issue for development
•Future technologies
•Industrial development trends
•Markets
•Tools and mechanisms of action
•Decision making processes.
OPTI
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## What are the opportunities offered by foresight at multi-country level?

- Shared vision of the future to be created
- They boost the position of a country group in facilitating the implementation of projects and joint infraestructures
- Compare different states of development in relation to a sector and facilitate benchmarking
- Identify synergies
- Strenghten the competitive position of a region





## Experience and results of UNIDO-OPTI cooperation

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## Future of the Fishery Industry in the Pacific coast of South America

**Project Objectives**

The complete production chain of the fishery industry:

- The inputs for fishing and aquaculture activities
- Fishing
- Aquaculture
- The processing of the products of fishing and aquaculture
- Marketing
- Consumption

**Participants**

- •*UNIDO*, as general coordinator
- •A high-level political counterpart in each country
- •A national coordinator in each country
- •OPTI as an agency with foresight expertise
- •Technical advisers

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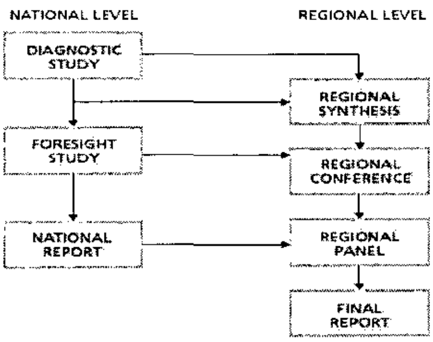
## Future of the Fishery Industry in the Pacific coast of South America

Structure of the project

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**Future of the Fishery Industry in the Pacific coast of South America**

The results: technology related trends – a common vision of the future:

Some technological challenges

FISHING

- Diversification of operations to include new species found in the exclusive economic zone
- Better detection of and prospecting for resources to permit a reduction in discards
- Fleet modernization which will allow improvements in techniques for handling, storage and processing on board

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**Future of the Fishery Industry in the Pacific coast of South America**

The results: technology related trends – a common vision of the future:

Some technological challenges

AQUACULTURE

- To improve feeding patterns for replacing totally carnivorous diets by diets including vegetable foods
- The eradication of viral diseases
- The production of new species
- The availability of seeds in adequate quantity and quality
- The utilization of genetic research and development

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## Future of the Fishery Industry in the Pacific coast of South America

<u>The results: technology related trends – a common vision of the future</u>:

Some technological challenges

<u>PROCESSING INDUSTRY</u>

- The incorporation of advanced conservation technologies
- The development and introduction on international markets of new products
- The modernization of production processes through the incorporation of new equipment and new methods





## Future of the Fishery Industry in the Pacific coast of South America

*<u>The results: policy and strategies to implement this common vision</u>:*

- Definition of a regional policy for strengthening the competitiveness and sustainability of the fishery production chain
- Technology up-grading and investment promotion for re-conversion and modernization of the industrial fishing and fish-processing vessels
- Creation of new regional center for capability building on fishery industrial technologies and technology watch
- Implementation of policy and infrastructure for establishing a quality mark of origin for the fish products of the region, taking into account tradability and traceability

## Future of the Food industry in six countries of CEE – towards higher food quality and safety

COUNTRIES: Bulgaria, Croatia, Czech Republic, Hungary, Romania and Slovakia

**Project Objectives**

1. To promote a new decision-making culture among managers and policy-makers in order to put quality and safety issues into the centre of the total food chain management.
2. To identify future key technologies and new business models

**Methodology**

1. Socio-economic scenario building exercise
2. Interviews
3. Survey on key technologies
4. Future visions exercise
5. Technology road mapping

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## Future of the Food industry in six countries of CEE – towards higher food quality and safety

**Financing Project**

European Comission through the Sixth Framework Programme (FP6)

**Partners**

- The project coordinator is UNIDO with the support of two advisers
  - Methodological Adviser OPTI
  - Economic Sector Adviser WIIW
- Experts in Technology Foresight and Innovation are responsible for the core project activities in their own country
- Committee of high-level national policy-makers
- A knowledge institution on food industry from each participating country

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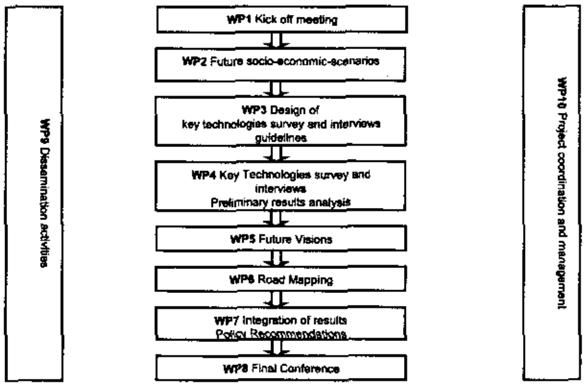
## Future of the Food industry in six countries of CEE – towards higher food quality and safety

Work plan flowchart

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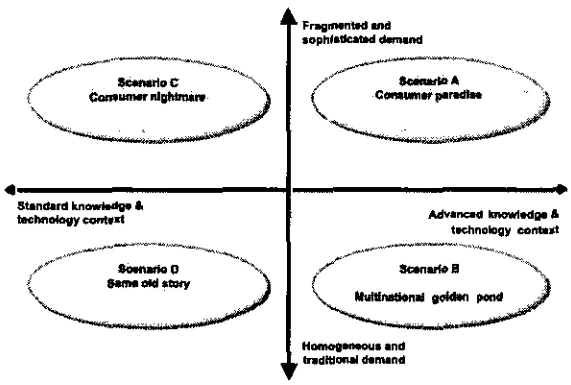
## Future of the Food industry in six countries of CEE – towards higher food quality and safety

The results – socio-economic scenarios building

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# The case of Wallonia

by Francoise Warrant
director of research
Destree Institute
Belgium





## Outline

- Wallonia at a glance
- Technology foresight in regional RTDI policy
- Technology foresight as a transverse concern
- Territorial foresight, an appropriate complement to technology foresight for a region

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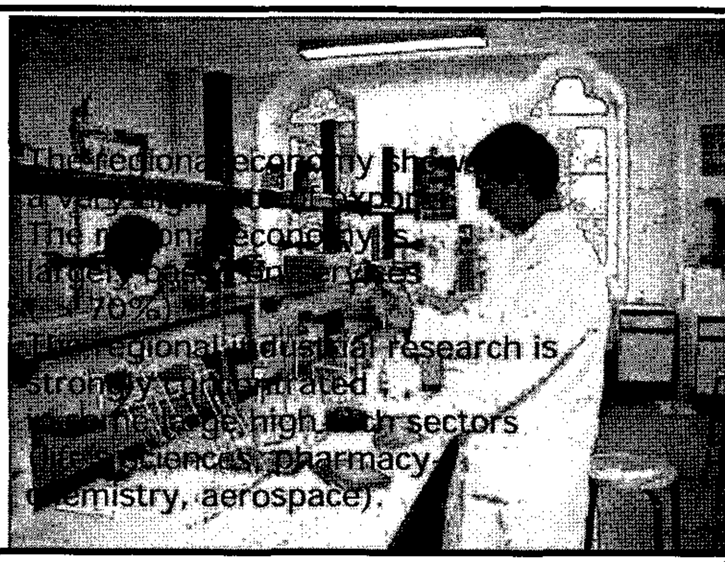


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# Technology foresight in regional RTDI policy

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## 40 Key Technologies in Wallonia

- The regional Innovation Strategy programme co-funded by DG Regio- EU was an important opportunity to conduct a foresight exercise.
- Identification of the 40 key technology fields for Wallonia by 2010 based on the needs and the potential of the companies based in Wallonia
- Three-fold ambition:
  - To find applications of key technologies in several sectors carrying regional growth;
  - To constitute a window for regional technological potential;
  - To hightlight public and private decision-makers





- MATERIALS – CHEMISTRY

  Ex. Non polluting surface treatments; New intelligent glazes; Recycling of refractors
- EQUIPMENT GOODS
- INFORMATION TECHNOLOGIES
- LIVING ORGANISM TECHNOLOGIES AND AGROTECH
- ENVIRONMENT – ENERGY – TRANSPORTATION –CITIES

- MATERIALS – CHEMISTRY
  Ex. Non polluting surface treatments; New intelligent glazes; Recycling of refractors
- EQUIPMENT GOODS
- INFORMATION TECHNOLOGIES
- LIVING ORGANISM TECHNOLOGIES AND AGROTECH
- ENVIRONMENT – ENERGY – TRANSPORTATION –CITIES

1. Characterization of the technology itself
2. Interactions with other key technologies
3. Current and potential market development
4. Regional position in the fields (degree of implication, degree of autonomy of the providers and of the users of technology, identification of the actors)





## Impact of foresight on RTDI policy

- The key technologies' study has been the foundation stone for technology clustering policy.
- Critical technologies as a foresight method has been predominant in the RTDI policy (scenarios, delphi, backcasting have not been used).
- Technology foresight has been a discontinuous process.

# Technology foresight as a transverse concern





- Technology foresight also reaches regional industrial policy ( economic clusters, competitiveness hubs) and employment policy (jobs and skills for the future).
- Technological watch is more practiced than technology foresight.
- The process of technology foresight is fairly decentralised: strategic positioning and technology detection and watching are carried out by the actors themselves.

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# Territorial foresight, an appropriate complement

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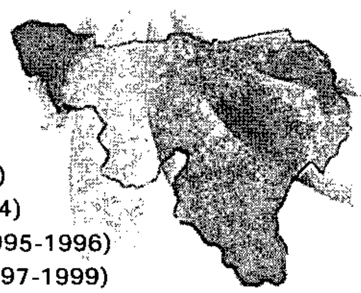
Since 1985, The Destree Institute had initiated the launching of five foresight exercises untitled

*Wallonia to the Future*



Towards a new Paradigm (1985-1988)
The Educational Challenge (1988-1994)
Competitiveness and Employment (1995-1996)
Evaluation, Innovation, Foresight (1997-1999)

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The aim of the latest foresight exercise called Wallonia 2020 (2005) was clearly to lead the citizens to experiment their creative and critical intelligence collectively in order to take part in the regional political agenda.



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# Outputs from Wallonia 2020

1. A renewed vision of the future of Wallonia at the horizon 2020
2. A strategic plan with 15 concrete proposals of actions, published and largely disseminated in 2004
3. A networking effect :
   - ✓ Launching of a Territorial Intelligence Platform
   - ✓ Launching of the Regional Foresight College

# Conclusions

- TF= a discontinuous process and a rather decentralized expertise in Wallonia.
- Even if technology foresight is rather limited in Wallonia, the region has accumulated a strong experience in territorial foresight.
- While globalisation has impact on territories, territorial (or regional) foresight foresight has become a major instrument of regional governance and an appropriate complement to technology foresight.

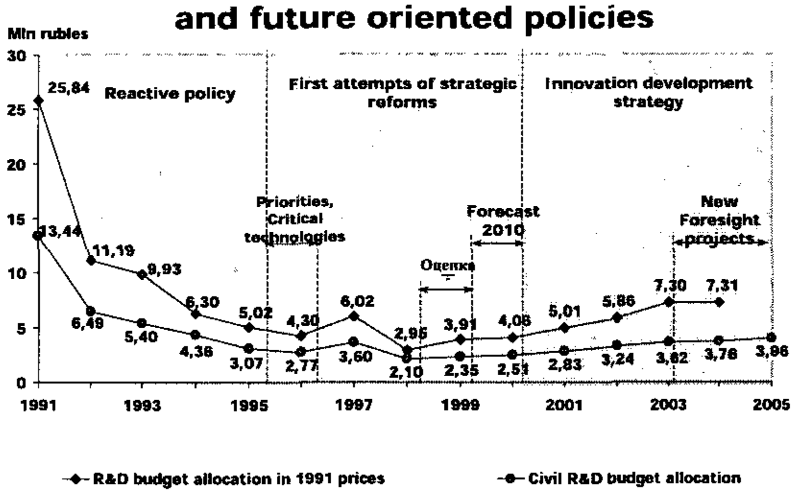
# Foresight in Bashkortostan: Identification of Regional Innovation Priorities

**Alexander Sokolov**
**Higher School of Economics**
**Institute for Statistical Studies and Economics of Knowledge**
**Foresight Centre**

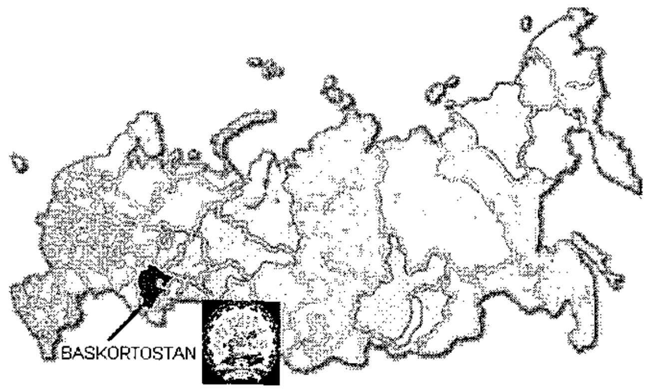




## Russia: Economic development and future oriented policies



## Bashkortostan








## The Republic of Bashkortostan

| | Population, mln | Territory, thsd sq. km |
|---|---|---|
| Bashkortostan | 4,0 | 143,6 |
| Austria | 8,0 | 83,9 |
| Hungary | 9,9 | 93,0 |
| Ireland | 3,8 | 70,3 |

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## Resources

**Natural resources:** oil, gas, coal, iron and copper ores, gold, salt, limestone and gypsum.
The raw materials and manufacturing industries
Machinery industry
Mining
Chemical and petrochemical industry
Energy

Human resources: 68 research institutes, 4500 researchers

Average GRP growth – 7% (2000-2006)

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## The Republic of Bashkortostan

| | |
|---|---|
| **Strengths**<br>Well developed raw materials and manufacturing industries<br>Energy resources<br>Strong R&D capacities (world class research in some areas)<br>Human resources in R&D<br>Skilled workforce | **Weaknesses**<br>Underdeveloped market institutes<br>Low share of value added<br>Dependence on the global fuels market<br>Deterioration of fixed assets<br>High costs of production<br>Low competitiveness<br>Lack of innovation culture |
| **Opportunities**<br>Sustainable economic growth in Russia and increasing domestic market<br>Favorable situation at the global markets<br>High oil and gas prices<br>Trade with neighbor regions | **Threats**<br>Joining WTO (increased competition)<br>Volatility of global economic situation<br>New legal regulations<br>High barriers to enter new markets |

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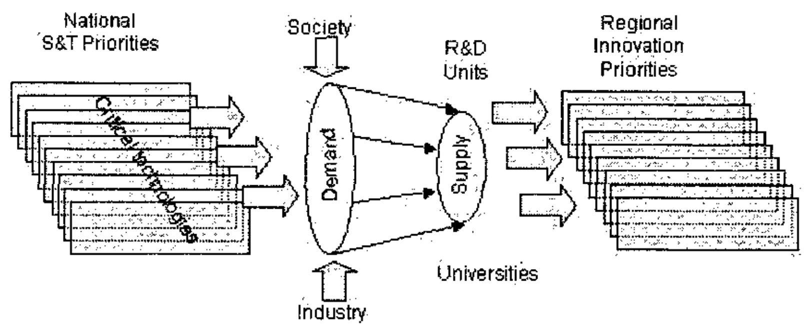
## Supply vs Demand

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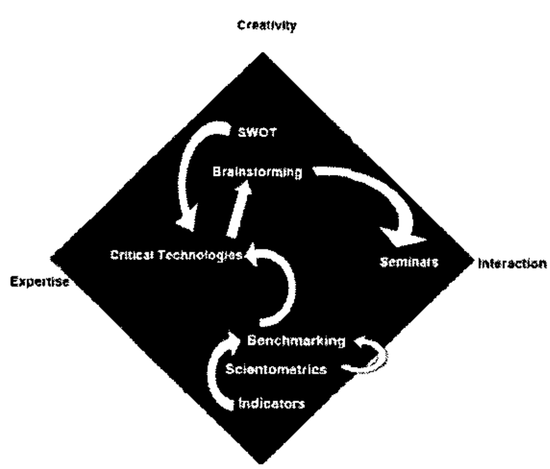
## Methods

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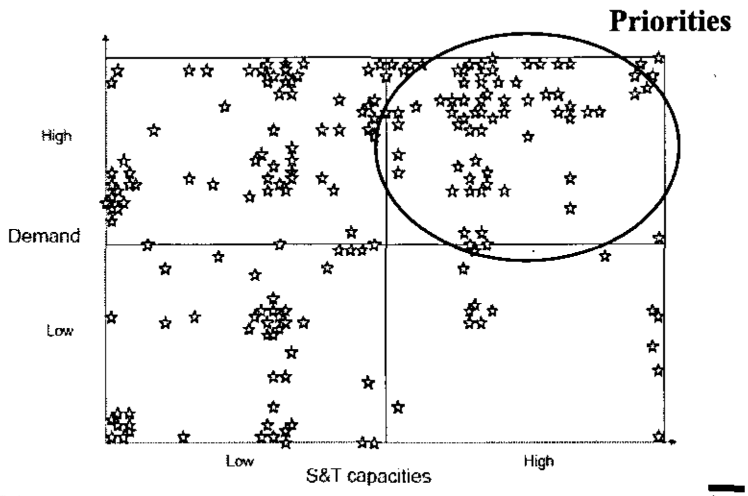
## Technology evaluation: results








## Regional priorities

| |
|---|
| **Transport and aviation**: transportation systems; aviation; energy-efficient engines |
| **Living systems:** bioengineering; biosensors, medicines; diagnostics; *preventive medicine* |
| **Nanosystems and materials:** nanomaterials; polymers and elastomers; ceramics; membranes; catalytical systems |
| **ICT:** computer systems, software |
| **Manufacturing:** mechatronics modules; laser and plasma technologies |
| **Rational use of nature** |
| **Energy:** renewable sources of energy; energy saving systems; energy production from organic raw materials |

## Policy implications

Intensification of innovation activities.
Competition based R&D funding.
Developing technology transfer networks (e.g. informal networks between major stakeholders in the region).
Mid-term (up to 2015) strategy for social and economic development (S&T and innovation related components).
Changes in the regional legislation.
Competition for innovators (projects aimed at innovation development at enterprises with participation of research units).
A web-site publishing requests from regional enterprises to researchers for particular technological solutions.





## THANK YOU

**SOKOLOV@HSE.RU**

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## Foresight for National STI Strategy

### Science and Technology Foresight in Romania

Prof. Adrian CURAJ

Adrian CURAJ — Executive Agency For Higher Education and Research Funding-Romania

UNIDO Technology Foresight Summit 2007
27-29 September, Budapest, Hungary

## Outline:

1. Introduction
2. Romanian Science and Technology Project
3. RTF – Methodology and Results
4. From Foresight process to RDI Strategy and Plan
5. Conclusions
6. Next steps

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## Introduction

**Political commitment for a fast increase in public funding of RDI, not affected by the general election in late 2004:**

- **from 0,24% of GDP in 2004,**
- *0.55% of GDP in 2007*
- **to** *1% of GDP planned for 2010;*

**The need of:**

- **planning the use of structural funds;**
- **a RDI Plan for 2007 –2013;**

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## Introduction

**An attempt to frame the initial existing context at the beginning of 2005 shows:**

**a heavily fragmented RDI system with impact on S&T governance system and quality of system's outputs;**

**Romania had no RDI Strategy in place since 1990.**

**a low level of science-society dialogue making difficult any attempt to open debates and discussions, and the stakeholders involvement;**

**a lack of experience in foresight;**

Executive Agency For Higher Education and Research Funding-Romania

## Introduction

**Political commitment for a fast increase in public funding of RDI, not affected by the general election in late 2004:**

**from 0,24% of GDP in 2004,**

*0.55% of GDP in 2007*

**to** *1% of GDP planned for 2010;*

**The need of:**

**planning the use of structural funds;**

**a RDI Plan for 2007–2013;**





## Romanian Science and Technology Project

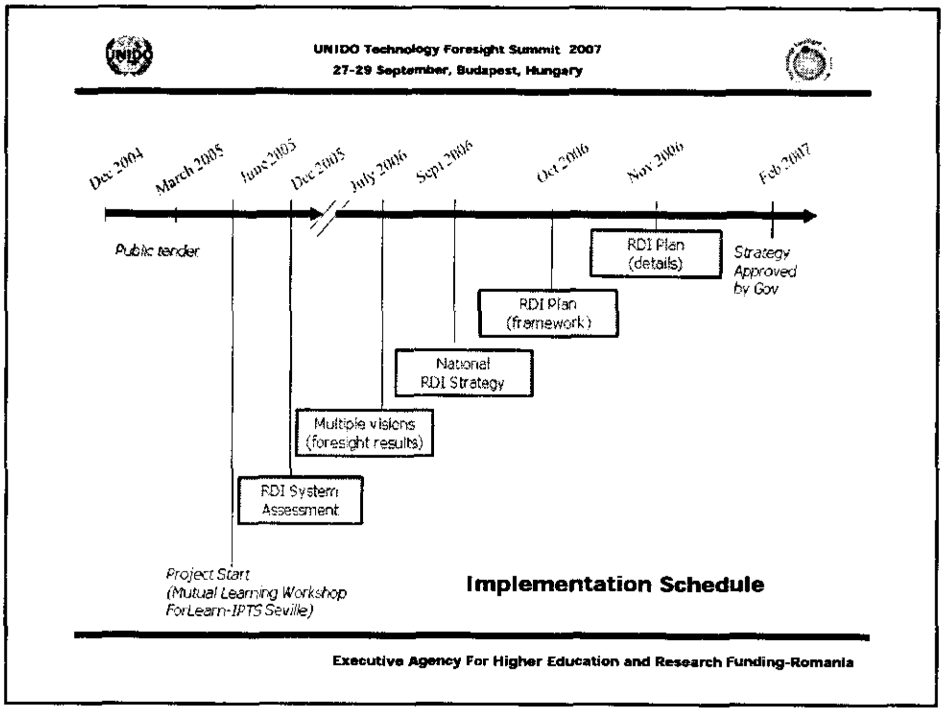
**Project Objectives:**

**To develop a National RDI system assessment;**

**To define the set of strategic and specific objectives for the RDI system for 2007-2013;**

**To develop the National RDI Strategy, structured upon the elements of a strategic planning, for 2007-2013;**

**To develop the PN II and to outline other programmatic** ***instruments.***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Dec 2004
March 2005
June 2005
Dec 2005
July 2006
Sept 2006
Oct 2006
Nov 2006
Feb 2007
Public tender
RDI Plan (details)
Strategy Approved by Gov
RDI Plan (framework)
National RDI Strategy
Multiple visions (foresight results)
RDI System Assessment
Project Start (Mutual Learning Workshop ForLearn-IPTS Seville)
Implementation Schedule
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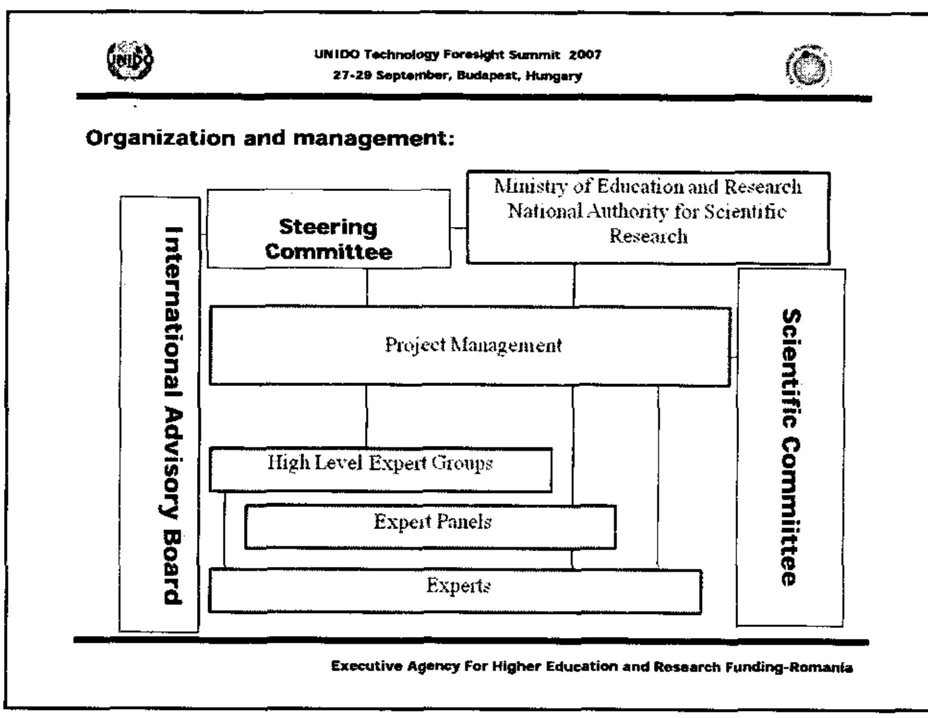
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Organization and management:
International Advisory Board
Steering Committee
Ministry of Education and Research National Authority for Scientific Research
Scientific Committee
Project Management
High Level Expert Groups
Expert Panels
Experts
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## Romanian Science and Technology Project

**Some of the decisions that contributed to the project's results:**

**The involvement, from the very beginning, of all the three traditional public actors of the RDI system (Universities, Romania Academy and Branch Academies as well as National Research Institutes);**

**The IAB whose recommendations were used as an *excuse* for proposed Changes;**

**Balanced representation of stakeholders ( scientists, S&T management, central and local administration, civil society).**

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## RTF – Methodology and Results

**Foresight Strategy**

**The context of Romania's National Foresight Exercise subscribes to a power-driven strategy of planning change.**

**Therefore, the role of the authority figure becomes more important and its involvement more necessary, in order to get an optimal result**

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## RTF – Methodology and Results

### Foresight Process

systematic;

collaborative;

prospective.

*A* learning by doing process... unfortunately having no contingency plan apart of developing a desk strategy.



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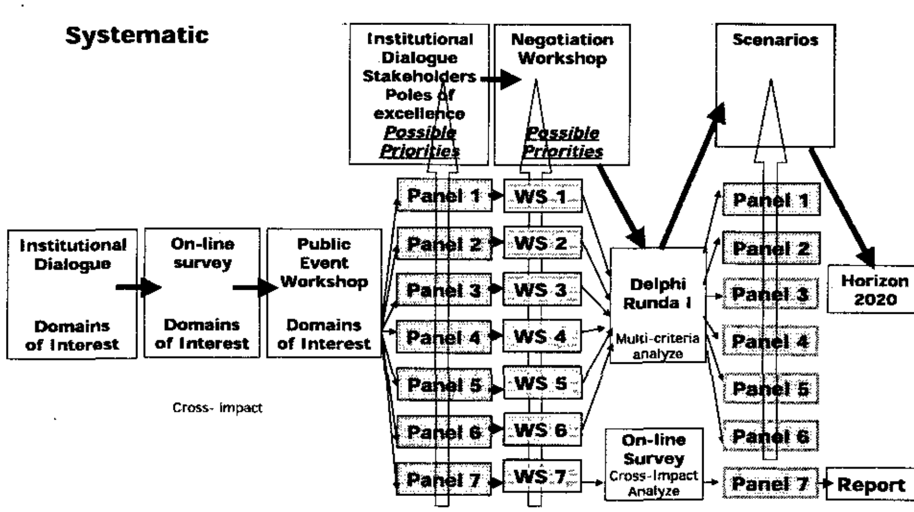
### Systematic

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### Collaborative

More than 800 people (individual stakeholders) working face to face ( panels, negotiation workshops and conferences);

More than 6000 persons (individual stakeholders) expressed their opinions on-line;

More than 600 institutions participated with institutional feedback.

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### RTF – Methodology and Results

**Expert Panels**

Panel 1: Information Society Technologies
Panel 2: Competitiveness through innovation
Panel 3: Quality of life
Panel 4: Social and cultural dynamics
Panel 5: Sustainable development
Panel 6: Institutional building/empowering
Panel 7: Science, frontier science, knowledge development

Executive Agency For Higher Education and Research Funding-Romania

UNIDO Technology Foresight Summit 2007
27-29 September, Budapest, Hungary

## Prospective

A. Research Priorities of socio-economic interest (26)

B. Priorities of the RDI system transformation

C. Scenarios of RDI system development (4)

D. Strategic vision (Horizon 2020)

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## From Foresight process to RDI Strategy and Plan

**Strategic objectives:**

1. Knowledge creation;
2. Increase the competitiveness of the Romanian economy;
3. Improve the Social quality.

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## From Foresight process to RDI Strategy and Plan

### Specific strategic objectives:

- Increase the overall system performance;
- Develop the system resources;
- Involve the private sector;
- Increase the institutional capacity;
- Extend the international cooperation.

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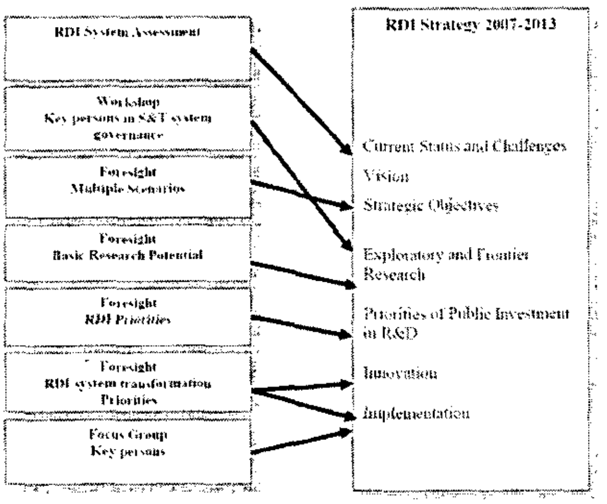


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## Conclusions

- RTF was process as well as product oriented;
- Both *Policy informing* and *Policy facilitating* functions of Foresight were exercised;
- The results were intensively used for the RDI 2007-2013 Strategy, National Plan for Research and Development and extensively used for planning the use of structural funds;

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## Conclusions

- RDI Strategy and RDI Plan 2007-2013 were approved by the Romanian Government, becoming core policy documents;
- For the first time after 1990 Romania has a RDI Strategy in place and all key stakeholders have agreed on the role the foresight process played in reaching this result;
- Foresight studies are to be funded in the RDI Plan 2007-2013.

Executive Agency For Higher Education and Research Funding-Romania

## Next steps

Evaluation of RTF;

A KE/KS Strategy for Romania ( ? )

Linking

RDI Strategy 2007-2013;

Higher/Tertiary Education Strategy ( the future of Higher Education in Romania and more specifically the future of research in Romanian universities);

Innovation Strategy;

ICT Strategy that is developing under the WB project for KE.



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## Thank you!

adrian.curaj@uefiscsu.ro

Executive Agency For Higher Education and Research Funding-Romania

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Thematic Panels

## Shaping New Realities in Urban Mobility

Dr. Frank Ruff

Society and Technology Research Group

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## How does the future come about?

**"Innovation is 5% inspiration and 95% perspiration."**

Thomas Edison

**Agenda:**

- "The limits of linear thought"
- "Innovation by thinking from the outside in"
- Co-designing turning points

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## How does the future come about?

**"The future is much like the present – only longer."**

Dan Quisenberry

**"Before we know what we do, we must know how we think."**

Joseph Beuys



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## How does the future come about? The limits of linear thought

**"Given the constant growth of transport with horse-drawn carriages, the territory of England will be covered by 1 metre of manure by the year 1961."**

(forecast from 1873)

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## How does the future come about? Innovations inspire new ideas

Invention of the motor carriage, 1886

L'Avenue de l'Opéra. Chocolate wrapper, around 1900

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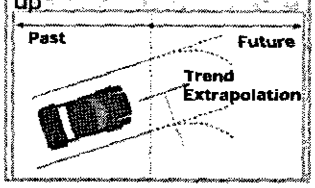
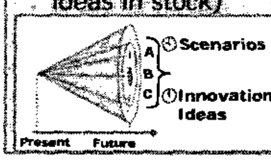
## Innovation through "thinking from the outside in"

**Trend Extrapolation =** "Looking in the rear view mirror with the windshield being sealed-up"




**Foresight =**
> Thinking from the outside in
> Considering changing contexts through alternative scenarios
> Thinking ahead (have ready ideas in stock)




① Assessment of ideas: Future-proof paths of innovation

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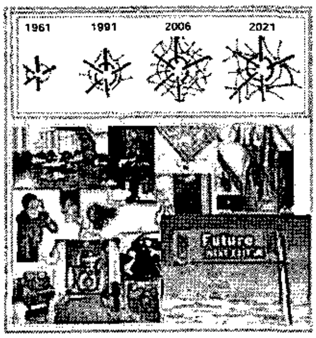
## Innovation through "thinking from the outside in"




**Foresight =**
**Questions about changing contexts:**

- How are urban living spaces developing – living, working, leisure time activities?
- What shortages are to be expected in cities of the future?
- *How are the lifestyles of urban trendsetters changing?*



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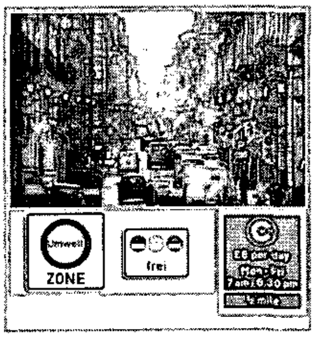
## Innovation through "thinking from the outside in"




**Urban Mobility - Driving Factors:**

- Increasing shortages in urban living space (circulation area, parking places)
- Usage, cost and image advantages for intelligent, resource - efficient solutions
- More flexible patterns of individual mobility
- Growth of mobile services in the city
- ...

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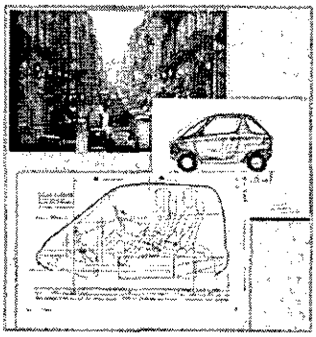
## Innovation through "thinking from the outside in"



**"The recognition of the external can only become a gateway to the future if it creates a bridge to the internal"**

Wassily Kandinsky, 1927

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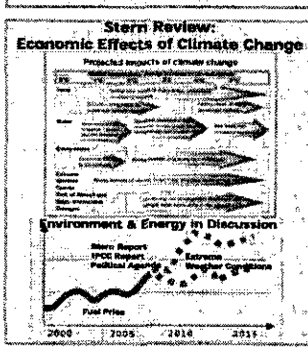
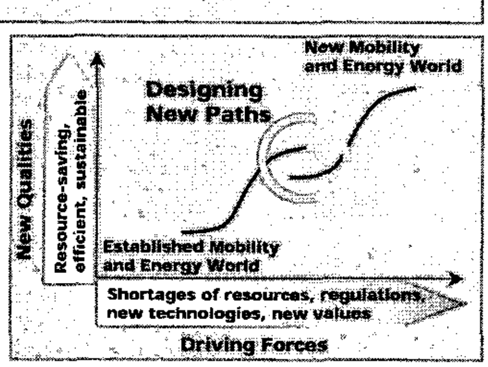
## Co-Designing turning points "green tipping point"

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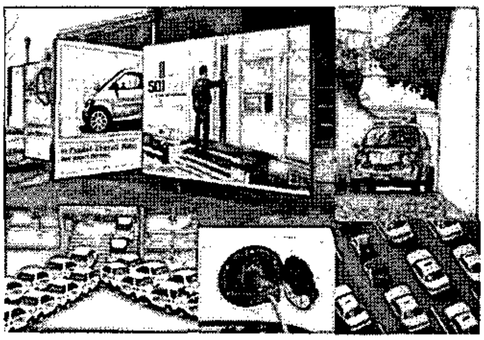
## Co-Designing turning points the principle of "AND"

**"This order of things departs from the basic rule of 'either – or' and slowly reaches a new – 'and' "**

Wassily Kandinsky, 1927





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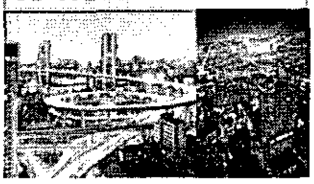
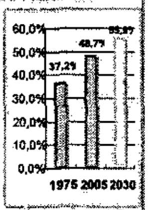
## Journey in time to the year 2022

**>> The attraction of cities continues to hold**



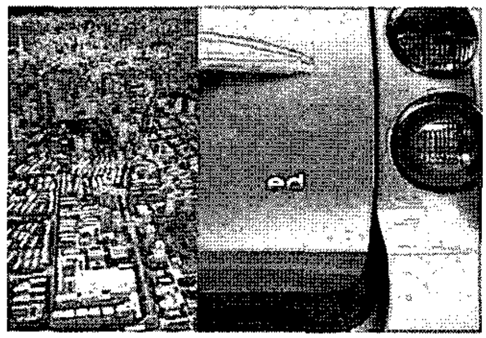
- In the year 2008 for the first time in history more than half of humanity lived in cities
- Today, in the year 2022, nearly 5 billion people reside in cities
- In the industrial nations four out of five inhabitants live in cities




Percentage of city population worldwide

## Journey in time to the year 2022

>> Great demand for hybrid and electro smart in mega and meso cities of the new industrial nations





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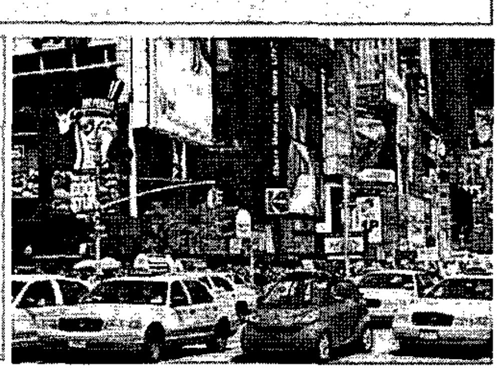
## Thank you very much for your attention!

>> These futures are closer than they appear



**Future Critical and Key Industrial Technologies
as Driving Forces for
Economic Development and Competitiveness**

**Professor Ron Johnston
Executive Director
Australian Centre for Innovation**

**Budapest, Hungary
27-28 September 2007**





# The Evolution of Foresight through Three Generations

1. **Generation 1** – *Technology forecasts, driven mainly by the internal* dynamics of technology
2. **Generation 2** - Foresight in technology and markets, in which technological development is understood in relation to its contribution to and influence from markets
3. **Generation 3** - The market perspective is enhanced by inclusion of the social dimension, meaning the concerns and inputs of social actors.

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## Interest in 1st/2nd Generation Foresight Remains Strong

- **The Rise of Technology Roadmapping (TRM)** - "a needs-driven technology planning process to help identify, select and develop technology alternatives to satisfy identified needs."
- **TRM** provides a means to develop a consensus about a set of needs and the technologies required to satisfy them, and a mechanism to help experts forecast technology developments in targeted areas.
- The promise or possibility of allowing emerging generic technology areas to be identified and prioritised for resource-allocation purposes

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## Some Recent Examples of Future Key Technology Identification

- US National Intelligence Council – *Mapping the Global Future* – 'over-the-horizon' analysis for the US Government
- NISTEP, *Japanese* Science and Technology Foresight Survey – Delphi-based analysis of future technology capabilities in terms of importance, impact, capability and date of realisation
- German 'Futur' project – assessment of the future needs and demands for science and technology and their broader implications for socio-economic and cultural development
- Consultant identification of 'top ten' technologies

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## Korean Industry Technology Vision and New Technology R&D Strategy

### A ' Parts and Materials' Technology Roadmap

- 50 core technologies for materials that create new functions
- 20 parts and components technologies for the value-added creation of core components
- 50 next-generation component module technologies





## The Findings?

- Energy
- Communications
- Biological modification
- New transport systems
- Ubiquitous computing
- Nanotechnologies
- Preventative healthcare
- Cognitive technologies
- Sensors
- Green technologies

## General Approaches to Future Key Technology Identification

**1. The criteria that are used to identify key technologies:**

- significance for trade balance and security – US
- expert opinion – US + Japan
- technologies the exploitation of which will yield benefits for a wide range of sectors of the economy and/or society – UK
- emerging technology - research has progressed far enough to indicate a high probability of technical success for substantial markets within 10 years – US
- ability to exploit technological opportunities ahead of other countries - UK





## General Approaches to Future Key Technology Identification

**2. The level of aggregation of technologies**

**Tension between:**

- broad generalisations which offer only limited intelligence and applicability
- precise specification of future technology/markets allowing precise implications to be drawn , but with high probability of error
- 'complete' lists of technologies that are so long and detailed that they offer little direction, only a menu

**3. The challenge of policy relevance**

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## Case Studies of the Impact of Foresight on Decision-Making

***1. Advanced Medical Devices***
- identification of shared interests between companies in this sector
- the basis for formation of an industry cluster
- the attraction of government support
- increased exports

***2. Future Housing***
- formation of cross-industry teams to pursue opportunities identified
- in two cases, IP negotiations prior to design and manufacturez

***3. Future of Irrigated Agriculture***
- major reconfiguration of the irrigation distribution system to dramatically increase flexibility
- reshaping of catchment management planning to meet major contingencies
- local Councils examining the implications for land-use planning, economic and demographic projections.

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## Lessons for Key Technology Identification through Foresight (I)

1. National foresight studies represent 'the most difficult case' in terms of clear demonstration of impact.
2. In Western predominantly market economies (eg US, UK, Germany) identification of potential key technologies operates as a signal and information to which private sector corporations can respond.
3. In Eastern more planned economies (eg Japan, Korea) investment in research and technology development can be more explicitly steered through foresight studies.
4. The impact of a foresight study is more evident and identifiable if it has precise and limited objectives, and focuses on a specific sector.

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## Lessons for Key Technology Identification through Foresight (II)

5. The increasing adoption of foresight within major corporations provides a market demonstration of their value. The favoured techniques are a mix of information scanning, scenario planning and technology roadmapping.

6. Technology is a key driver of future competitive advantage but not the only one. The ways in which technology generates new capabilities is shaped by the socio-economic context and the capacities of innovation systems – the supportive environment within which technologies are shaped, identified and refined.

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## Conclusion

For companies, as for governments, advantage arises:

- not from knowing the future with certainty, but
- having developed robust and adaptive processes and systems that allow some sense to be made of how the future might unfold,
- that provide the capacity to monitor and identify at an early stage new contingencies, and
- that have a deep organisational capacity to respond to and take advantage of these changes.

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# Key technologies for Czech National Research Programme

Karel Klusacek
Technology Centre AS CR
Prague

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## Background information

- results based on recently finished foresight project in the Czech Republic (June 2006 - June 2007)
- main objective – identification of key technologies for National Research Programme (2009 – 2013)
- a guide for selection of priority thematic areas for infrastructural investments into research capacities using EU Structural Funds (2007-2013)
- project sponsor – Czech Government through the Ministry of Education (responsible for R&D policy)
- project coordinator – Technology Centre AS CR
- results are now in hands of state administration (decision-making bodies)
- final proposal of National Research Programme will be submitted for approval to the Czech Government in March 2008

2

## Two basic questions

- What are the key opportunities and challenges for the Czech Republic in the time horizon 2015-2020, to the solution of which research may contribute?
- What are the related key thematic research directions?





## Methodology

A problem-oriented multi-disciplinary approach consisting of several methodical steps

- analytical desk research (R&D analysis, structural analysis of Czech economy, analysis of human resources for R&D)
- work of multidisciplinary panel of experts - about 70 people from a wide spectrum of scientific disciplines (ranging from socio-economic fields to technical areas)
- exploratory and normative scenario building
- prioritization procedure based on multicriterial assessment of themes suggested by experts
- combination of a back-cast look (analyses) and forward looking (scenarios generated by experts)
- final formulation of research priorities

# Results

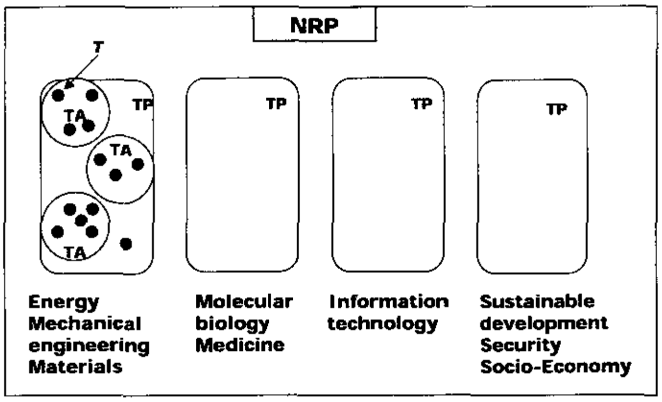
- Thematic research priorities
  - 34 thematic areas were defined and grouped into four thematic priorities (see conference materials for details)
- Investments into new R&D infrastructure
  - a guide for thematic orientation of new research capacities developed by using the EU Structural Funds (> € 5 billion in 2008 - 2013)
- Accompanying measures
  - supporting measures (policy, legislation, national R&D system, human resources) specified

Results still have to be refined and processed by policy-making bodies (state administration) in the second half of 2007





# Hierarchy of the National Research Programme




Themes (T) are grouped in Thematic Areas (TA), which are further grouped in Thematic Priorities (TP)

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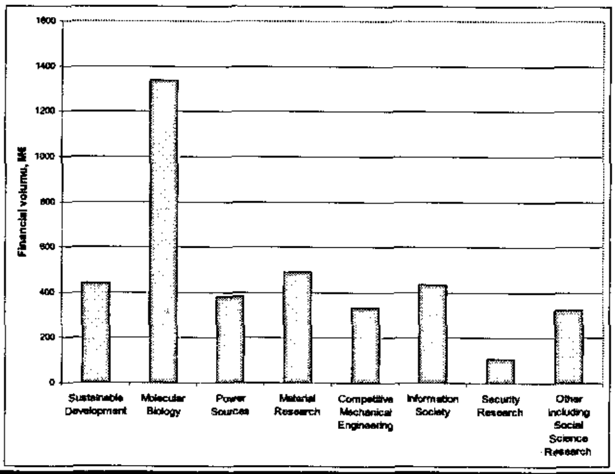
**Expected thematic distribution of investments into research infrastructure using Structural Funds in the Czech Republic in 2007-2013**

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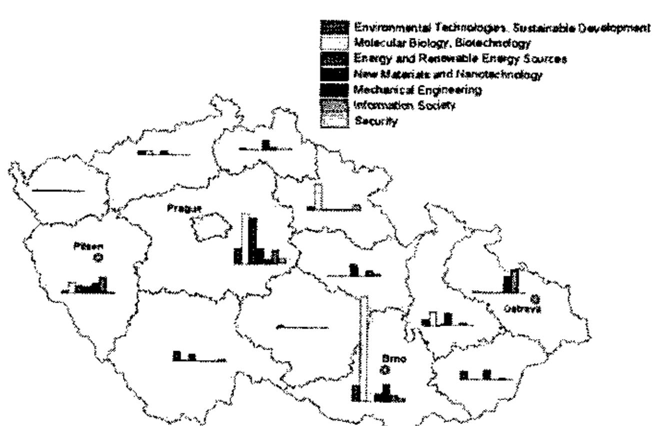
**Expected geographical distribution of investments into research infrastructure using Structural Funds in the Czech Republic in 2007-**

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## Links between financial instruments NRP~SF

- Comparison of previous two figures showing thematic and geographical distribution of SF in the Czech Republic with hierarchical table of the NRP depicting thematic distribution of key priorities in the NRP shows thematic links between both financial instruments
- Investment into research infrastructure from Structural Funds become operational in the next 3-5 years which is matching the assumed launching of the NRP in 2009
- National Research Programme is thus potentially capable to contribute in a coordinated manner jointly with Structural Funds to growth and employment in general and to boost R&D to achieve research excellence in particular thematic areas





# Thank you for your attention

**klusacek@tc.cz**

# Scenarios and Road mapping for Key Technologies.

## UK Case Note – Scenario Analysis in Flood and Coastal Defence

Ian Miles, Manchester Institute of Innovation Research, University of Manchester
Ian.Miles@mbs.ac.uk





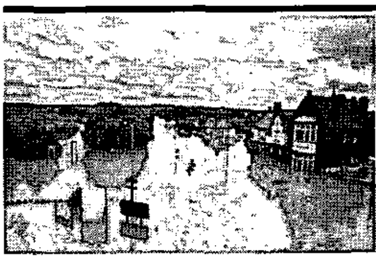
## UK Foresight – third cycle

- First two cycles set out to cover practically all technology areas
- Third cycle (2002-) sets out a programme of *focused Foresight*
- At any one time 4 (+) projects on S&T-related issues requiring cooperation across government departments. 2 each at *early* and *late* stages of work ... and 2 with more *technology-push* focus (exciting areas to develop) and 2 with a more *problem-driven* focus (difficult challenges to address)

Cognitive Systems; Exploiting the Electromagnetic Spectrum; Intelligent Infrastructure Systems; Sustainable Energy Management & the Built Environment.

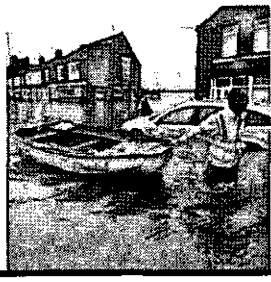
Cyber Trust & Crime Prevention; Brain Science, Addiction & Drugs; Detection & Identification of Infectious Diseases; Mental Capital & Wellbeing, Tackling Obesities.

- **Flooding and Coastal Defence** – use of scenarios



Catcliffe, near Sheffield...is under water. Tony Blair expressed his sympathy to the families of the dead and those displaced by what he described as an 'extraordinary and very serious event' (Peter Byrne/PA)

Villages in Yorkshire suffered some of the deepest floodwater after two months' rain fell in twelve hours (Lewis Whyld/PA Wire)



Floodwaters ... in Toll Bar near Doncaster, where a reservoir overflowed during heavy rain (John Giles/PA )

**Photographs from Times Online**
**June 2007**



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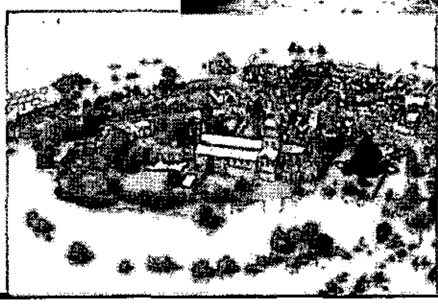


**From Guardian Unlimited**
**July 2007**

## FCD – Why and How

- WHY? In an normal year, c£800 million spent on flood and coastal defences; c£1400 million repairing damage caused by flooding.
- Climate change, urban development, farming practices all exacerbate risks. Costs to life and (increasingly valuable) property; challenges environmental objectives (biodiversity etc.)

- HOW? Aim. cooperation across government departments.
- FCD thus reported both to a technical expert advisory group and to a high-level ministerial stakeholder group. Strong support from the Environment Minister, close links with Defra (Environment Ministry).
- Leading professor devoted for one year as a lead expert; Defra provided about 0.5 person per year (spread among 6-7 persons) – spreading "ownership" of the project's process and results.
- The project design involved a wide range of stakeholders, as sources of expertise and knowledge to bear, and agents for implementing the action plan. (Some provided further funding for specific studies, some provided intellectual property (e.g. datasets).
- Methodology - combined various methods - expert-driven, views-based. Detailed plans but required flexibility





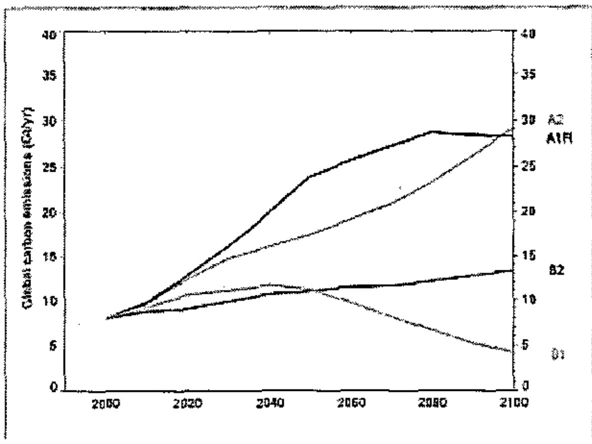
## FCD Process

**Phase 1**
- *Scoping the problems* of flooding and coastal erosion; developing methodology for subsequent phases.

**Phase 2**
- *Analysis of drivers and potential impacts* of future flood risk under **baseline** assumption - existing flood management policies continue unchanged - enabling existing policies to be assessed against future risks, and identification of useful changes. Better understanding of the drivers, their impacts and relationships, adding additional qualitative and quantitative analysis to Phase 1's.

**Phase 3**
- *Analysis of responses.* potential changes to flood management and related policies that would improve the management of future flood risk. Different flood management responses explored, to provide policymakers with indicators as to possible future policy directions. Assessment of impacts on flood risk of varying flood management responses, against a background of different futures scenarios, and of uncertain climate change

## IPCC Climate Scenarios...



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## ...Combined with Sociocultural Scenarios


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of Innovation Research
MBS, University of Manchester

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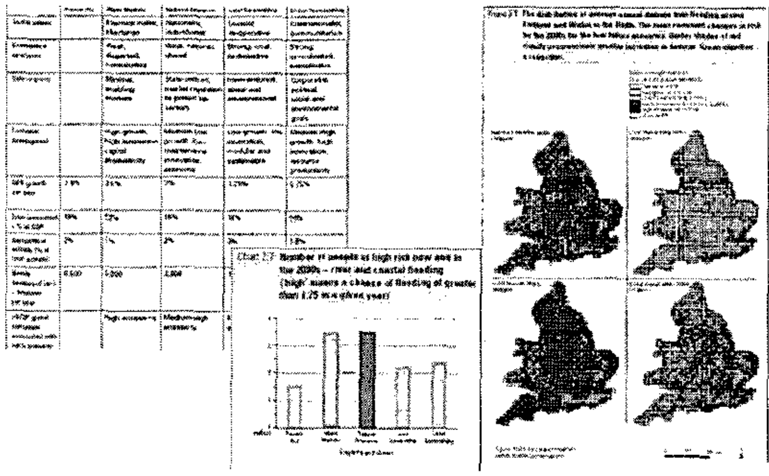
## ...and elaborated into quantitative and qualitative, verbal and visual accounts



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## OUTPUTS

- **Aims for future flood management.**
- **Importance of managing climate change to the risks from flooding.**
- **Additional challenges for towns and cities.**
- **Factors that should inform long-term approach to flood management.**
- **Governance.**
- **Implications for science and technology.**
- **Implications for skills.**

Range of reports, tools; much media coverage; many follow-up studies

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## Impacts

- Provision of "holistic" view showing need to recognise interrelations across wide range of policies and activities
- Major impact on flooding policy, developing long-term strategies (2007 – added urgency)
- Action plans for central government and regions
- Major impact on research – defining topics, helping forge communities
- Alerting much wider range of stakeholders to issues and debates
- Scenario approach important tool for communication (and negotiation)
- Scenario approach highly influential on subsequent studies, including several focusing on quite different issues (such as future of manufacturing)





**End of Presentation**

# Foresight exercise on zero discharge

Design, results and recommendations of the study

Budapest, 27th – 29th of September 2007

IFOK. ForSociety



## A UNIDO commissioned Foresight Study on Zero Discharge in CEE

### Overview

- Background and Frame Conditions
- General Approach
- Organization and Institutional Setting
- Design and Process
  - Research - Scenario Workshop - Scenario Building
- Results and Recommendations
  - General Conclusions
  - Scenario Spotlights
  - Recommendations to Industry, Policy, Administration

IFOK. ForSociety

## Background and Frame Conditions
## - Rationale -

Rationales for the foresight project are...

- new technological, political, economical and social trends of waste water management will impact the industrial sector in the *CEE region*
- foresight exercises are requested to cover structural and functional change scenarios, as well as technology developments
- vision building contributes to build consensus and agreements among the key stakeholders to conduct the transformation in a sustainable manner.





## Background and Frame Conditions
## - General Frame -

The general frame of the foresight project is...

- performance of a transnational foresight exercise on behalf of the UNIDO Technology Foresight Unit in the frame of UNIDO's regional foresight initiative in Central European Countries (CEE)
- duration of the project: March 2007 – December 2007
- delivering reports on process, results and recommendations *for experts in foresighting and water management, for regional* stakeholders and for UNIDO

## Background and Frame Conditions
## - Objective -

The transnational foresight exercise is aiming at...

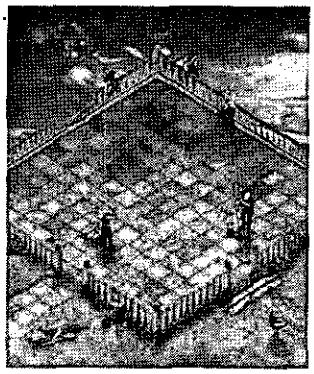
- identifying common issues and developments likely to occur in the field of advanced water discharge in CEE
- conducting future visions to address the future development of industry and other relevant sectors in this field
- formulating recommendations for future foresight, economic and political actions





## General Approach
## - Guiding principles -

Guiding principles for the foresight exercise are...



- broadening scope: taking push and pull factors both into account (technologies, standards, but also market demands and social values)
- focussing scope: systematic selection of key driving forces and prioritisation of future shaping factors and actors
- delivering concrete, multifacetted and consistent future visions of possible industrial, technological, social and political development in CEE countries

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## General Approach
## – Methodology -

Key characteristics
of IFOK's foresight methodology are ...

- to design creative, open-minded and strongly goal-oriented working processes
- using potential synergies by cooperation with key actors, networks, platforms and working in a transdisciplinary manner
- combining innovative forms of fact finding and visionary work to link up societal and market demand aspects with technological ones
- enhancing participatory approaches for knowledge production

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## Organization and Institutional Setting
## - Project leader -

IFOK.

IFOK - Institute for Organisational Communication is ...

- think tank and consultancy shaping change processes in society, business and politics
- well-known for innovative foresight and strategic processes for business and politics
- trendsetter for cooperative ventures
- *management expert for participative processes*
- german member of ForSociety and several EU foresight and innovation expert groups

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## Organization and Institutional Setting
**- Partners -**

ForSociety
Transnational Foresight ERA-Net

- European network of national foresight managers
- Tries to co-ordinate foresight competencies and activities within the EU
- Develops and implements transnational foresight exercises called „Future Dialogues"

Global Water Partnership
Central and Eastern Europe Division

- Platform for CEE water research and policy
- Part of large global network of water experts from industry, academia and NGOs
- Promotes the concept of integrated water resources management as a vital approach to managing the world's water resources





## Organization and Institutional Setting
**- Contributors -**

Industry

Water policy networks

Consulting institutes

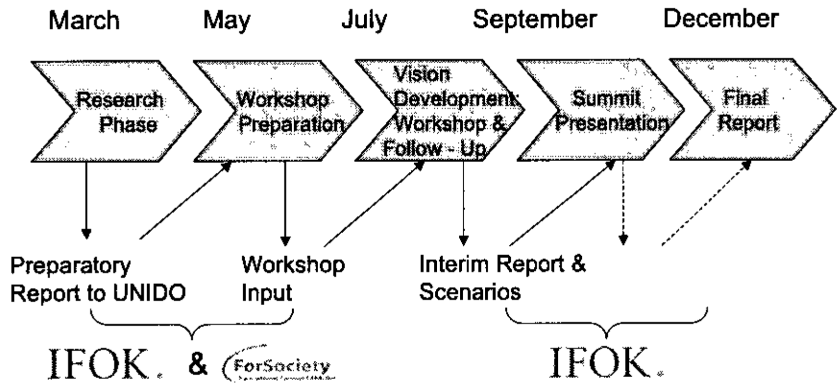
**International Experts from ...**

National and international administrations

NGOs

Universities and other research institutes

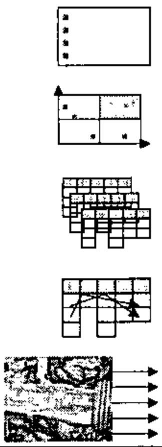
## Process and Design
## ′ - Schedule 2007 -








## Process and Design
## - Milestones -



- Exploration of the scenario field
- Identification of shaping factors and actors
- Discussion, brainstorming and prioritisation of factors
- Systemic exploration and linking of shaping factors
- Drawing storylines as basic structure for future visions
- Drawing conclusions for policy advice from future visions

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## Results
## - Conclusions regarding the exercise's starting point -

- Little visible knowledge regarding future studies in the field of waste water management/ zero discharge for CEE countries could be identified
- This is true for the national as for the regional and transnational level, although water systems, water use, waste water management and water policy are crucial matters for single CEE societies and the entire region
- The UNIDO water foresight project is highly valuable as it starts to
  - tackle the issue of water related futures in CEE
  - bring out the potentials of foresight for research and strategic action
  - reflect the future from the local up to transnational level - and thus initiates a valuable debate

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## Results
## - Conclusions regarding the exercise's starting point -

- The study has to be seen as a first step in foresighting waste water futures in CEE, exploring parts of the field and indicating vast areas of non-knowledge
- Therefore, the results are indicative and preliminary, the recommendations suggestions for further foresight work and only first ideas for strategic action
- Visions can hardly be formulated for the whole region as there are
  - different political framework conditions (EU, EU accession, EECCA)
  - differences in natural water supply (rivers, lakes, coastlines)
- Visions should be developed by experts not only from the area in question, but also with the expertise of neighbouring countries (neighbourhood policy, transboundary aspect of water).

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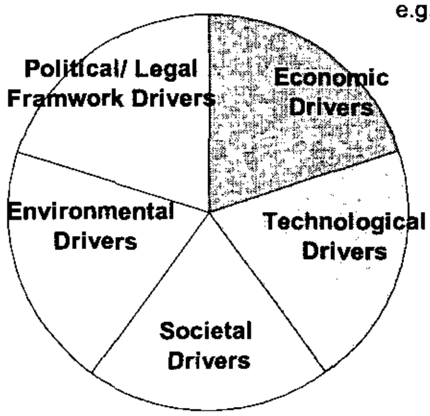
## Results
## - Key driving factors -




e.g.:
- Economic & industrial development
- „Reputational Risk“ for firms
- *Climate Change*
- Consumer movements
- Bio- and Nano-Technologies
- National/ International standards for technologies and water qualities
- Implementation and enforcement mechanisms





GLOBALISATION · MINITURISATION · DEMOGRAPHIC CHANGE · INFORMATION & COMMUNICATIONS TECHNOLOGIES · GLOCALISATION · CLIMATE CHANGE · CONVERGING TECHNOLOGIES

**Economic Dimension**

- *Economic growth-induced increase in waste water* (independent of increased water efficiency)
- International trade-induced increase in waste water (independent of increased water efficiency)
- Efficient management of water resources as decisive competitive factor
- Quality/state of and access to waste water infrastructure for industry
- Industrial districts
- Public-private partnerships
- Vertical integration of companies' value chains
- Path dependency/dividing of labour within the region
- Future economic make-up and structure and their attendant waste wa-ter impacts
- Outsourcing of industrial waste water (treatment) facilities
- Price of fresh water and industrial water
- Costs for discharging waste water
- Degree of privatisation
  - Of waste water producing industries
  - Of companies/organisations in the water (*provision and* treatment) sector
- Degree of competitive pressures for and between companies

**Environmental Dimension**

- *Warming - lower water table, increased* competition for water, availabi-lity of fresh water
- Rising sea levels
- Decrease of Glaciers and glacial melt waters which feed fresh water into rivers
- Droughts and situations of low water leading to inapplicability of waste water discharge systems
- Floods, including flash flooding, leading to the contamination of indus-trial (waste water treatment) facilities
- *Changes in local/regional ecosystems and* biodiversity

**Technological Dimension**

- Integrated technology transfer
- Increasing water productivity
- Closed loop systems
- National and international standards for technologies and water qualities
- Competition for emission rights
- Increasing recycling frequency and increasing accumulation of pollutants
- Relevance of process waste vs. product waste
- Concentration/type of contaminants' dilution effects
- Contamination by nanoparticles
- Contamination by complex bio-chemical substances
- Diffuse or non-point sources of waste water

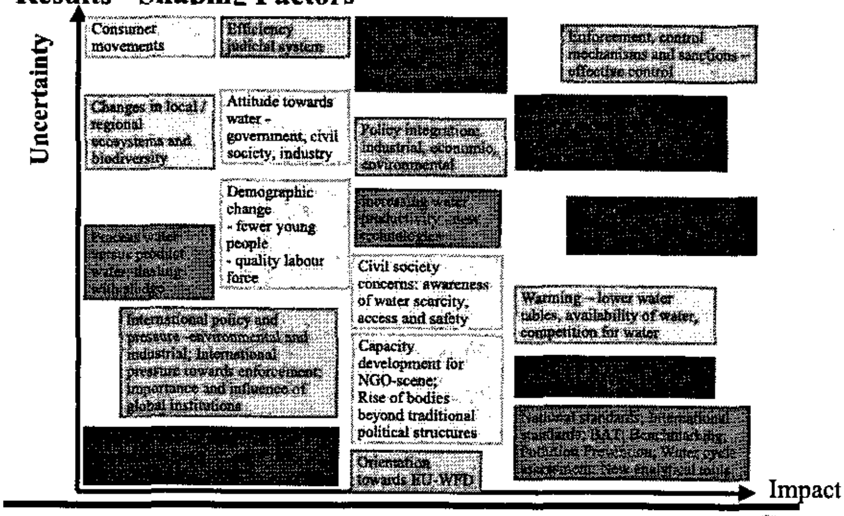
**Framework Dimension**

- *International environmental and industrial and development* policy and pressure
- Importance and influence of global institutions
- Orientation towards EU-framework/directives
- Transnational intraregional co-operation agreements and mechanisms
- Limitations in access to water management technologies due to intellectual property rights (TRIPS)
- Basin-level water management (T)
- Rise of platforms, organisations and bodies outside of national or international political structures e.g. Global Water Partnership, International Commission for the Protection of the Danube River Basin
- Capacity
  - Integration of industrial/economic and environmental policies
  - Enforcement – control mechanisms and sanctions
  - Longevity – timeline of policies and policy decisions
- Implementation and enforcement at local (governmental/administrative) level
- Co-operation with neighbouring administrative districts

**Societal Dimension**

- Urbanisation leads to changed water demand and discharge patterns
- Fragmentation increases non-point sources of discharge and water de-mand
- *Civil society concerns and pressures*
  - Access and safety fears
  - Awareness of water scarcity and other environmental issues

## Results - Shaping Factors -

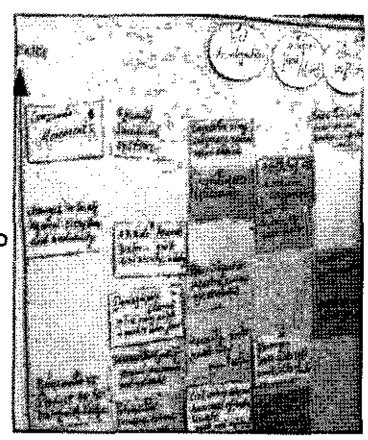







## Results
## - Framing the Scenario Field -

- Focus on manufacturing industries
- Focus on the production, not the product cycle
- From the focus of waste water towards integrated waste management
- Visions aiming at, but not based on zero emissions and discharges
- Diversity of CEE, EU and EECCA
- Interdependency of technology, economy, regulation, society and the environment



## Results
## - Three future visions -

The following visions focus each on different aspects, though none of them is exclusive:

Catching up and taking the lead – the industries & economies of the Eastern EU

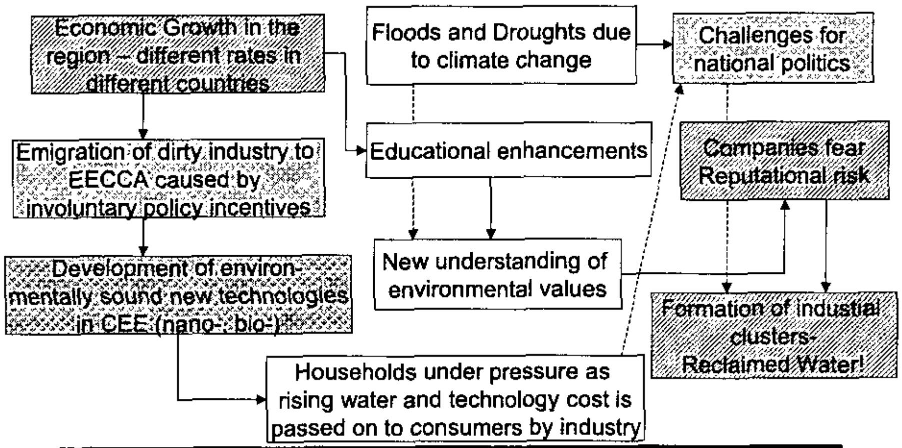
Bottom-up water management for zero emission targets

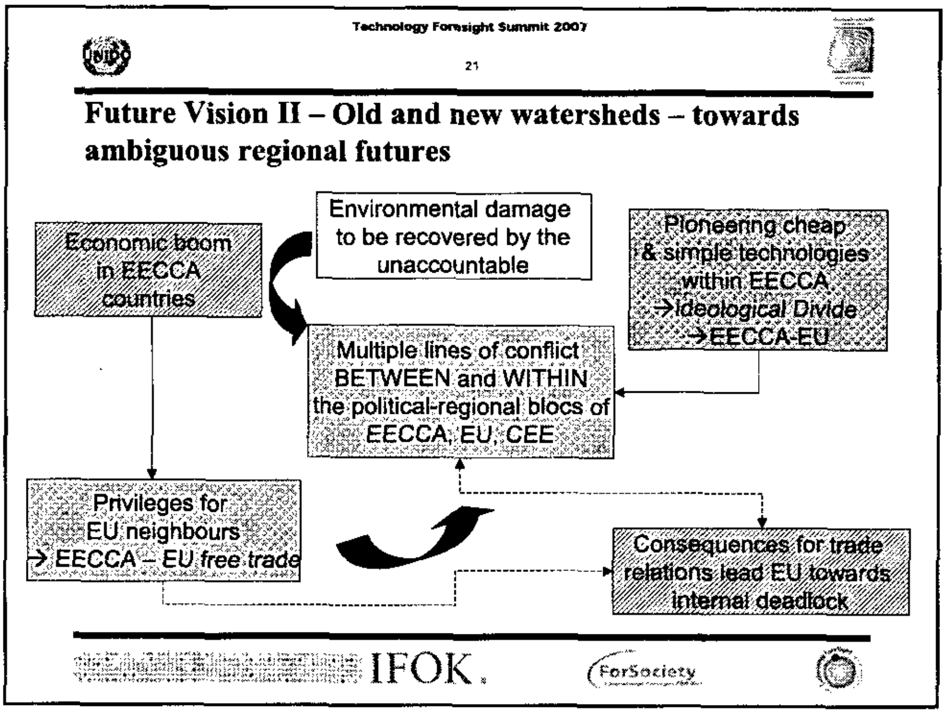
Old and new watersheds – towards ambiguous regional futures





## Future Vision I – Catching up and taking the lead – the economies in the Eastern EU

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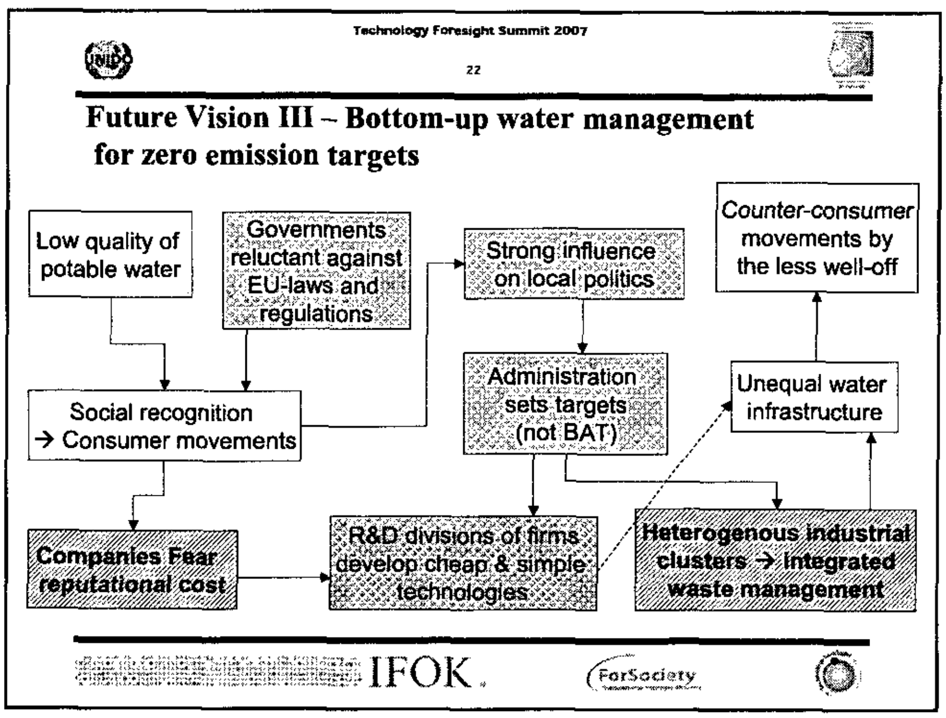
Future Vision II – Old and new watersheds – towards ambiguous regional futures
Economic boom in EECCA countries
Environmental damage to be recovered by the unaccountable
Pioneering cheap & simple technologies within EECCA → Ideological Divide → EECCA-EU
Multiple lines of conflict BETWEEN and WITHIN the political-regional blocs of EECCA, EU, CEE
Privileges for EU neighbours → EECCA – EU free trade
Consequences for trade relations lead EU towards internal deadlock
IFOK
ForSociety


Technology Foresight Summit 2007
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Future Vision III – Bottom-up water management for zero emission targets
Low quality of potable water
Governments reluctant against EU-laws and regulations
Strong influence on local politics
Counter-consumer movements by the less well-off
Social recognition → Consumer movements
Administration sets targets (not BAT)
Unequal water infrastructure
Companies Fear reputational cost
R&D divisions of firms develop cheap & simple technologies
Heterogenous industrial clusters → integrated waste management
IFOK
ForSociety

## Recommendations
## - regarding industry -

*Because of highly different and interlinked shaping factors and the present uncertainty of opportunities and threats industrial managers and associations in CEE as beyond should ...*

- cooperate with financial investment organisations, research, administration and policy on future visions for water technologies, water systems, water use and
- engage in local, regional and sectoral stakeholder dialogues





## Recommendations
## - regarding industry -

*Because of new auditing technologies and standards, the variety of water functions in production processes and the crucial role of water productivity for zero discharge strategies industrial managers and associations in CEE as beyond should ...*

- analyse and audit systematically production processes concerning
  - the quantitative and qualitative demands regarding water withdrawal and water consumption
  - the quality and quantity of emissions and waste discharges
- redesigning production processes and products by combining technological, managerial, organisational and communicative tools

## Recommendations
## - regarding industry -

*Because of technological and economical synergy effects, emerging opportunities of cooperation and increasing pressures to advanced waste management strategies industrial managers and associations in CEE as beyond should ...*

- identify potentials for internal and external reuse and recycling of waste water and integrated waste management
- intensify knowledge transfer networks and build up water related industrial districts, water related clusters and reclaimed water relationships within and beyond their economic sector
- reflect their strategic positioning to contractors and consumers and take into account costs of future reputational risk due to environmental rating





## Recommendations
## - regarding national governments -

*Due to the lack of strategic foresighting for water policy and deficits in the scope and effectiveness of future vision building national and subnational regional governements should ...*

- set up initiatives for strategic foresight on water systems, water use and waste water management ...
- take up the issue of water in product life cycles and extend the focus beyond waste water towards integrated waste management
- use the strategic knowledge and interests of business and financing institutions, involving also local knowledge

## Recommendations
## - regarding national governments -

*Because of emerging pressures and opportunities for cooperation and the relevance of incentives, standards and target setting for successful water governance*
*national and subnational regional governments in CEE should ...*

- initiate and support stakeholder and civil society participation in local, regional, national or transboundary planning and implementation processes with effect to water systems
- set powerful incentives and develop adequate frameworks for industrial activities towards
  - installing water clusters, districts and other kinds of cooperations
  - using best available technologies, but also testing alternative and pioneering techniques





## Recommendations
## - regarding UNIDO and international organisations -

*Due to emerging transnational and transsectoral dimensions of water stress and water policy and deficits in the scope and effectiveness of future vision building UNIDO and international organisations should ...*

- foster national, sectoral and other foresight initiatives regarding water and related issues of international and global concern
- support and initiate transboundary and transnational future work
  - concerning water systems and infrastructures transgressing national borders and
  - concerning countries and regions yet less involved in foresight like EU neighbours and members of EECCA
- broaden the technological and industrial focus of foresight towards
  - other water-relevant sectors (agriculture, public sphere, households)
  - complementing dimensions like social, cultural and governance issues

## Recommendations
## - regarding UNIDO and international organisations-

*Due to the growing complexity of water problems and the environmental, financial and political needs to link strategic visions, knowledge and resources UNIDO and international organisations should ...*

- enhance cooperations in foresight and water policy with other bodies like EU, WHO, OECD, UNEP/UNESCO or development financing institutions like EIB, EBRD and WorldBank
- link up industrial as environmental energy, climate change and water policies to meet the future challenges and options of their increasing interlinkages
- focus on probably emerging conflict lines regarding water issues within and between EU- and non-EU-members of CEE and EECCA-countries





## Recommendations
## - regarding research and research policy -

*Due to the lack of consistent knowledge bases for longterm water policy and deficits in the scope of water systems reflection research organisations in CEE and beyond should ...*

- intensify transdisciplinary and transsectoral research on water systems, water use and waste water management beyond short-term perspectives and linking water, energy and climate change aspects
- analyse in more detail the role of specific stakeholders in water use and water management and the conditions for success of new governance mechanisms in CEE countries
- develop cheap and simple technologies, which are economically available for industry and consumers and adjusted to local or sectoral demand

## Recommendations
## - regarding administration -

*Because of the need of innovative, consistent and effective water governance modes as a supporting frame for new technological and economic potentials of water administrative bodies in CEE should ...*

- initiate, support and casually facilitate stakeholder dialogues on future developments in the water sector
- engage in enforcement of auditing industrial production processes, standard and/or target setting, fostering selfregulative mechanisms in industry, but also control mechanisms
- optimise of the interplay of local, national and transnational regulative mechanisms (e.g. adaptation of BAT standards to local situations)
- *strengthen cooperations between municipalities with industry on* infrastructures, cluster-building and reclaimed water





## Thank you for your attention

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# UNIDO Foresight Study:

# "Avoiding Water Discharge by Industry in the Future – Towards a Zero Discharge in the Countries of Central and Eastern Europe"

## Progress Report

### Presented at the Technology Foresight Summit 2007

Berlin, August 2007

This document has not been edited

## Content

*The present progress report presents the current status (August 2007) of the technology foresight exercise "Avoiding Water Discharge by Industry in the Future – Towards a Zero Discharge in the Countries of Central and Eastern Europe (CEE)" undertaken by IFOK on behalf of UNIDO and in co-operation with the foresight ERA-Net "ForSociety".*

*The outline of the project, including objectives, methods and deliverables, has been presented to UNIDO in a preparatory report (March 2007), based on the terms of reference of the UNIDO's request for project proposals (December 2006).*

*This progress report contains a description of the steps and methods of the foresight study on zero water discharge in CEE countries, as well as the main process aspects, results and recommendations of the foresight exercise as they will be presented to the UNIDO Technology Foresight Summit in September 2007 in Budapest, Hungary.*

*On the basis of the discussions and recommendations to the Summit, the exercise will be finalized by December 2007.*

**Acronyms**

BAT – Best Available Technologies

CEE Central and Eastern Europe

EECCA - Eastern Europe, Caucasus and Central Asia

ERA – European Research Area

EU – European Union

GWP – Global Water Partnership

IPPC - Integrated pollution prevention and control: IPPC Directive

MME - Multi-national Enterprises

WFD – Water Framework Directive

UNEP – United Nations Environment Programme

UNESCO – United Nations Educational, Scientific and Cultural Organization

WHO – World Health Organization

# Background

UNIDO is implementing a global initiative on technology foresight that draws on regional initiatives. For UNIDO, technology foresight is "the most upstream element of the technology development process. It provides inputs for the formulation of technology policies and strategies that guide the development of the technological infrastructure. In addition, technology foresight provides support to innovation, and incentives and assistance to enterprises in the domain of technology management and technology transfer, leading to enhanced competitiveness and growth." This applies especially to countries with economies in transition like those in Central and Eastern Europe (CEE). UNIDO's regional technology foresight initiative assists such countries. The overall objective is to provide more sustainable and innovative development, thus fostering economic, environmental and social benefits at national and regional levels. The regional initiative aims at developing policies and R&D programmes that focus on innovation, industrial growth and competitiveness. By this means, national and regional knowledge as well as the capability of using technology foresight for designing policies and strategies are to be established and strengthened.

Against this background, UNIDO initiated a technology foresight exercise on the issue of "Avoiding discharge by industry in the future - towards a zero discharge in CEE countries." Water discharge and pollution by industry are crucial items in the area of water usage and sustainable water strategies. Industrial water use accounts for approximately 20% of global freshwater withdrawals. At the same time, a number of new technology developments in water treatment is emerging and becomes implementable and economically viable. They cover the range from mechanical, chemical, biological and optical technologies and combinations of those to techniques of substitution, increasing efficiency and mitigation strategies, linked to more organisational and economical strategies.[1]

UNIDO and IFOK, the latter being charged with realising this foresight project on behalf of UNIDO, agreed to focus the exercise on the following aspects:

- Main future demands in society and markets in the future regarding water (such as clean drinking water, modern recycling technologies, new production processes minimizing discharge, regulatory trends in water policies, societal trends, environmental developments etc.).
- Major concepts and technological developments (zero discharge, reuse and recycling technologies, water quality, etc.) and their challenges and technologies.
- Definition of future key factors and key actors influencing the application of zero discharge concepts and water-technologies in industry, cities, etc. Competitiveness needs innovative technology, but no successful technology implementation is possible if these

1 See for example UNEP, Water and Waste Water Reuse, An Environmentally Sound Approach for Sustainable Urban Water Management, 2005

key factors are not taken into account (e.g. sectoral regulations, societal and environmental demands, etc.).

- Delivery of several pictures - "future visions" - of the future of industrial development in the CEE stressing the zero discharge process in the horizon of 10 years. This includes an exploration of how aspects such as unemployment, inequality, sustainability or risk can be balanced against competitiveness, and the illustration of critical paths to an imbalanced world.
- Uses of foresight as a means of advice to policy makers that face the challenge of balancing competitiveness against sustainability.

# 1. Phase of preparing the exercise (March 2007)

As a first step, IFOK prepared the detailed organisation, design and methodology of the foresight exercise, and presented the results to UNIDO in a Preparatory Report in March 2007. The report outlined IFOK's general approach and specific methods for the whole foresight exercise, complementing the proposals formulated in the original tender of January 2007.

Secondly, IFOK involved ForSociety, an ERA-Net for transnational foresight coordination commissioned by the Directorate-General of Research of the European Commission as cooperation partner for the first half of the project.[2] ForSociety supported the project with its recent expertise in different transnational foresighting exercises ("future dialogues"), contacts to potential CEE experts and stakeholders and financial resources.

# 2. Phase of desktop research (March until June 2007)

## 2.1 Research on trends and experts

IFOK has been carrying out desktop research from March until June 2007. The efforts aimed at

- specifying the scenario field and the relevant future developments, therefore reviewing technological, economic, social and political trends relevant for an application of zero discharge concepts in the future and identifying the most important ("shaping") factors and actors related to this issue. Case studies of the application of advanced water discharge technologies have also been identified. The results are summarised and formulated in form of an input paper for a subsequent expert scenario workshop.

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[2] Due to ForSociety's time schedule the engagement focussed on the first phases including the scenario workshop

- identifying a limited number of foresight and research experts as well as a limited number of representatives of shaping actors in the field of industrial water management as resource pool for the project's workshop and interview partners. Potential international water experts from the NGO scene, technological and other scientific institutions, waste water treatment agencies and enterprises in general, as well as governmental/ administrative representatives had been contacted. A special focus was put on participants from the CEE region as those are bound to know best about the future development in the field. The final list of participants is attached in Appendix 1.

## 2.2 Workshop methodology

At the same time, IFOK had been working out a detailed and adequate methodology for the expert scenario workshop, ensuring a creative and result-oriented expert meeting to develop visions on industrial zero water discharge in CEE countries. In April 2007, IFOK started inviting potential participants and took up the organisational preparations for the workshop, the final design and programme.

## 2.3 Subcontracting expertise for national overviews on selected CEE-countries

To complete the IFOK desktop research with national and regional expertise on relevant contexts, trends and actors in CEE countries, IFOK contracted experts of the worldwide network Global Water Partnership and its Eastern Europe section GWP-CEE.[3] As a subcontractor, the GWP-CEE-secretariat in Bratislava (Slovakia) was asked to identify CEE water experts as potential authors for representative national studies on waste water and as participants of the scenario workshop. Additionally, GWP-CEE Slovakia was responsible to coordinate this work and sum-up the expertise on a regional level. During June 2007, the CEE experts drafted the national zero emission reports for Bulgaria, Poland, Romania, Slovakia and Ukraine, as well as the brief regional report. Despite restrictions in space and time, the main aspects of these reports were integrated into the shaping factors input paper by IFOK. However, all reports were distributed among the workshop participants in early July 2007.

## 2.4 Drafting the expertise input on relevant factors/actors in the scenario field

During June 2007, IFOK worked out the workshop input, providing the participants with clarifications and proposals for the definition of the scenario field "future of water discharge in CEE", a detailed workshop methodology and agenda, and a number of factors and actors most relevant for the future development of discharge strategies in CEE countries. The workshop input compiles

3 For further informations see http://www.gwpceeforum.org/?page=27

all results of the research phase including the empirical and analytical work of IFOK and GWP-CEE. Sources have been scientific literature, foresight studies, publications from water policy-related institutions, and expert interviews. IFOK integrated arguments and facts taken from the preliminary national reports that had been conducted by the GWP-CEE experts.

Issue areas in which drivers relevant for conducting a foresight exercise on industrial waste water discharge as identified by IFOK are:

- economic drivers,
- technological drivers,
- environmental drivers,
- societal drivers,
- political-legal framework drivers.

The input paper did not only serve the purpose to describe major trends in the development with relevance to waste water management, but also to report case studies of applied advanced technologies (see Appendix 1).

# 3. Phase of vision development: Scenario workshop and follow up (July and August 2007)

## 3.1 Expert scenario workshop

On 11th and 12th of July 2007, twenty waste water experts from all over Europe gathered in Berlin to discuss the future of industrial water discharge in the CEE region on the basis of the input paper and the national studies provided by IFOK and the GWP-CEE experts. During the intensive discussion

- the scenario field "Avoiding Water Discharge by Industry in the Future – Towards a Zero Discharge in the Countries of Central and Eastern Europe" was more precisely framed and defined;
- the key driving factors identified prior to the workshop were thoroughly discussed. Shaping factors were prioritised; those can be seen as the main driving forces shaping the scenario field in the next 10 to 15 years according to the participants;
- the different future developments of such shaping factors were identified, outlined and linked up to consistent storylines of future visions describing possible and consistent futures in the scenario field. Also some first ideas for recommendations to stakeholders in the field were collected. Both issues were elaborated in a follow-up process after the workshop.

## 3.2 Elaboration on future visions, conclusions and recommendations

Based on the research and workshop results and with the storylines as a starting point, IFOK outlined a total of five future visions of industrial discharge in the CEE region until late July. Together with a full documentation of the workshop proceedings and first ideas for further activities in the field, these vision outlines have been distributed among the participants for comments and approval. UNIDO received a copy of this documentation. During August 2007 IFOK picked up the feedback by participants and elaborated more specifically on the future visions and recommendations. In the process of reviewing the results the drafted visions were rearranged and reformulated to three future visions (see below).

Conclusions regarding the respective foresight landscape, the scenario field and the portfolio of shaping factors were formulated. In addition, recommendations have been drafted bearing reference to the implications of the foresight exercise and its results for foresighting, strategic and political action in the field, also pointing out the most relevant actors to whom the recommendations should be addressed.

# 4. Results

## 4.1 General Process Design and the Scenario Field

At this point in time, some conclusions can be drawn with respect to the thematic field and specific foci of the foresight exercise. In the language of scenario work: the scenario field can be further defined, based on intensive desktop research and the inputs and discussions of experts during the scenario workshop.

**Conclusions regarding the design of the foresight study**

The desktop research into the foresight landscape, together with the co-operation and discussion with representatives from GWP-CEE, showed that the UNIDO/ForSociety study takes up a very relevant strategic question for CEE and their industrial, environmental and research policies. Hardly any foresight or future studies dealing with the question of the present study could be identified. As a first pragmatic approach to gain insights into the future developments in this complex issue area, embedded in a highly differentiated social and political territory, the study will produce concrete visions on the impacts of various future situations with regard to advanced waste water management/zero discharge. These visions are explicitly of instructive value, comprising extremely different regional, technological, social and industrial developments in an efficient way, in the short term and for the purpose of giving valuable ideas for more intensive and extensive foresight work.

**Conclusions regarding the industrial sector as a focus of the scenario field**

There was agreement that the study and discussion should focus on manufacturing industries – in accordance with UNIDO's definition of its main industrial focus. This decision is relevant as there are very different forms of water use in the primary sector, e.g. energy production and coal mining, and forms of water use in the manufacturing sectors like the chemical, food, textile or paper industries. Nevertheless this is a matter of differentiated analysis and scenario work when carrying out foresights in the field of waste water. Therefore, the manufacturing industry represents the main field of reference in the present and more general study, but single references to other sectors are made based on the national foci of waste water problems chosen by the CEE experts, in no small part because of their partially crucial importance in national waste water productions.

**Conclusions regarding water discharge as a focus of the scenario field**

There are three different basic aspects of the discharge concept with high relevance for framing and limiting the scenario field.

**A. Production or product water cycle:** Water, in its essence, transgresses boundaries. Therefore it is necessary to distinguish between water discharges as a consequence of the production process within (manufacturing) industries, directly related to industries' water cycles and the industrial facilities (point sources), and water discharges from the users of products – themselves produced by means of industrial production processes. Although the latter kind of discharge, e.g. remains of pharmaceutical products in household discharge etc., is an extremely complex and pressing matter to deal with, this study focuses on industrial waste waters as they will pose the bigger challenge for the next 10 to 15 years in the CEE region. [4] By contrast, within the western EU countries, industrial waste water is no longer a pressing issue. The future relevant challenges in countries like Germany are product-related water problems in combination with the development of technologies and management approaches that achieve emissions reductions for this extremely dispersed type of waste. This also implies that this kind of challenge cannot be neglected in the long run as a crucial context for future developments in CEE.

**B. Zero waste water discharge or integrated waste strategy:** Water has multiple functions for industrial activities, implying extremely different kinds of water use and water quality after use during the production process. Different quality standards are to be met, depending on the preconditions of ecological systems, human needs, industrial uses etc. When talking about water use in industry, it needs to be borne in mind that different uses (cooling, dissolving, cleaning, transporting, etc.) require different water qualities in terms of pollutant load. It is therefore advisable to carry out a water auditing process when aiming at reducing effluent, at the same time keeping in

[4] Consequently also concepts like that of "virtual water" were left out of the discussion, although they are of extremely high relevance as innovative strategies for future water policy.

mind the principle of matching water quality to use requirements. On the other hand, specific water technologies may reduce the problematic load of water but, in doing so, shift the waste problem to other media (e.g. by extraction of pollutants from the water, producing sludge with problematic effects to soil (dumping sites) or air (burning, evaporation). Therefore the study does not stick to zero water discharge, which signifies the fact that all the effluent that would normally be discharged is treated, recycled or sold to other users ("cradle-to-cradle"-concept). Instead, a wider environmental concept is considered that is directed towards integrated waste and recycling strategies which also comprise other media than water, e.g. energy consumption for the waste water treatment process. Without losing the focus on water, the study refers to such a broader approach.

**C. Zero emissions or zero effluent discharge:** A further implication can be drawn from the conceptual reflections of A and B – the goal of zero emission has to be related to the question in how far some specific emission discharges or effluent discharges may or may not have negative effects at all for further users. As the study is dealing with realistic and crucial visions for the next 10 to 15 years these questions most probably will not be top priority. Thus, the study treats the explicit zero emission objective as a long-term orientation in CEE, not as a target definitively realised in 2020. Instead of focusing on the goal of reducing polluting emissions into water to a feasible, yet technologically and economically over-ambitious and thus overly onerous degree (zero emissions discharge), the study takes into view more pressing objectives in the direction of zero discharge. These are a 85 to 90% level of water cleanliness that will be reached by reducing effluent discharges and enormously increasing water efficiency and productivity during the next 10 to 15 years.

**Conclusions regarding the regional focus on CEE of the scenario field**

There seem to be markedly different definitions of what constitutes Central and Eastern Europe. During our workshop, we aimed at keeping to UNIDO's own definition which includes Belarus, Bulgaria, Czech Republic, Hungary, Moldova, Poland, Romania, Russia, Slovakia, Slovenia and the Ukraine. Early on in the project it was realised that in terms of water policy, management and technology, a crucial distinction would have to be made between those Central and Eastern European countries – constituting those countries as defined by UNIDO – that are members of the European Union (Poland, Czech Republic, Slovakia, Hungary, Slovenia, Bulgaria, Romania) and those which are not (Moldavia, Ukraine, Belarus, Russia as part of the Eastern Europe, Caucasus and Central Asia - EECCA group).

Although there is no reason to formulate uniform future visions for both groups of states, it is highly valuable to formulate future visions for the EU part of CEE, thereby looking at the causes and effects of future developments which link these futures with the second group, here referred to as the "EECCA countries". This is also the rationale for taking Western EU members into the scenario building process for CEE as they are of crucial relevance in CEE as economic and regulatory drivers for the future development. On the other hand, the EECCA countries should also be subject of (more specified) future visions. But the central problem encountered when building scenarios for the whole group of CEE EU members, namely overly-reduced complexity making the output of questionable validity, is encountered to a far greater extent when drawing up visions for the whole of the EECCA region. Such visions encompassing the region as a whole can neither be built nor provide any useful basis for further work given the massive differences – even greater than those which exist between the CEE EU members – which exist between EECCA countries in cultural, economic, geopolitical and regulatory terms (and prospects). Therefore the vision was based on the expertise of Moldavia and Ukraine present in the foresight exercise.

All visions argue on a mainly transnational and transregional level, making reference to individual nations and regions for illustrative purposes. But neither in the case of EU- nor the Non-EU-members of CEE do the visions claim to meet exactly the future situation of one specific country or of all countries of a group.

**Conclusions regarding the technological focus in the scenario field**

The technologies in waste water management are highly sophisticated, opening far-reaching options for emissions reduction. Their application is regulated to a great extent by standards and benchmarking mechanisms. Therefore technological development paths are closely linked with the economic and financial resources available; the political, legal and administrative systems in place; the awareness of engineers, entrepreneurs, consumers and civil society given and other factors to be explained in this study. The technical expertise offered by the participants from the different countries have, therefore, been working with quite some dedication on links to economic, social, institutional and political innovations in which technological innovations will be embedded in the future. Consensus was achieved within the expert group that a broad understanding of technology and technology foresight is highly fruitful. Expertise in macro-economic processes in the region is of crucial relevance, especially with regard to local industrial development. Expertise in social and political dynamics and expertise from fore-running companies and from the NGO scene are also of great value in order to build 'the bigger picture', i.e. integrated visions, taking into account the Water Framework Directive - WFD development and implementation process and energy flow analyses and concepts.

## 4.2 Results concerning shaping factors (with highest and unpredictable impact)

*On the following pages, the relevant factors for the future of waste water in the CEE-region as* identified by IFOK and the participants are listed. The list is followed by the priorisation-matrix of crucial factors.

***Economic Dimension***

- Economic growth-induced increase in waste water (independent of increased water efficiency)
- International trade-induced increase in waste water (independent of increased water efficiency)
- Efficient management of water resources as decisive competitive factor
- Quality/state of and access to waste water infrastructure for industry
- Industrial districts
- Public-private partnerships
- Vertical integration of companies' value chains
- Path dependency/division of labour within the region
- Future economic make-up and structure and their attendant waste wa-ter impacts
- Outsourcing of industrial waste water (treatment) facilities
- Price of fresh water and industrial water
- Costs for discharging waste water
- Degree of privatisation
  - Of waste water producing industries
  - Of companies/organisations in the water (provision and treatment) sector
- Degree of competitive pressures for and between companies

**Environmental Dimension**

- Warming - lower water table, increased competition for water, availabil-ity of fresh water
- Rising sea levels
- Decrease of Glaciers and glacial melt waters which feed fresh water into rivers
- Droughts and situations of low water leading to inapplicability of waste water discharge systems
- Floods, including flash flooding, leading to the contamination of indus-trial (waste water treatment) facilities
- Changes in local/regional ecosystems and biodiversity

**Technological Dimension**

- Intensity of technology transfer
- Increasing water productivity
- Closed loop systems
- National and international standards for technologies and water qualities
- Competition for emission rights
- Increasing recycling frequency and increasing accumulation of pollutants
- Relevance of process waste vs. product waste
- Concentration/type of contaminants' dilution effects
- Contamination by nanoparticles
- Contamination by complex bio-chemical substances
- Diffuse or non-point sources of waste water

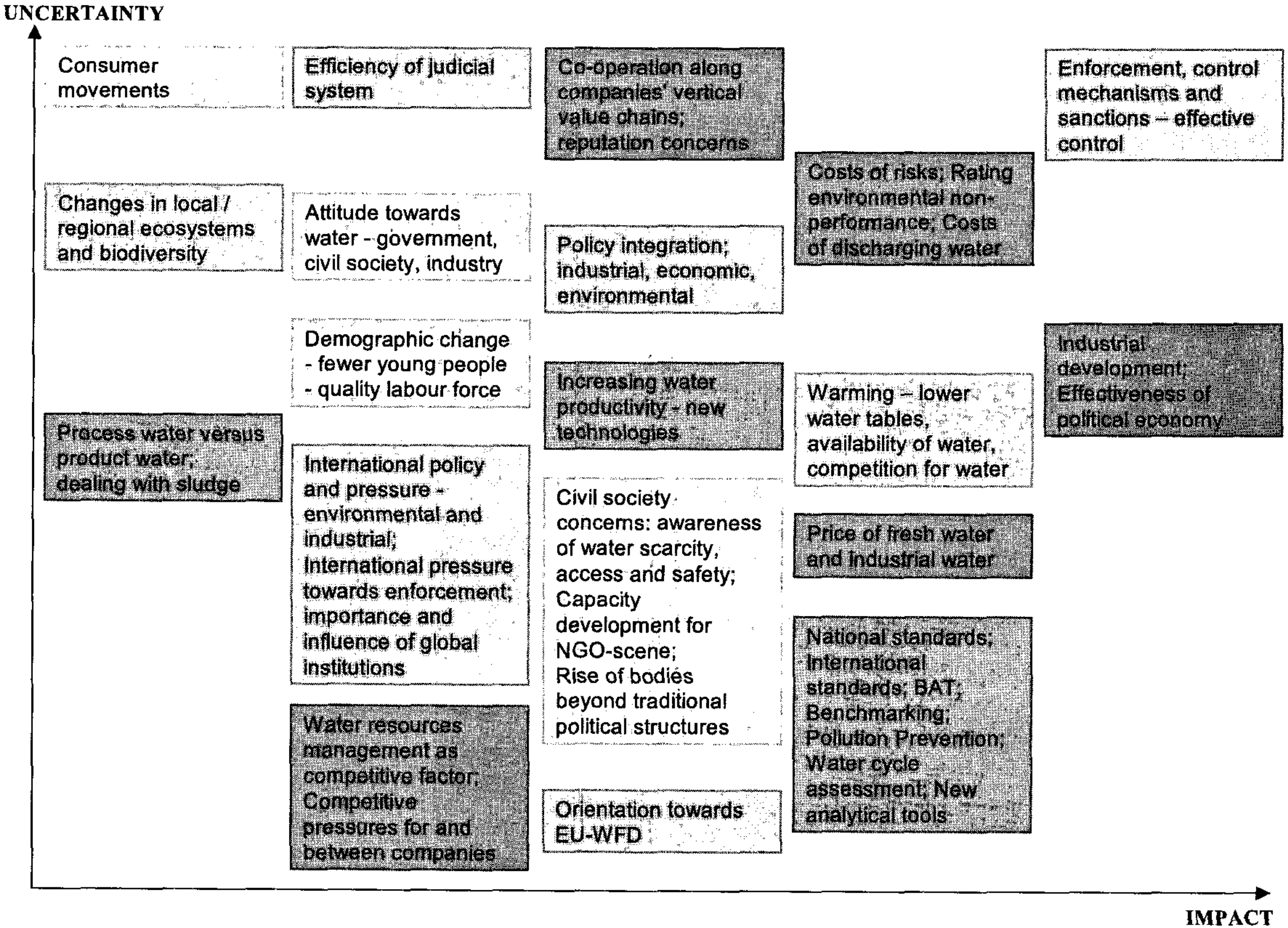
**Framework Dimension**

- International environmental and industrial and development policy and pressure
- *Importance and influence of global institutions*
- Orientation towards EU-framework/directives
- Transnational intraregional co-operation agreements and mechanisms
- Limitations in access to water management technologies due to intellectual property rights (TRIPS)
- Basin-level water management (T)
- Rise of platforms, organisations and bodies outside of national or international political structures e.g. Global Water Partnership, International Commission for the Protection of the Danube River Basin
- Capacity
  - Integration of industrial/economic and environmental policies
  - Enforcement – control mechanisms and sanctions
  - Longevity – timeline of political and policy decisions
- Implementation and enforcement at local (governmental/administrative) level
- Co-operation with neighbouring administrative districts

**Societal Dimension**

- Urbanisation leads to changed water demand and discharge patterns
- Fragmentation increases non-point sources of discharge and water demand
- Civil society concerns and pressures
  - Access and safety fears
  - Awareness of water scarcity and other environmental issues

MINIATURISATION
GLOBALISATION
DEMOGRAPHIC CHANGE
GLOCALISATION
INFORMATION & COMMUNICATIONS TECHNOLOGIES
CONVERGING TECHNOLOGIES
CLIMATE CHANGE


UNCERTAINTY
Consumer movements
Efficiency of judicial system
Co-operation along companies' vertical value chains; reputation concerns
Enforcement, control mechanisms and sanctions – effective control
Costs of risks; Rating environmental non-performance; Costs of discharging water
Changes in local / regional ecosystems and biodiversity
Attitude towards water – government, civil society, industry
Policy integration; industrial, economic, environmental
Demographic change - fewer young people - quality labour force
Increasing water productivity - new technologies
Industrial development; Effectiveness of political economy
Warming – lower water tables, availability of water, competition for water
Process water versus product water; dealing with sludge
International policy and pressure - environmental and industrial; International pressure towards enforcement; importance and influence of global institutions
Civil society concerns: awareness of water scarcity, access and safety; Capacity development for NGO-scene; Rise of bodies beyond traditional political structures
Price of fresh water and industrial water
National standards; International standards; BAT; Benchmarking; Pollution Prevention; Water cycle assessment; New analytical tools
Water resources management as competitive factor; Competitive pressures for and between companies
Orientation towards EU-WFD
IMPACT

## 4.3 The three future visions

**Catching up and taking the lead – the industries and economies in the Eastern EU**

The first vision focuses on three main aspects. It pictures, firstly, a generally positive economic development for the CEE region and an innovating industry concerning water use. Secondly, it *emphasises the political, cultural, economical and environmental diversity of the region*, thus acknowledging the fact that economic growth takes place all over the region, yet with considerable differences between the countries. As a third aspect, the risks and consequences of climate change are taken into account, leading partly to highly critical situations in the countries.

**Old and new watersheds – *towards ambiguous regional futures***

This second vision focuses on the future developments in the EECCA region taking up old and new dividing lines in the framework for water discharge strategies between EU and non-EU-countries in Eastern Europe and between fast and slower transforming EECCA members. It features strongly reversed processes, in which some EECCA members implement pioneering techniques and *governance modes that are incompatible with EU legislation. At the same time, economic* partnerships are established between some EECCA countries and the EU.

**Bottom-up water management for zero emission targets**

This vision takes into focus the societal dimension of the future of waste water. The deteriorated water infrastructure gives rise to a number of consumer movements, which gain large influence on local and even national politics. Administration has to resort to the innovative method of setting targets for waste water management rather than standards. In the end, this leads to the very innovative and highly competitive development of new technologies by industry themselves.

### Future Vision 1:
### Catching up and taking the lead – the industries and economies in the Eastern EU

*Future vision one focuses on three main aspects. It pictures, firstly, a generally positive economic development for the CEE region and an innovating industry concerning water use. Secondly, it emphasises the political, cultural, economical and environmental diversity of the region, thus acknowledging the fact that economic growth takes place all over the region, yet with considerable differences between the countries. As a third aspect, the risks and consequences of climate change are taken into account, leading partly to highly critical situations in the countries.*

*Significant economic growth in the region ...*

Up to the year 2017 the political economy of the CEE region has developed in a positive manner, with growth in the industry and services sectors bringing prosperity to the region. There have,

*...but highly disparate growth rates on the national level*

though, been notable differences in the strength and degree of economic growth in the region: Poland and the Baltic states have seen their economies double in the past 10 years, while the Danube countries have enjoyed steady, medium economic growth around 2% per annum during the same period. These differences occurred due to the wide disparity among the EU-members of the CEE in terms of regulation, geographical situation, speed of economic and political innovation. Although legislation has mostly been harmonized with EU-law, the implementation status differs among the countries. Where Poland for example has already implemented ion exchange technology for waste water minimization in nearly all its coal mining sites, other countries like Bulgaria are still lagging behind due to the implementation cost and lack of efficient political action. The technological advanced Polish mining industry reduces the amount of sodium and carbonates that typically pollutes mining waste water even beyond most advanced standards.

*Dramatic regional and local differences concerning access to modern water infrastructure*

Adding to this notable disparity is the issue of infrastructure. As the pre-2007 (waste) water infrastructure has already then been identified as being in a disastrous state, no region-wide improvements came about. The traditional rural-urban divide was to be blamed for that, directly followed by the intra-urban divide between residential and industrial districts. Due to the risk perception of private investment funds and emerging new self-concepts of public bodies in several regions water-infrastructures were built up in private-public-partnerships. Where industry and public bodies were ahead of things, a new and top technology waste water infrastructure was established within months from innovative technological developments. Where this was not the case, i.e. often in rural areas, people and the environment suffered from ever more deteriorating infrastructure, letting them take health risks and fostering rural exodus – according to what people could afford to do. In addition, even promising infrastructural developments provided for various supplemental problems, as all actors in the field experienced typical transition problems – for example facing the challenge to run and sustain newly installed infrastructure based on public-private-partnerships. Often the national as well as regional and local administrations were unable to cope with these promising but complex technical but even more economic, legislative and organisational innovations.

*Private-public-partnerships start successfully ...*

*... but their adaptation is challenging.*

*Policy gives incentives for emigration of dirty industries ...*

*...inducing shrinking processes and unemployment in specific sectors...*

*...but also dynamic innovation and growth*

The outstanding dynamic of northern countries was based on the high-tech and services sectors of the economy, which has been despite the emigration of high polluting industries (e.g. heavy industry) into the neighbouring EECCA-region. This has in no small part been thanks to a governance orientation cored by a consistent economic development policy adopted by the governments. Their global competitiveness with a highly skilled labour force, smart subsidies, new investments in infrastructure, loose regulations and low taxes have enabled them to catch up partially with established economies of the EU. The loss of big industrial companies and SMEs in traditional sectors and related production, income and employment was not easy for CEE members of EU to compensate. But significant investments by high-tech companies in CEE region have helped to bring about this change in the economic structure. Consequently high polluting industry has been almost forced out of these countries, with e.g. textile production moving to the southern Eastern European EU states and the raw materials processing sector completely relocating to the EECCA countries so as to avoid a continuously tightening environmental legislation.

*Consequences of climate change: floods and droughts in Eastern Europe challenge the diverse political landscape*

As a consequence, water productivity rose in the flourishing and fast modernising CEE countries and waste water effluents diminished significantly. Nevertheless, economic expansion between 2007 and 2017 brought with it a major increase in overall water consumption. Despite the emigration of "old" waste water intensive industries and water productivity improvements, the overall increase has almost negated these trends and – even worse - climate change caused water stress in the region and put high pressure on the demand and supply side of water. The increasing number of floods and droughts all over (Eastern) Europe, accompanied by severe pollution of surface and ground water, proves to be a difficult challenge for the countries of this large and extremely diverse region.

However, especially in the highly prosperous parts of CEE the challenges of climate change have amplified the developments already underway in the economic make-up of these countries, spurning on the anyway flourishing field of innovation and technology development, including highly innovative and efficient water use in industry, households and municipalities. The Best Available Technologies - BAT for lower use, improved efficiency and the ambitious target of zero emissions have been developed and brought to market in the past years. But whereas in 2015 some 50% of all industrial companies in northern CEE had adopted a zero emissions approach, in other CEE countries only few facilities implemented advanced waste water systems, but without the macroeconomic and environmental promising context of the forerunning CEE states.

*Education enhancements lead to a new understanding of environemental values....*

The research- and knowledge- intensive development did not only enhance the overall level of education, but led to the dissemination and integration of new societal values and competencies, not least concerning the use of water or valuing engineering and other techniques for closed water loops. New forms of water scarcity and water perceptions contributed to companies considering more closely the impacts on their reputation of their environmental performance, coupled as it is with changing attitudes by consumers. The risk of "reputational cost" dawned upon companies: citizens would very likely boycott products that did not meet the recently implemented regulatory standards. On the other hand companies felt that they could establish enormous consumer trust when proving that the processes were environmentally neutral at least. As a consequence in 2017 most of the SMEs in Slovakia for example redesigned their production processes and products referring to big fore-runners like Coca-Cola-Company, which already in 2007 adopted an environmentally friendly approach in their corporate commitment when promising to "replace the water we use".

*...causing companies to fear the risk of reputational cost*

Technological innovations have enabled companies to respond to these new attitudes and the fact that environmental performance is increasingly a basis of competition between companies.

*Technological interface: bio-, nano-, genetic technologies lead to improved water balance for companies*

After the era of major adoption and development of BAT by CEE companies the EU's BAT register has of late been massively influenced by those developments and technological improvements being undertaken in the progressing economies in the Eastern part of the EU. Most notably the paper industry has been actively introducing systems above former EU-standards, such as nanofiltration systems along with integrated waste management systems. Heavy industries, as long as they remained close to the EU-border or border countries even developed systems using the technological interface of bio-, nano- and genetic technology in order to clean their waste water from the mostly toxic substances that used to make it absolutely un-recycable.

*Industrial clusters take advantage of the concept of reclaimed water*

One of the most striking effects on the progress towards zero water discharge resulted from industries' heavily increased acknowledgement of co-operation, also as a key concept in resource and water management. Industries clustered together, not just for economic reasons, but because they found out that "one man's junk is another one's treasure". The energy industry became a driving force in this development towards "clusters for reclaimed water", as the cooling water of power plants could excellently be used as intake water for paper and apparel industries. Another win-win-situation emerged when technologies reached the market which allowed to obtain energy from waste water – not only by directly recycling it (energy savings by avoidance of cooling/ heating the outtake/ intake water), but also by using it to feed small, plant-integrated hydropower stations.

*Rising water and technology prices...*

*... are passed on to consumers, thus putting households under pressure*

The price of water has not been unaffected by these significant changes. Increased waste water costs and costs of discharge permits have at first been balanced out by the dramatic efficiency improvements achieved through the implementation of new technologies. However, these new technologies were increasingly expensive to develop and implement, and these costs are now passed on to consumers via higher product prices. In addition, the costs of water and sanitation for households rose as water utilities companies have also passed on their technology costs to consumers. In national contexts with consumers' growing "green conscience" and economic welfare above CEE average those price increases have been socially accepted. But in some less prosperous countries of CEE consumers showed a strong reluctance against the further development of technologies, as they feared to not be able to cover their living expenses from their salaries anymore. In some of the affected countries, this even led to strong "water-price-movements" and strikes.

**Future Vision 2:**
**Old and new watersheds – towards ambiguous regional futures**

*This future vision focuses on the future developments in the EECCA region taking up old and new dividing lines in the framework for water discharge strategies between EU and non-EU-countries in Eastern Europe and between fast and slower transforming EECCA members. It features strongly reversed processes, in which some EECCA members implement pioneering techniques and governance modes that are incompatible with EU legislation. At the same time, economic partnerships are established between some EECCA countries and the EU.*

The decade before 2017 has seen a continuous movement of high polluting industry out of the EU and into the neighbouring EECCA countries. This kind of foreign direct investment caused something of a boom in several European EECCA economies as industrial businesses sought to escape the ever tighter strictures of EU water and environmental legislation and the unwillingness of consumers to have such industry located near them. But not all EECCA countries have been facing this impulse for growth.

*Privileges for EU neighbours resulting in a new free trade*

Though the neighbouring countries of the EU have not joined the union as full members, some of them have enjoyed a number of privileges and a variety of innovative policy solutions were drawn up so as to offer an attractive alternative to full membership. Within the EU neighbourhood policy it was possible to couple increases in trade resulting from the relocation of industry with slight improvements in environmental performance. This development culminated in a free trade zone with some of the EECCA countries and a privileged partnership with Russia for trade purposes in 2015.

*Lines of conflict turn out ...*

*...in the political sphere ...*

*... in old and new markets...*

In turn, this lead to a number of political conflicts between the EECCA countries themselves, as those countries bordering the EU gained enormous profits from the free trade area, while the eastern Caucasus states for example were excluded from this preferential treatment. Heads of states and the industrial managers realized, that part of the discriminative treatment from EU and their former EECCA-peers was nothing but a consolidation of traditional political differences. Yet, what used to be purely political or even political culture-related, developed into economic (dis-) advantage. Companies within the free trade area did not only profit from new markets, but also from increased technology transfers among themselves as well as between EECCA and EU states, leading to product, process and resource management innovations. Thus, they could continuously develop their competitive advantage.

*... and the area of technological standards*

At the same time, the Eastern Caucasus countries became increasingly reluctant against implementing environmental standards of the EU and even the new free trade area. In part, this was also caused by contradicting guiding principles of technological innovation in the EU- and the

*Competing principles of best available, simple or pioneering technologies ...*

Non-EU-sphere. While water expertise and regulation in the sphere of EU-orientation supported the view that best results are achieved by implementing and thus cementing well-tested technologies at a certain point of time as BAT, other countries of the CEE region, especially those in the far east, differed in their dealings with technology. They believed that best technologies are simple and cheap or of pioneering technological character, and that there is no use in legally prescribing which technologies should be implemented, since such action would prevent innovation. Instead, these countries were convinced that it is more adequate to set certain output/ waste targets that need to be met within a certain period of time.

*... imply political consequences far beyond the sphere of environmental policy*

While industrial activities and cooperation within CEE and between EECCA and EU partially prospered, this resulted in 2017 in complex difficulties for industrial businesses in other CEE countries to trade and cooperate across EU-borders or even within the specific countries and regional blocks. In terms of policy, technology and markets some countries of the CEE-region were literally running into the arms of the EU, while others stood for themselves. The same held true for EECCA with some of these countries having excellent relations to some of the CEE countries, while others do not even bother to establish or keep up basic diplomatic relations, in part not even with EU countries. This difficult situation with conflicts arising here and there among the EU countries, the EECCA countries and with the danger of even developing strong differences between EU and EECCA sharpened through the tensions on the energy market. All EECCA countries supplying energy used their market power more and more to put pressure on other Eastern countries and EU member states.

*Consequences for trade relations might lead the EU towards deadlock*

All this showed consequences for the "old" EU as known at the beginning of the century, Though there had been the tendency to open up the borders, which already manifested itself in the realization of the free trade zone, EU countries now showed a liking of conflict. The beginning of a political divide stood out, as some of the traditionally known as liberal EU countries sought to open up the union even further – including technological, environmental and not at last water policy standards. On the other side, the larger conservative part would strictly deny access to such parties and insist on traditional principles of technological progress and regulation, for example not implementing standards according to BAT. By 2017, the Union is slowly steering towards deadlock, not at least stuck in the discussion about the adequate balance of global, national and local level governance.

*Environmental damage to be recovered by the unaccountable*

As a matter of fact the EU is unable to foist the limited water management demands it makes from others on some of the EECCA countries and companies located there. The cost of the environmental damage caused in the region are borne by those EU member states and EECCA countries bordering areas locating high polluting industries. Thus, actors who are not responsible for the pollution must clean it up so as to meet the stipulations of the EU, sequentially leading to ever higher conflict potential.

*Technological innovation within EECCA manifests ideological divide between EU and EECCA*

However, other industrial players in EECCA realise significant technological innovation concerning water productivity and diminishing water pollution and discharges, thanks to the new political incentives and expanding economies. The alternative technological mindset of several experts, managers and administrations in EECCA on the one hand and the self-blocking and eroding trends concerning the BAT-philosophy of the EU on the other led to radically different water management approaches than normally adopted by the EU. Cheap and simple water technologies based for example on old traditions like cascade filtration took root, often combining techniques, new materials and organisational tools in innovative and highly efficient ways.

*Some EECCA countries ahead in technologically dealing with new pollutants*

On the other hand, highly advanced pioneering techniques like nano- or bio-nano-based filtration could be applied without reference to BAT standards and procedures and depending too much on public risk discourses concerning those new technologies. Those "experimental waste water facilities" are now partially designated to clear waste water from new pollutants like genetically modified material and other bio-engineering production process remains. Those by-products of advanced high-tech-processes become an increasing problem for pharma and chemical companies in the EU. Therefore, some EECCA countries may, a few years from 2017, achieve a unique selling proposition in supplying specific waste water facilities in combination with infrastructural systems concepts to treat these new pollutants adequately and hence removing the bottleneck for these crucial production lines in emerging markets. As a consequence more and more business managers seriously consider already by 2017 to move bioengineering plants and whole companies based on those to selected EECCA countries. The rising wealth from expensive energy exports will help some of the EECCA-members definitely to invest in such and other costly zero water discharge technologies, whereas others suffered from the energy crisis, the economic stagnation and the worsening of environmental conditions.

**Future Vision 3:**
**Bottom-up water management for zero emission targets**

*This future vision takes into focus the societal dimension of the future of waste water. The deteriorated water infrastructure gives rise to a number of consumer movements, which gain large influence on local and even national politics. Administration has to resort to the innovative method of setting targets for waste water management rather than standards. In the end, this leads to the very innovative and highly competitive development of new technologies by industry themselves.*

*Reverse developments of industries and technology cause new problems*

At the beginning of the third decade of 21st century, Europe and in particular the countries of Central and Eastern Europe had to face the severe deterioration of their water infrastructure. The quality not only of surface and ground water but also of potable water declined - people opened their water tabs facing a thin, dirty trickle of water. How did this situation come about? The region in question, above all Poland and Slovakia, experienced impressive economic growth following the year 2009, which took place on the basis of old, weakly enforced regulations concerning water use. Yet, an enormous number of industrial sites had been brought up, and the mining industry is still dominating together with textiles and chemical industry. Output in waste water has risen by 75% compared to the beginning of the century, as the development of waste water technologies was not able to keep up with the economic boom.

*Reluctance against EU laws and regulations is strengthened by corruption*

This outset was completed by a high reluctance against EU-laws and regulations, as old resentments pushed their way back up front. The Water Framework Directive has been signed and adopted, yet this turned out a purely bureaucratic effort: instead of enforcing and effectively controlling the implementation of new waste water technologies, the administration and industrial actors agreed upon a mutually advantageous strategy as industry paid the administration an 'additional salary'. Such corruptive mechanisms kept administrative staff quiet in its anyway low ambition to control, and saved a lot of money for the industry.

*Consumer movements evolve to actors with a voice in water policy ...*

Social recognition of these facts brought with it an unparalleled blossoming of consumer movements. NGOs seeking to deal with the myriad of aspects linked to the issue were established and campaigning on what seemed like a daily basis. What began as small, local initiatives borne out of the discontent felt about a local water problem soon began to have a major impact, first within civil society and then in the economic and governmental sphere. NGOs and single well-educated consumers, demanding better water quality, tried to pressurise companies into taking over responsibility for their actions and began to impact upon the local political agenda with great success. Many local government elections which took place in the last years before 2017 in the CEE region presented the consumers movements with the ideal forum into which to channel the discontent felt by the broad public about the water issue. The movement was able to mobilise a considerable number of voters, bringing with them a slow but definite change in policy. Politicians

*... and gain strong influence on local politics*

understood that they could no longer ignore the facts accepted as true by the public and scientists, so they started to think about how to meet their environmental demands. A curious event, however, was that the scepticism and even mistrust against foreign legacy, e.g. through EU regulations, kept growing.

*Companies fear "reputational cost" and obey to the pressure*

These changes in attitude and approach were not limited to local politics. Parallel to the water issue creeping up the political agenda, industry became increasingly aware of environmental ratings, the risk of "reputational cost" and market losses. It dawned upon them that companies would have to prove that their products and production cycles were unlikely to worsen the water quality. And companies felt that they could establish enormous consumer trust and competitive advantages when proving that water cycles can evolve to closed loops. While politicians were still arguing over optimal solutions and the framework to present industry with, industry took matters into its own hands and started to act, partially in cooperation between big industry and SMEs to meet the challenges of the rising water consciousness of local as well as global markets.

*R&D develops cheap and efficient new systems to reach tailor-made solutions ...*

*... which leads to significant divides in environmental quality*

What they did was to push their own research and development departments to develop cheap, easy-to-use, purpose-built waste water systems, and to make them ready for use as fast as possible. Some of them even managed to achieve zero emissions with the new systems, but not all industries could use the same waste water management system. The situation was, therefore, one in which by 2017 the CEE region was home to many different waste water management systems and strategies, most tailor-made to an industry's or a plant's needs, but not all to the satisfaction of the movements' demands, experts expectations and administrations principles. This was in part caused by the fact that the diverse distribution of industrial sites in the CEE region – i.e. the traditional rural-urban divide, partnered by the urban internal divide between residential and industrial districts – provided for a strong but unequal waste water infrastructure.

*Counter-consumer movements by the less-well-off fight high prices*

Although these developments were not over-onerously costly, they lead to a rise in the general cost of living. Not only became beverages more expensive, but every water intense product suddenly increased in price. This gave rise to a counter-consumer movement: the less well-off, i.e. those that did not directly benefit from the economic growth, constituted themselves as influential civil society groups. Their goal was to fight high prices, and boycott the expensive products they were faced with due to the new conscience of industry. Today in 2017 it is not clear whether the environmental or the social water movement will bear the palm of impact on water policy.

*Wake-up call for administration, who now sets targets, not standards ...*

Amid the realisation that their first, feeble attempts at regulation had been outdated faster than new regulatory could have been written, several local and even some national political actors decided to make the best of the situation. Rather than implement regulation that set standards about the methods and instruments to be used they set targets, together with a date for their fulfilment. The most ambitious of these was the achievement of zero discharge across the region even including an emissions trading system for water related wastes. The crucial point within this legislation was that any actor or entity producing waste water was absolutely free in how it dealt with its waste water; the only stipulation was that no waste water be discharged. This included the by-products of waste water treatments and sludge. As a result, what used to be called the implementation of BAT for waste water treatment was now transformed into a completely new approach, which simply put high enough incentives with a strong, effective control mechanism in place that would necessarily lead towards technological innovation in the field. In case of success, this led to a decrease in prices, as industry was fast in developing efficient solutions to meet these new demands. Thus, in those sectors and countries the price-driven consumers were kept in line. In other parts of CEE this system of new governance did not work, with socially and environmentally negative effects.

*... but the liberal mode of water governance did not work successfully in all regions and sectors.*

*Industrial Clusters form in order to benefit from reclaimed water and an integrated waste management strategy*

One more substantial impact of these developments on industry was the establishment of very heterogeneous, geographically co-located industrial clusters. Huge areas were, to all intents and purposes, closed to any use or activity other than industrial activity as industrial actors realised that they could best meet the targets set by closely co-operating vertically along their value-chains and horizontally across industries. New technological insights helped facilitate this. These developments have the potential of achieving an integrated waste management in the next 10 years, thus achieving overall zero discharge in 2025/2030. With an integrated waste management approach, companies themselves dealt with all of their waste: waste water, by-products, sludge, toxic substances, usual office waste, etc., and did so in increasingly cooperative structures, since – see above – one company could easily benefit from "reclaimed waste".

As a general challenge even in cases of successful self-regulation and cooperation the lack of general standards and coordinated water policy above local and sectoral levels have been pointed out as substantial problems by experts, national governments, international environmental organisations like UNEP, WHO, EU and even supranational NGO-platforms.

# 5. Recommendations

## 5.1 General Recommendations

Firstly, the present foresight exercise delivers a basis for further transnational foresighting in the scenario field at present, but at the same time gives several reasons to also carry out such foresight processes at national and sub-national level. They could be adopted to level and sector specific challenges and driving forces, bringing together the whole spectrum of national and local water stakeholders and experts, and being performed through various steps so as to creatively open and pragmatically close the process.[5] The experts that took part in the current foresight process suggested that UNIDO might want to take up the idea of an expanded waste water foresight in CEE, as this would possibly enhance cooperation among the CEE countries (water being a physical transboundary issue) and could be the best example of the practical usefulness of foresight exercises.

Other foresights for CEE might therefore reasonably refer to the broader concept of the product water cycle, as point sources of waste water like in other EU member states may also lose weight in CEE within the next two decades. The aim of reducing effluent/ discharge may not only require new waste water management/ treatment techniques, but may also be achieved through redesigning process and product designs. Yet again may a broader focus be applied to further foresight exercises, as some experts raised the question whether for example the optimisation of water cycles has to be linked to the optimisation of nutrient or energy cycles. In how far does it make sense to aim towards zero emissions of industrial water discharges if they contain nutrients or other reusable resources to be kept in the ecological productive cycle? And what about waste water as a future source of energy, related to the idea of closed energy cycles?

In the event of more regionally and locally differentiated foresight studies being undertaken, it will also be necessary to include expertise from neighbouring states as the issue of water is a physical transboundary one, not bound by political territories (e.g. foresight referring to Black Sea neighbours, river basin settings etc.).

Besides the research and policy detailed and an interdisciplinary strategic outlook, the topic should be discussed with economic actors in the field of waste water technology and management as this would prove highly fruitful. There is a huge lobby industry within the field, i.e. every enterprise that produces waste water, and every enterprise that has accounts in waste water treatment and technology. The lobby is accompanied by the EU as the relevant frame-setter, thereby putting pressure on the lobby actors.

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[5] One could refer to the process of building future water scenarios for the World Business Council on Sustainable Development supported by Shell foresight experts. This process comprised several regional/local workshops, the results from which were then put together in a report and discussed during a further meeting with specialists who also participated in the regional workshops. The whole process took two and a half years.

## 5.2 Recommendations to industry

With regard to the work on strategic future outlooks on the topic of waste water, firstly and most strongly, industry should intensify this work. As there were hardly any studies found for CEE – neither from industry nor from academia – that actually deal with the issue, it is advisable to strengthen such efforts. When doing so, the scope of the work should be extended beyond the usual short-term perspectives of months or a small number of years. The present exercise showed that we only just stand at the dawn of new industrial developments and progresses, of which the results are hardly estimated in the short run. Yet the factors hint at decisive developments that will outroll within a longer time frame. So industry has nothing to fear but to gain economically viable insights into the future development of their field, which will make them well-prepared to cope with the situation lying ahead. By the same token, industry should overcome organisational borders in order to make out regional and, even more importantly, sectoral future trends in order to maintain their market positions. Co-operation with actors representing the investment community, research, administration and policy on the development of future visions for water technologies, water systems, water use and related issues should become a matter of course. Also, we suggest industry to intensively engage in local, regional and sectoral stakeholder dialogues with consumers, water users and civil society on shaping future water systems. In that way, industry can realise what has been proposed before, but also tackle the problem of consumer movements and questions of legitimacy.

Taking into view the internal processes of industries, here with explicit reference to the manufacturing branches, it is recommended to implement comprehensive mechanisms of water auditing. That is, above all, to systematically analyse and audit the site's production processes with regard to water. Auditing in this context means to find out about the specific purposes the intake water has to serve in the different production steps, and how much water of what quality is actually needed – does it have to be drinking quality or may a lower quality be sufficient? In addition, it is necessary to carry out the same procedure for the emissions side. This will give information on the pollutive load of the water and the quantity and quality of the waste or by-products that need to be discharged, thus allowing for an intake-output record. Based on this record, industry should reconsider their product portfolio in order to explore opportunities to increase their water efficiency and productivity. In redesigning production processes and product portfolios, best results will be achieved by combining technological, managerial, organisational and communicative tools.

Turning to the outward perspective, industry should orientate their external activities towards the identification of potential clients for reusing and/ or recycling their waste water. Also, considerations should be made regarding industrially integrated waste management strategies, i.e. not simply leaving waste and waste water to public sewerage (after little pre-treatment), but taking care of all the waste that is produced within the site or even the existing industrial district. Where there are no such districts, industry should aim at forming those, be it sector-related districts or highly heterogeneous clusters, complementary in terms of waste water. Such clusters and districts might best be established in cooperation with other economic sectors, public bodies and research institutions, the latter of which are likely to be interested in on-site research. Naturally, a redesigning of the traditional industrial structure should also include reflections on the strategic positions towards consumers and the risk of reputational cost that may develop due to environmental rating results (cf. also above). In the same context, industry should increase cooperation among large companies and SMEs along value chains or within sectors in order to achieve comprehensive implementation of BAT or meet the set emission targets, thus creating a win-win-situation for all actors involved.

## 5.3 Recommendations to national governments

Considering the work on future outlooks and foresighting activities, we suggest that initiatives for strategic foresight on water systems, water use and waste water management should be brought on the way. This is of special importance, as it is national governments that are able to implement necessary incentive structures, for example by charging higher waste water fees that could be claimed on regional/ local level and re-invested in improving infrastructure, or in order to fund research activities. In detail, such initiatives should have a broad and nationally or even sub-nationally adjusted scope of issues like water in product life cycles, water cycles in relation to nutrition and energy cycles and waste water and integrated waste management, and the like. Consequently, the actors involved in such initiatives need to mirror the thematic scope. Business and the investment/ finance community may be worth including in the process, as it is their interests and knowledge, that enables research on the topic. Local actors as well are providers of good knowledge, either generally or of the local situation, and as the risk of reputational cost is also one for governments, this would be a way to reduce it.

With regard to water policy, we advise national, sub-national and regional governments to initiate and support stakeholder and civil society participation in water-affecting local, regional, national or transboundary planning and implementation processes. At the same time, again, strong incentives in combination with an adequate framework need to be created that will effectively make industry form districts or clusters and realise other forms of cooperation in reference to their water demands and waste water emission. A promising concept that should be the "guiding star" of such activities is that of reclaimed water. Similar ways must be explored in order to push forward the application of BATs. However, the exploration of pioneering alternative and possibly cheap, simple-to-use technologies also needs to be ensured in so acting.

## 5.4 Recommendations to UNIDO and other international organisations

These actors, having already made important efforts to put technological foresight into the centre of their actions, may nevertheless improve their action. Firstly, foresight activities regarding water and related issues of international and global concern should be fostered on national, sectoral and regional level. Those attempts need to be complemented by future work on a transboundary/ transnational level with regard to water systems and border-transgressing infrastructure. Some relevant countries and regions at this point in time are, for various reasons, not as much involved in foresight activities as possible, for example a number of EU neighbouring countries like Turkey, Israel and the EECCA-states. They are to be explicitly integrated in water foresighting activities. As shown by the future visions presented here, specific parts of the EECCA-region are of high relevance for the future waste water infrastructure in the CEE-region. Therefore, it is crucial for UNIDO and other International Organisations to shift their focus and make EECCA subject to specific visionary work, as EECCA is also bound to hold the balance for the general future orientation of the EU border countries.

Although a technological/industrial focus of foresight activities is of good value, international actors may want to consider to broaden their perspective, thus integrating other sectors important to (waste) water management, as for example agriculture, the public sphere and private households. In doing so, the issues of the social and cultural realm as well as governance issues can be included.

On a more operative level, it is suggested that UNIDO and other International Organisations not only enhance cooperation in foresight and water policy with other bodies like EU, WHO, OECD, UNEP, UNESCO, but also with development financing institutions like EIB, EBRD and WorldBank – both on the level of strategic foresighting and support of water management by industry, government and civil society. In doing so, more direct connections between the foresighting community and those being part of the implementing side, i.e. governments, can be established. Thus, an ongoing flow and exchange of information about the results of foresighting is secured, and the way to realisation of future visions is shortened.

At the same time, linkages between local and national foresight processes and to strategic regional future work are to be established so as to bring together relevant geographical areas and political blocks. This is not limited to foresight and the respective organising bodies: linkages between different policy fields like industrial and environmental energy, climate change and water are necessary when aiming at effectively meeting the future challenges of the anyway increasing interlocking of these issues. In doing so, international actors may not leave out the consideration of new conflict lines regarding water within and between EU-members and non-EU members of CEE and EECCA-countries that are very likely to emerge in the nearer future.

## 5.5 Recommendations to Research and Research Policy

Scientific work on future outlooks of water systems, water use and waste water management needs to be intensified. In doing so, it is important to keep in mind the long-term perspective in order to gain valuable insights for the implementation of ideas and methods that will be developed in such work. As already pointed out before, water, energy and climate change aspects may not be researched separately, as the present exercise showed that those are closely interlinked in their effects. Future research efforts need to also be strongly oriented towards transdisciplinary and transsectoral approaches, as the future waste system will be an integrated one, and technologies are very likely to converge to a high degree. By the same token, it should be focused increasingly on systemic local and regional solutions. In terms of specific research tasks, the role of specific stakeholders in water use and management is crucial to be analysed in detail in order to explore the condition for success of new governance mechanisms in CEE countries. Furthermore, the development of cheap and simple technologies that are economically feasible for industry and consumer demands as well as well-adjusted to the respective local or sectoral need is highly recommendable to be taken into focus.

## 5.6 Recommendations to administrative bodies

Administrative bodies all over Europe need to enforce water auditing processes in order to achieve a systematic, comprehensive application, aiming at improvements in water productivity. This is also the reason why attention should be put on standard setting and effective enforcement/ control mechanisms. Here, a clear relation is visible to the general state of administration in the CEE region. Their engagement in the enforcement and evaluation of industrial water auditing processes, aiming at improving the water efficiency of the production process, and of effluent audits on a comprehensive scale is of crucial importance. The same holds true for standard setting/ target setting and enforcement mechanisms. Administration needs to also carefully balance the mechanism of BAT against target-setting in achieving best results. It is highly recommended to put effort in the creation of self-regulating mechanisms for industry, but the issue of control is never to be underestimated. In addition, it is important that administration pays attention to the diverse effects such control mechanisms exert on different enterprises. Large companies may not fear the cost of using BAT, yet their subcontractors, usually SMEs, may suffer from immense financial losses when trying to do so. Thus, administration needs to develop strong mechanisms that ensure cooperation between the companies in terms of technological knowledge transfer and assistance.

These mechanisms need naturally be of optimal interplay, i.e. local, national as well as transnational regulative mechanisms are to be coherent and subject to the principle of subsidiarity. Thus, administration should be responsible for adapting BAT standards to the local situations. Administration faces the challenge to optimise and bring into accordance local, national and global regulations and communication structures, answering the interlinkages of local but also regional and global dimensions of water stress and water management. Yet, with regard to communicative structures, it is important that also those between municipalities and industries are improved so as to be better able to co-operate on infrastructure issues and the implementation of the concept of reclaimed water.

Since adequate qualification is usually organised by administrative bodies, it is suggested that an emphasis will be put on proper trainings. This is important not only on the professional level, i.e. for engineers, but also for the wider public, as well-educated people are rather able to effectively handle the future water challenges than those who never enjoyed proper education. Neither are the qualification efforts to be limited to this, as new technologies can only be used to their best effect if complemented by up-to-date management and governance techniques, including out-standing communication strategies. Administration seems to be the appropriate actor to facilitate the stakeholder dialogues on future developments, the fostering of which had been part of the recommendation to governments. Linked to those processes they should support, initiate and facilitate stakeholder dialogues on the future developments in the water sector.

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## 1. Discussion of Factors and Actors in the Scenario Field – List of Factors

**Economic Dimension**

- Economic growth-induced increase in waste water (independent of increased water efficiency)
- International trade-induced increase in waste water (independent of increased water efficiency)
- Efficient management of water resources as decisive competitive factor
- Quality/state of and access to waste water infrastructure for industry
- Industrial districts
- Public-private partnerships
- Vertical integration of companies' value chains
- Path dependency/division of labour within the region
- Future economic make-up and structure and their attendant waste wa-ter impacts
- Outsourcing of industrial waste water (treatment) facilities
- Price of fresh water and industrial water
- Costs for discharging waste water
- Degree of privatisation
  - Of waste water producing industries
  - Of companies/organisations in the water (provision and treatment) sector
- Degree of competitive pressures for and between companies

**Environmental Dimension**

- Warming - lower water table, increased competition for water, availabil-ity of fresh water
- Rising sea levels
- Decrease of Glaciers and glacial melt waters which feed fresh water into rivers
- Droughts and situations of low water leading to inapplicability of waste water discharge systems
- Floods, including flash flooding, leading to the contamination of indus-trial (waste water treatment) facilities
- Changes in local/regional ecosystems and biodiversity

**Technological Dimension**

- Intensity of technology transfer
- Increasing water productivity
- Closed loop systems
- National and international standards for technologies and water qualities
- Competition for emission rights
- Increasing recycling frequency and increasing accumulation of pollutants
- Relevance of process waste vs. product waste
- Concentration/type of contaminants' dilution effects
- Contamination by nanoparticles
- Contamination by complex bio-chemical substances
- Diffuse or non-point sources of waste water

**Framework Dimension**

- International environmental and industrial and development policy and pressure
- Importance and influence of global institutions
- Orientation towards EU-framework/directives
- Transnational intraregional co-operation agreements and mechanisms
- Limitations in access to water management technologies due to intellectual property rights (TRIPS)
- Basin-level water management (T)
- Rise of platforms, organisations and bodies outside of national or international political structures e.g. Global Water Partnership, International Commission for the Protection of the Danube River Basin
- Capacity
  - Integration of industrial, economic and environmental policies
  - Enforcement - control mechanisms and sanctions
  - Longevity – timeline of political and policy decisions
- Implementation and enforcement at local (governmental/administrative) level
- Co-operation with neighbouring administrative districts

**Societal Dimension**

- Urbanisation leads to changed water demand and discharge patterns
- Fragmentation increases non-point sources of discharge and water de-mand
- Civil society concerns and pressures
  - Access and safety fears
  - Awareness of water scarcity and other environmental issues

MINIATURISATION · GLOBALISATION · DEMOGRAPHIC CHANGE · GLOCALISATION · INFORMATION & COMMUNICATIONS TECHNOLOGIES · CONVERGING TECHNOLOGIES · CLIMATE CHANGE

# Appendix 1: Scenarios Workshop: shaping factors and participant list

## 1. Discussion of Factors and Actors in the Scenario Field

During the course of the discussions at the scenarios workshop (11-12 July 2007, Berlin), the following factors were discussed. Some of them are complementary to the initial list on the previous page:

## Identifying Factors

### Economic dimension:

**a) Effectiveness of industrial and economic development in the region and efficient political economy (Complementary)**

The ability to deal with local water and waste water problems would be significantly determined by the whole region's economic growth, structure and future industrial development. An effective political economy in the region is needed as this is the determinant of abilities to deal with (waste) water. An effective political economy is characterised by its high differentiation, high degree of integration (networking and co-operation), and is dominated by the services sector. In an efficient political economy the introduction of new technologies can be subsidised or supported through reimbursements, thus accelerating its implementation. By the same token, water quality may be enhanced.

**b) Reputation concerns of firms (Complementary)**

For international companies, i.e. MNEs, reputational risk is extremely important and they cannot transgress societal values of this sort. Thus, MNEs develop a high interest in environmentally sound water policy. Reputation can be an issue for national companies as well as for international ones, as international firms can exert pressure on local firms to meet their standards (spill-over effect). This links into the question of vertical integration, the degree of competition and the cost of risks.

**c) Environmental rating (Complementary)**

The discussion of the reputation risks for companies led to the idea of environmental rating. Insurance and re-insurance, risk issues (and costs), companies' responses were all mentioned in this context. Environmental ranking was proposed as a means that has to be implemented as it seems to be one of the best ways to solve problems, including possible economic benefits.

**d) Future economic make-up and structure and their attendant waste water impacts**

This is a decisive factor, as the future make-up of the industry and division of labour will be highly heterogeneous within the CEE region. For Bulgaria, food beverages and textiles are the most important future industries, whereas for Poland, mining will still play a dominant role. Thus, the energy sector may be one of the crucial waste water emitters. Countries will need differentiated, fit-for-purpose waste water management solutions. This holds also true for single companies, as they also will need tailor-made solutions for their waste and water management in general, as each industry poses different demands on the quality of their water intake.

**e) Cost-effectiveness-analysis / analytical tools (Complementary)**

New technologies needed, it was felt, to be made cost effective and the analysis of this too.

## Technological dimension:

**a) Waste water as an energy source (Complementary)**

This was seen as a potential income stream for companies implementing such technologies, and as a potential way of dealing with rising energy prices.

**b) Implementation of integrated waste management strategies (Complementary)**

This factor arose from the discussion about the question of how to deal with sludge and by-products of waste water. It was considerer of crucial importance as the processing of these by-products could be more difficult, costly and the substances more dangerous then if they are diluted in water. This had obvious impacts upon whether a zero-emissions policy should be followed and technological implications. The implementation of integrated waste strategies closely links in with the cost of risks, as sludge and by-products do pose general risks for waste water producing actors, as well as with the issue of insurance and environmental rating.

## Framework dimension:

**a) National/ International Standards for technologies and water qualities**

The discussion of technological and economic factors gave rise to the discussion of Best Available Technologies (BATs). This is an instrument, widely used by the EU, making the adoption and implementation of the most efficient and advanced technologies and techniques available compulsory for all member states. What constitutes best available is defined in Best-Reference Documents (BREF-Documents), subject to regular, multidimensional review and revision. It is from this that allowed emissions levels are derived. The BREF-Documents are at present only backgroundpapers for authorities. During the discussion, it was recommended that they should achieve a relevance upgrade. BAT is extremely influential in shaping the future development. As a factor, it includes some of the factors that came up in the discussion, i.e. benchmarking, and complete assessment of production processes. The importance of Pollution Prevention as creating win-win situations was also highlighted during the BAT-discussion when special attention was given to IPPC.

When talking about BAT, the need to consider other wastes and environmental impacts, for example energy needs for implementation of BAT, was highlighted – BAT is not just about water quality, but also about other environmental impacts. The issue of control, also of the stepwise implementation procedures, was also discussed, with the need for effective control within industries and of substances etc. Conclusion of this discussion was that the factor be moved into the framework dimension.

**b) International pressure**

This factor was refined into "Pressure towards enforcement attitudes" (from national through to local level).

**c) Implementation and Enforcement at local (governmental/ administrative) level**

During the discussion, this was split into two new factors, one being "efficiency of the judicial system", the other one labelled "effective control". This split came about when the issue of corruption was mentioned, as corruption works towards an inefficient judicial system and ineffective control mechanisms. Yet both instruments are designed to function independently of each other. Corruption does also play a decisive role concerning privatisation procedures, as there is a lot of semi-legal fiddling between administration, industry and private financial actors in the accession states and EECCA. In addition, corruption may be found in the licence/ concession procedures and within the controlling and monitoring systems.

**d) Simplification and efficiency of administrative procedures (Complementary)**

This was discussed and added with regard to the process of permit issuing as it was felt that more efficient procedures could be more effective and more effectively enforced.

**Societal dimension:**

**a) Demographic change**

Due to decreasing population figures and a brain drain leading to the danger of not having a sufficient, the issue of qualified labour force was mentioned so as to make more precise the impact of demographic change for the region.

**b) Consumer movements**

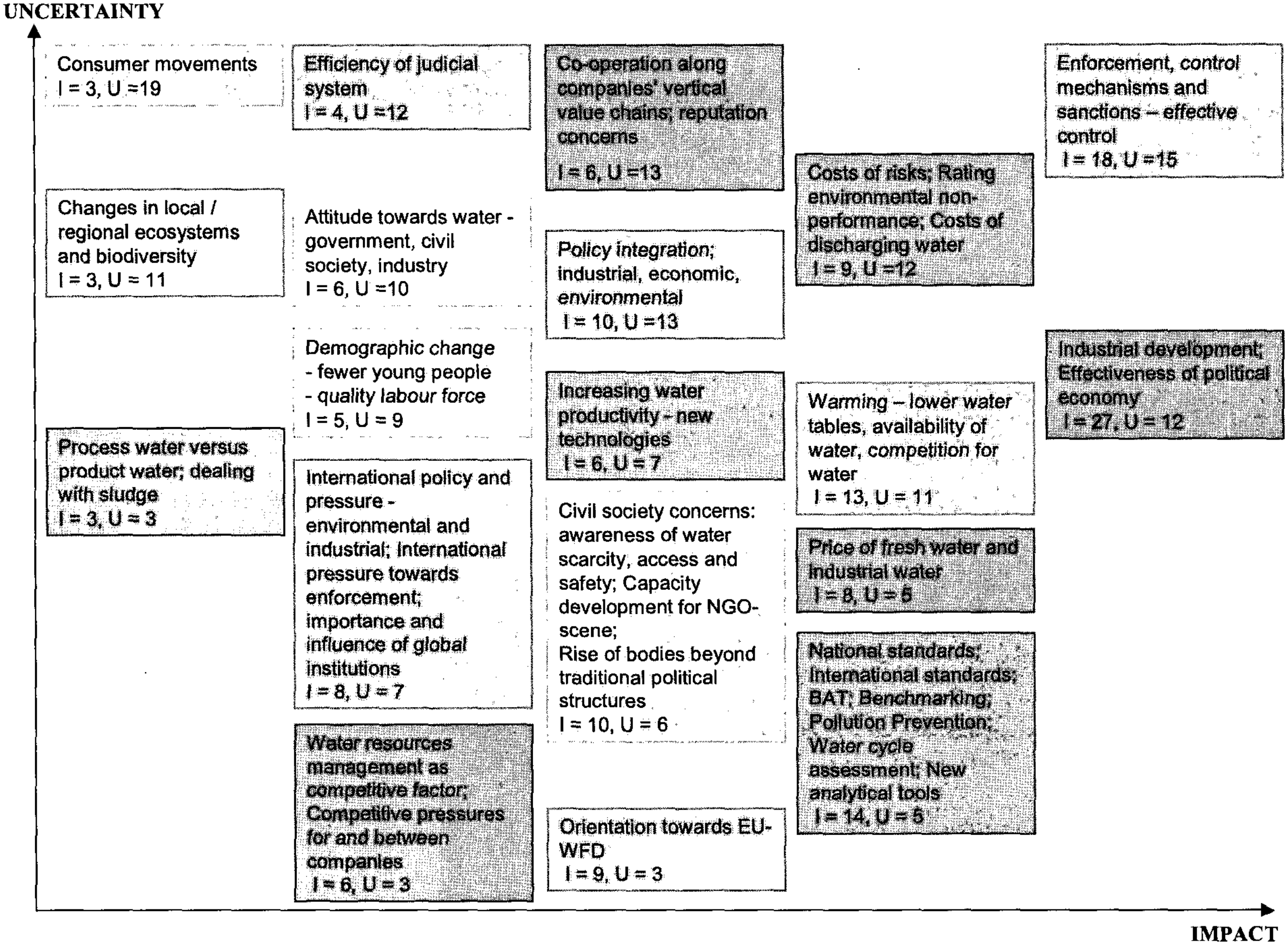
Consumer movements were identified as a potential future driving force in the CEE region. The desire to be able to bathe in rivers, for example, could change in the future and thus change the attitude towards water. Such consumer movements could, however, focus on the price dimension rather than on the societal or recreational dimension of water management.

**c) Capacity development of NGO scene**

The ability of NGOs to shape and determine the agenda was highlighted. Their influence and ability to do so would be strongly determined by capacity building for them to take on their quasi-regulatory role.

## Prioritisation of factors

Following the discussion, participants were asked to rank the original factors and those added to the list according to the impact they would have and according to the uncertainty surrounding the final shape they would take.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Consumer movements I = 3, U =19
Efficiency of judicial system I = 4, U =12
Co-operation along companies' vertical value chains; reputation concerns I = 6, U =13
Enforcement, control mechanisms and sanctions – effective control I = 18, U =15
Changes in local / regional ecosystems and biodiversity I = 3, U = 11
Attitude towards water - government, civil society, industry I = 6, U =10
Policy integration; industrial, economic, environmental I = 10, U =13
Costs of risks; Rating environmental non-performance; Costs of discharging water I = 9, U =12
Demographic change - fewer young people - quality labour force I = 5, U = 9
Increasing water productivity - new technologies I = 6, U = 7
Warming – lower water tables, availability of water, competition for water I = 13, U = 11
Industrial development; Effectiveness of political economy I = 27, U = 12
Process water versus product water; dealing with sludge I = 3, U = 3
International policy and pressure - environmental and industrial; International pressure towards enforcement; importance and influence of global institutions I = 8, U = 7
Civil society concerns: awareness of water scarcity, access and safety; Capacity development for NGO-scene; Rise of bodies beyond traditional political structures I = 10, U = 6
Price of fresh water and industrial water I = 8, U = 5
National standards; International standards; BAT; Benchmarking; Pollution Prevention; Water cycle assessment; New analytical tools I = 14, U = 5
Water resources management as competitive factor; Competitive pressures for and between companies I = 6, U = 3
Orientation towards EU-WFD I = 9, U = 3
IMPACT

## Possible Future Developments of Shaping Factors

As a preparatory step for linking-up shaping factors to storylines and scenario modules two parallel workgroups discussed possible developments and characteristics of the shaping factors prioritised and looked for sudden events or clear breaks from current trends and trajectories which could turn developments of those shaping factors upside-down (so-called "wildcards").

Possible ideas for wild cards to be included in the scenario building process were

- a global market crash
- the disintegration of the EU
- the formation of a union between Russia and neighbouring states
- a global energy crisis
- major emblematic events in the environment like a major drought or a major flood or a major industrial accident
- dramatic political destabilisation of the CEE-region through ethnic conflicts.

Shaping factor **"Industrial development"**. The following was suggested as possible developments:

- Region's development "might go very quickly which would be wonderful or might go very slowly, which would be tragic"
- Differences in the region's future development were identified and economic growth subdivided into very high in Poland and the Baltic states, with the economy doubling by 2025; middle economic growth in the Danube countries – a steady annual increase of some 5%; and high economic growth in the EECCA countries as dirty industry moves out of the EU into those countries
- Within a positive economic path industry remaining will be very efficient in its water and energy use, some branches/sectors would fall away and be replaced by other, high-tech and services sectors. One such sector would be the coal industry, currently a major energy source for the region, which would be replaced by cleaner sources and the coals mines would close.
- An alternative economic and industrial development path would mean a slowly expanding economy unable to mobilise and afford the technologies and resources for achieving zero emissions.
- The actors identified as central for developments in the political economy of the region were Russia, the EU, the relationship of the EU with the resource-holding countries, national governments and multinational companies, given that there currently is no EU energy policy.

**Shaping factor "Environmental factor of warming/water stress".** The following was suggested as possible developments:

- As impact of global warming for the region was predicted that water deficient regions will become more deficient while water abundant regions will become more so, water stress is set to increase. This prospect is reinforced by the ongoing competition for water for food and energy production that has a high impact on local water balance and regional climate.
- Adaptation was felt to be determined by the rate of such climatic changes as desertification in southern Bulgaria and Romania or floods – rapid change would present greater problems than a gradual change.

Shaping factor **"Water price".** The following was suggested as possible developments:

- There would be significant differences in the region between those countries "governed" by the WFD (EU Member States) and those not (EECCA countries).
- For those bound by the directive, the most important issue is that of full cost recovery and its influence on the price of water.
- It was argued that prices would rise steadily and continuously, whilst water quality might very well deteriorate.
- In the case of economic growth leading to price increases, it was mentioned that prices can be increased when it is politically feasible to do so.
- It was noted that in the Ukraine, not governed as it is by the WFD, water prices are rising, but only for water from utilities companies – withdrawal from rivers is not, making water management all the more important.
- There should be increased charges for waste water discharge. To solve the question what these increased charges should be used for, the group agreed that it would be best utilized for environmental action, or what has been called the improvement of the environment. This could be sponsoring of further research towards new water (management) technologies, or investment in the implementation of up-to-date technologies, or sponsoring of local environmental projects.
- The group established a clear link to the economic factor of refinancing mechanisms/ cost recovery mechanisms.

Shaping factor **"Water framework directive implementation".** The following was suggested as possible developments:

- It is not predictable whether nations like the Ukraine would adhere to this directive voluntarily. Neighbourhood policy and external pressure were felt to be the most important aspects influencing this.

- The group wholeheartedly agreed that the WFD was a main driving factor, but that it was also the cause of a major divide, pushing those countries covered by it but not those exempt. It was felt to be a more important driver than IPPC.
- The approach taken by industry also plays a role here, with some industries perhaps trying to "escape" the directive and moving out of the EU. The likelihood of this was, however, felt to be limited as though industry would be able to "flee" the WFD, other location advantages such as a qualified workforce etc. would keep them tied to a location or the EU.

Shaping factor **"Attitudes towards water"**. The following was suggested as possible developments:

- It was generally felt that the trend was towards saving water with decreased consumption by industry and by households noted everywhere.
- Clean water was felt to be more highly valued, also for recreational or aesthetic reasons, and this brought with it greater awareness on the matter.
- The trend towards drinking bottled water was also mentioned, whereupon it was asked whether this meant that industry could pollute.
- It was estimated that if industry was able to pass costs using expensive, new technologies to household consumers it would be willing to implement and use such technologies. It was highlighted that industry is normally very responsive to price increases, responding with increases in efficiency, whilst households do not see it that way and do not respond in the same manner.
- It was felt that civil society pressure would increase in future, especially in light of their increasing internationalisation and greater international co-operation and networking. With a view towards the impact of NGOs on industry, it was agreed that their influence would increase and hence their control on industry.

Shaping factor **"Water infrastructure"**. The following was suggested as possible developments:

- The collapse of water infrastructure was discussed, in particular the situation in EECCA countries, Bulgaria and Romania.
- Infrastructure and its governance may change rapidly from socialist and centralised modes to market and democracy. This can show several consequences. At first it is possible that actors will experience difficulties in adapting to the new governance situation, which possibly results in unnecessarily long bureaucratic processes and the like. It may as well lead to a very diverse situation: where a market for a working infrastructure is seen, it will be provided for (cities), where this is not the case (rural areas), actors will still have to cope with the old, deteriorated infrastructure – if there is a water infrastructure at all.

- One of the dangers discussed was that of failing and superfluous investment as it needs to be found out whether a regionally decentralised or centralised water infrastructure fulfils best the requirements of the new demographic situation. As an effect of regionally decentralised water infrastructure, the complete built-up of industrial sites and even industrial districts with fully integrated waste water management will develop.

Shaping factor **"Demographic change".** The following was suggested as possible developments:

- As population figures will decrease, it is possible that new infrastructure will be built up in order to meet the new demands (e.g. less fresh water, but demands more geographically spread, or higher demands in urban regions (urbanisation), increasing number of non-point sources etc.).
- The group was unanimously of the opinion that this will be done by targeted and well-defined investments that are exactly aligned to the need of the future, that is: smaller population.
- Brain drain and lack of qualified labour force were also decisive issues discussed in this context, as it is especially the young and the skilled that leave the region. There was felt the risk of high-tech waste water systems being implemented without skilled specialists, thus leading to lower efficiency of even environmental danger.

Shaping factor **"Judicial / administrative system".** The following was suggested as possible developments:

- It is a decisive element if water management will be organised on local, regional or national level. [During the workshop, participants agreed that water management will increasingly be organised on local/ regional level, yet according to supra-regional/ national standards, e.g. the WFD]
- It was claimed that there should be a "deal" between local and national administration and companies, since consumer demands towards local companies are most likely to determine companies' compliance behaviour.
- It is feasible not to have one central national authority for water management, but administrative water bodies on municipal level.

Shaping factor **"Consumer movements".** The following was suggested as possible developments:

- Yet, there is no clarity about how such consumer movements will actually look like. One of the main demands of a consumer movement will be that political, environmental and industrial development challenges need to be balanced.

- If that is one of the important issues for the movement, then local elections will become a crucial element as consumer movements will be strongest on local levels. Consumer movements will be so successful that consequently, water issues will be regulated strictly on local level.
- Consumer movements will be constituted transnationally, for example along rivers. One successful case of the power of consumer movements is that around the Danube river: a movement in Hungary claimed that Austria would discharge to much waste into the river. The issue became highly politicised, resulting in Austria changing its behaviour.
- Yet, consumer movements must be also thought of in the opposite direction. If prices generally will rise, for economic reasons, the consumer will turn to cheap priced goods and take health risks.

Shaping factor **"Best Available Technologies / Standards".** The following was suggested as possible developments:

- National standards and their development are discussed in various ways. There is agreement that standards will undergo enormous changes, yet it is not clear which form these changes will take.
- The group developed a common understanding towards a development of lower, i.e. less strict standards due to a compromise between governmental, financial and industrial actors and operative administration, followed by controlled adaptation to BAT as a first step. A crucial element for such a compromise is the (political) power of industry as a lobby group.
- The group detects a clear split of countries' attitude towards the EU-frame. Countries that already accessed the EU or entered accession negotiations orientate themselves necessarily closely towards the Framework. Others, the status of which is unclear, like Ukraine, are quite reluctant with regard to the implementation of EU-standards.
- Even though there is the problem of EU- and Non-EU-States that has to be tackled, the implementation process and harmonisation procedure will still be troublesome. They will differ within different countries, as they have reached different political and technological levels in water management and environmental protection laws. This starting situation cannot be improved by the fact that, although a strong commitment is given, competence and control are not. In general, lack of (efficient) control of implementation is seen as an enormous problem.
- The demand for a commonly accepted (EU-) international controlling body or authority is raised, as this would simplify the matter of control. Such a body should have the right to carry out surprise visits of polluters, i.e. industrial sites, and it should have the power to force single industrial actors, i.e. specific plants, to comply to the standards.
- With regard to the control discussion, the group achieves agreement on a clear distinction between standards and targets, leading to separate consideration of each.

Standards will be changed according to, e.g. the WFD, whereas targets need to be set according to the real local situation.

- The question rises as how BAT possibly can be implemented. When establishing new industrial sites or plants, it is no problem to introduce up-to-date technologies. However, if old plants are still kept in operation, an immense financial problem rises. Therefore, strong incentives need to be introduced for industrial actors in order to foster the implementation of BAT and new technologies.
- Two more problems are discussed on the background of BAT implementation. The practical implementation of BAT is influenced by cooperation between local and governmental level as well as be cooperation between industry and administration, and also by cooperation among industry themselves. As important as that are the financing possibilities, i.e. the resources for standard implementation, and a well-skilled work force and experts.
- Also, a problem is posed by different plant/ company sizes. Does the existence of local rules imply local enforcement? This will be extremely difficult if a large MNE settles in the region. A MNE is easily able to pay the local pollution fines. A local SME is not able to achieve this, as it possible has lower turnover figures etc. In addition, local rules are tailored to fit local companies and not necessarily global players. SMEs are thus put under high pressure.
- Discussion also includes aspects as to what the long-term consequences of implementing the WFD are. The EU runs the risk of literally "cementing" technologies as standards that may be up to date today, yet may be quickly outdated within the following years. This poses a challenge for industry especially in the CEE region, as they probably will be reluctant towards renewing their intra-plant systems following each innovation. Thus, implementation of the WFD may have unwanted consequences in terms of the implementation of old technologies.

Shaping factor **"Increasing water productivity"**. The following was suggested as possible developments:

- There is agreement on the thought that if BAT is finally implemented according to the IPPC-Directive, chances are very good to achieve general water treatment up to 80-85% cleanliness, i.e. 80-85% of water discharged by industry will be literally clean. From such a high degree of clean water, huge economic advantages are expected.

Shaping factor **"Lower water tables"**. The following was suggested as possible developments:

- Lower water tables are a pressing factor, especially for energy industry, as less cooling water is available. This is potentially increased as there is also the problem of thermal pollution. This results in lower water quality.

- In addition, there might be a lack of waste water discharge possibilities, as larger seasonal differences in water table are expected.

Shaping factor **"Waste sector development"**. The following was suggested as possible developments:

- A future option is integrated waste management. Waste water treatment usually leaves toxic, or extremely dirty by-products and sludge, so the question is also how to deal with these things when tackled the problem of waste water.
- Yet, not only will future waste management be highly integrated, but also left to municipal actors, including waste water management.
- This factor could also take a different shape, for example that no clear waste water policy and technology competence exists and thus no integrated waste water management within the CEE-region is possible.
- This factor may as well develop towards the increasing use of reclaimed water, i.e. reusing wastewater that was produced elsewhere. It is important that in such a case the principle of matching water quality to use requirements must be followed, and that the "cradle-to-cradle"-concept is also kept in mind.

## 2. List of participants of the Scenarios Workshop, 11-12 July 2007, Berlin

| | Name | Organisation |
|---|---|---|
| 1. | Tony Allan | Professor of Water and Water Policy, Kings College London and SOAS, London |
| 2. | Galia Bardarska | Institute of Water Problems at Bulgarian Academy of Sciences |
| 3. | Friedrich Barth | European Water Partnership<br>IFOK Bensheim |
| 4. | Bronislaw Bartkiewicz | Warsaw University of Technology, Warsaw |
| 5. | Andriy Demydenko | Ukrainian Center of Environmental and water Projects |
| 6. | Dumitru Drumea | International Association for Danube Research |
| 7. | Joachim Heidemeier | Federal Environmental Office Dessau and International Commission for the Protection of the Danube River Basin |
| 8. | Viktor Kliment | Ministry of the Environment of the Czech Republic |
| 9. | *Pavlina Krecmerova* | *Institute on Water Research* |
| 10. | Krasimira Kuzmanova | Managing Director DELPHIN Projekt Ecotechnica Ltd., Sofia |
| 11. | Milkana Mochurova | Institute of Economics – Bulgarian Academy of Sciences<br>Regional and Sector Economics Department, Sofia |
| 12. | Anna Novotna | Spolana a.s. |
| 13. | Engelbert Schramm | Institute for Social-Ecological Research |
| 14. | Cristian Rusu | Banat and Oltenia River Basin Mangement Plans team, Bucharest, Romania |
| 15. | Dirk Weichgrebe | Institute for Settlement Water Management and Waste Technologies, Leibniz Universität Hannover |
| 16. | Elena Fatulova | GWP – CEE Consultant |
| 19. | Jaime Moll de Alba | UNIDO |

| | | |
|---|---|---|
| 20. | Ferenc Kovats | National Office for Research and Technology |
| 21 | Maura Teodorescu | Institute for Industrial Ecology, Bucharest |

# Appendix 2: Summary of technological aspects of the future of waste water management

The outline of the UNIDO project, the analytical work of IFOK and the expert interviews and discussions during the foresight exercise until now all indicate that waste water technologies are a highly dynamic field, with an increasing variety and quality of ways to treat production processes and water discharges towards enhancing water productivity, lowering emissions of pollutants and diminishing discharge effluents. Beyond pure waste water treatment techniques developments will occur dynamically also in several directions, from concepts of water auditing, product policies and reorganisation of production processes over the technological fine-tuning of the concept of reclaimed water to the implementation of complete new water systems and infrastructures.

All these advanced technologies and techniques presently available and the potential developments in the near future are subject of research and development, discussion or even practise and standardising routines. In so far the present foresight exercise did not and could not identify new techniques shaping the future of the next 10 to 15 years, nor was it possible and necessary to analyse and prioritise specific technologies. The expertise involved made clear that its not the technologies per se driving the future but the technologies as embedded in and linked to industrial, economic, social and political systems. This implies that for example the knowledge about advanced technologies and their practical potential for reaching high water productivity and zero discharge targets to a very large extent is materialised in complex routines and institutional arrangements like Best Available Technologies (BAT). In the context of this small and pioneering foresight the development of BAT therefore is of more interest and value than the in-deep-analysis of specific technology paths.

This is the reason to identify some more general lines of technological developments and fields of application and to search for cases of applied water technologies which illustrate possible and powerful future trends These trends may be summed up along the following lines, which are in part complementary:

- Auditing methods in order to increase water efficiency, eventually realising zero discharge
- Methods and technologies without further (chemical, biological) additives, e.g. water reclamation/ matching water quality to use requirements
- Mechanical water treatment systems, i.e. filtration and membrane systems (classical waste water treatment
- Methods and technologies that apply chemical or biological treatment, i.e. classical waste water treatment technologies

## Auditing Methods

According to water experts, water audits will become increasingly important in the future. Achieving zero-discharge where there has not been zero discharge before is only possible if knowledge is gained about how much water the industrial site is taking in, which processes and products necessitate what quality and quantity of water, and how large the waste water output is – and to what it actually relates. In order to gain this information, a variety of specific technologies is needed as to measure temperature, quantity of output, dosage of pollutants etc. Once this ata is gathered, leakages can be closed, and advice can be given concerning a future orientation towards higher water efficiency either in the production or the product cycle. In addition, it is possible to rate future facilities for reusing the waste water in question. Thus, water auditing is a perfect and promising instrument in laying the ground for achieving zero discharge in existing sites.

## Examples for Auditing:

### Coca-Cola Company (Beverages)

The Company pledges that "The Coca-Cola Company will set specific water efficiency targets for global operations by 2008 to be the most efficient user of water within peer companies. These targets will build on improvements already made by The Coca-Cola Company and its bottlers in water-use efficiency over the past five years, a period where total water use has decreased by 5,6% while sales volume has increased by 14,6%. In that same period water productivity improved 18,6%.

The Company will align its entire global system in returning all water that it uses for manufacturing processes to the environment at a level that supports aquatic life and agriculture by the end of 2010. While water is treated currently to comply with local regulations and standards, the Company has wastewater treatment standards that are more stringent than applicable standards in many parts of the world. Nearly 85 percent of Company and independent bottling operations are aligned with the Company's higher standards, and the Company pledged to align 100% of its entire global system." 1

### Bharat Electronics Ltd, India (Defence Products)

(Auditing → Classical Treatment → Recycling)

"Environmental initiatives: The Company has been maintaining a clean and green environment at all its nine units, which are all ISO 14001 certified. Clean surroundings, green environment, stringent pollution control measures, waste water treatment, zero effluent discharge, rainwater harvesting, energy conservation, water conservation, systematic management and disposal of hazardous and other forms of wastes and several other endeavours have become a part of the well-established Environmental Management System. In a bid to harness renewable energy, the

[1] The Coca-Cola Company 2007: News Release, Beijing, June 5th 2007.

Company commissioned a 2.5 MW Wind Energy power plant in September 2006 at a cost of Rs 13.65 crores in Davangere District of Karnataka. The energy generated by the plant is wheeled through KPTCL / BESCOM grid to the Company's Bangalore Complex for consumption. The total energy generated so far is over 11 lakh units. With the peak generation expected from May to August, the expected generation is around 50 to 60 lakh units per annum. The Company is setting up another Wind Energy Power Plant of 2.5 MW capacity during the financial year 2007-08 in Karnataka"2

"The effluent treatment plants, after treating the domestic and process effluents, recycle them for reuse to meet approximately 42% of the water requirement. Bharat Electronics is a Zero Discharge company as no waste water is allowed to leave the factory premises. Around 2,500 Kiloliters of water is treated and recycled every day. This not only avoids pollution but also conserves a precious natural resource."3

## El Salvador Dairy Companies

A typical dairy company in El Salvador was using 10 litres of milk (and about 80 litres of water in the process) in order to produce one kilogram of cheese. Nearly 9 litres of whey were produced as a byproduct, and were simply discharged into the wastewater. Whey is a highly concentrated organic liquid, containing proteins and lactose. Large dairy companies use ultra-filtration plants to produce pure lactose, additives for ice-cream and other food products from this byproduct. However, this technology is not affordable for small and medium-sized companies.

The solution proposed by the National Cleaner Production Centre in El Salvador was to process the whey in order to produce a marketable whey-fruit drink. Such drinks are available on the European market and are popular with consumers. No additional investment was required by the company in order to process the whey. The estimated benefits were found to be as follows:

- 11.5% reduction in the volume of waste water
- 40,000 mg/l reduction in BOD level in waste water
- 60,000 mg/l reduction in COD level in waste water
- US$ 60,000 per year saving in waste water treatment costs

Other dairy companies in El Salvador are starting to produce this product, and similar programmes are being developed in Guatemala and Mexico. This case study shows that there are substantial financial benefits to be found in waste recovery, hand-in-hand with the goals of reducing pollutant loading and waste water discharge.[4]

[2] www.indiaearnings.com/sub_india/corpannoun.php?sel.comp=BE03 (01. July 2007)

[3] http://www.bel-india.com/BelWebsite/index.aspx?q=&sectionid=30 (01 July 2007)

[4] Grobicki (2007): The future of water use in industry.

**Intel micro-chips**

(Auditing → Recycling)

... the micro-chip manufacturer Intel established the Corporate Industrial Water Management Group to improve water-use efficiency at its major manufacturing sites, which use large amounts of highly treated water for chip cleaning. The group includes representatives from fabrication sites, corporate technology development experts, and regulatory compliance staff. Intel set an initial goal to offset by 2003 at least 25% of its total incoming fresh water supply needs with recycled water and more efficient systems. In 2002, the company exceeded this goal by achieving 35% water savings through recycling water and efficiency gains.[5]

## Methods and technologies without further (chemical, biological) additives, e.g. water recycling and waste reuse

Water recycling is an important future way of achieving zero discharge. Several ways of introducing it are feasible. Quite an efficient way to implement it is within heterogeneous industrial clusters where one industry can use the other's junk as its own treasure. There are various ways, as former cooling water from energy plants can easily be used as intake water for other industries (best case). As there are different water quality levels necessary for different water uses ("matching water quality to use requirements"), it is also possible to reuse water from chip cleaning as intake water for cooling or other without treating the water beforehand, thus also reusing the waste left by other entities as intake. Large and very diverse corporations may even be able to reuse their own waste water on-site. However, depending on how the waste water is specifically polluted – organically? Thermal? Other? – technologies are needed as to measure the pollution and then match the water quality to use requirements. If, for instance, an industrial production site could take in cooling water from a nearby power station, its input temperature might need to be adjusted. It is advisable to find technologies that are cost-efficient and environmentally sustainable. Others would include classical waste water treatment technologies, to be implemented with careful focus on the quality that the water needs to have in order to be reused – which is only in a very few cases that of potable water. As these techniques may often be close to cost-neutral, they have been identified to play a decisive role in future waste water management strategies in the CEE-region. Those methods will be complemented by an overall integrated waste management strategy and the overall concept of reclaimed water.

## Examples for water recycling:

**(Waste) Water Management in Singapore**

(Auditing → Recycling)

[5] Grobicki 2007: The future of water use in industry.

Singapore follows a very strict water policy. Currently, the public sewerage system serves all industrial estates and almost all residential premises in Singapore. All wastewater is required to be discharged into the public sewerage system which is operated by the Public Utilities Board (PUB). Industrial wastewater must be treated to the specified standards before discharge into a sewer or watercourse (if the public sewer is not available). These standards are set to protect the sewerage infrastructure and workers maintaining the sewerage system, to prevent adverse effects on treatment processes at the downstream sewage treatment works, and to protect aquatic life.

Industries generating large quantities of acidic effluent are required to install a pH monitoring and shut-off control system to prevent the discharge of acidic effluent into the public sewer.

Industries may apply to PUB for permission to discharge their trade effluent containing biodegradable pollutants, as determined by their biochemical oxygen demand (BOD) and total suspended solids (TSS) loading exceeding the allowable standards, directly into the public sewers on payment of a tariff. The tariff is levied to recover the costs incurred in treating the additional pollution load at the sewage treatment works.

The water quality of both inland water bodies and coastal areas is regularly monitored. For inland water bodies, the parameters monitored include pH, dissolved oxygen, biochemical oxygen demand, total suspended solids, ammonia and sulphide. Coastal water samples are analysed for metals, total organic carbon and other physical, chemical and bacteriological parameters.

The provision, operation and maintenance of sewerage system is governed by the Sewerage and Drainage Act (SDA). The treatment and discharge of industrial wastewater into public sewers are regulated by the SDA and the Sewerage and Drainage (Trade Effluent) Regulations. These sewerage Act and Regulations are administered by PUB. The discharge of wastewater into open drains, canals and rivers is regulated by the EPCA and the Environmental Pollution Control (Trade Effluent) Regulations. The EPCA and its Regulations are administered by PCD."6

## (Waste) Water Management in St. Petersburg, Florida, USA

(Auditing → Recycling)

The city of St. Petersburg in Florida, USA, is the first municipality in the world to have achieved zero effluent discharge to its surrounding surface waters. Situated on a bay, which is a major tourist attraction, the city has laid an extensive dual-reticulation system. All the domestic and industrial wastewater generated is treated to a high standard. The reclaimed water is then reused for irrigation and industrial cooling applications by thousands of customers, accounting for nearly half of the city's water needs of 190 Ml/day. By substituting reclaimed water for potable water in many applications, the city has eliminated the need for expansion of its potable water supply

[6] http://app.nea.gov.sg/cms/htdocs/article.asp?pid=1528#water (01 July 2007)

system until the year 2030. Equally importantly, there is no pollution of the beaches and marine ecosystems by municipal wastewater, and no unsightly sea outfalls.[7]

[7] Grobicki (2007): The future of water use in industry.

### Mechanical water treatment systems

*Mechanical filtration or evaporation systems form the first step of today's waste water treatment.* When waste water is passed on the public sewage system, it is run through large filters in order to separate solids from the then still polluted water. These purely mechanical filtration systems may be complemented by nano-technology or different membrane filter systems that are able to filter other organic (nano-) particle so as to reduce the pollution. Such systems could be included into any industrial site, allowing not only for the reuse of the sludge/ by-products, if they are organically valuable, but also reducing the general load of the water released into the public system or directly into surface/ ground waters.

## Examples for mechanical water treatment systems:

### Millar Western – A zero-Effluent Pulp Mill CANADA (Pulp & Paper industry)

*(Mechanical)*

"The most challenging environmental problem for pulp mills involves polluted effluent discharged into natural water systems. When Millar Western decided to build a new pulp mill at Meadow Lake, Saskatchewan in western Canada, the company faced an unusually difficult situation. The area was blessed with high quality aspen pulpwood, access to power, good transportation and a quality work force. But one piece of the puzzle needed to be found. The Beaver River, the only water source available, had an extremely low flow and in winter the entire river froze. The river was virtually a pristine water body which it was judged could not accept effluents from a pulp factory no matter how clean.

So the company made a strategic decision to try to close the loop and go for zero effluent discharge. Water recycling is extensively practiced in the pulp and paper industry. But the degree to which water systems can be closed is always limited by the build-up of contaminants in the system. The bleached chemi-thermomechanical pulp (BCTMP) used by Millar Western allowed organic extractives and inorganic salts to enter the wastewater at the rate of 200 kilograms per ton of pulp. In order to recycle wastewater, these residues must be removed.

The company chose the evaporation process. Every drop of wastewater is collected and solids removed by sedimentation and floatation. The clarified liquid is then evaporated to produce clean distillate which can be recycled back into mill processes.

The solid residue is then concentrated and burned in a recovery boiler. The inorganic fraction, 84% sodium carbonate, is solidified into ingots and stored at a secure land fill. The company is currently working with research organizations to find ways to convert the salt into caustic soda or peroxide which could then be recycled back into the mill.

Millar Western and its consultant, NLK Consultants Inc., chose the evaporative process in 1992. Just 24 months later the plant came on line and within budget. Four months later the plant was producing high quality pulp at an average rate of 710 tons per day, in excess of design capacity of 680 tons per day. Now five years later, production and quality have never been affected by the zero effluent treatment system. Company officials say that reliability of their treatment system exceeds that of biological control systems and that operating costs are competitive with conventional treatment."8

## Methods that apply chemical, physical or biological treatment

These are the most commonly used methods to clean toxic/ highly polluted waste water and complement the traditional mechanical methods. It is expected that with new developments of bio- and nano-technology, as well as other complex or converging technologies, there will be an immense upturn in waste water technology, being applicable for the CEE-region as well. Nano-Materials can be used as separators, thus separating the pollutive particles from the H2O-compund, leaving clear water and by-products. Clear water is then easy to reuse, whereas, in connection with an integrated waste management strategy, by-products are either simple to deal with, or can even be split up and recycled as well.

## Examples for biological treatment:

### Holland America Ships

(Biological treatment –> Recycling)

"Holland America has installed a revolutionary water treatment process aboard its 1266-passenger ms Statendam and 1440-passenger ms Zaandam that will purify grey and black water to near-drinking water quality before discharge. Following U.S. Coast Guard certification of the treatment plant, which begins this week, Holland America will install the wastewater treatment system at a cost of U.S.$2.5 million each on three additional Alaska-bound vessels before May 2002. ...

Developed by ZENON Environmental Inc. of Oakville, Ontario, Canada, the treatment plant processes wastewater through a two-step bio-chamber stocked with bacteria that break down and consume harmful bacteria and chemicals.

Water then passes through a patented ZeeWeed(R) filtration system. ZeeWeed(R) filters the treated water by using a slight vacuum to suck the water through thousands of tiny tubes with a .03-micron pore size that allow only water molecules to pass. Suspended solids are left behind in the ZeeWeed(R) filtration chamber.

Filtered water finally passes through ultraviolet light as a final polishing stage before discharge. The discharge water is pure and would meet Environmental Protection Agency (EPA) drinking water standards except for a slight saline content."9

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[8] Taken from: http://www.un.org/documents/ecosoc/cn17/1998/background/ecn171998-bp13.htm (01 July 2007)

[9] http://www.waterandwastewater.com/www_services/newsletter/july_30_2001.htm (01 July 2007)

**Namakwa Sands (South Africa), Part of Anglo American (Mining)**

(Biological and mechanical treatment)

"Mining giant Anglo American's Namakwa Sands heavy-minerals mine is realising the benefits of an acid water neutralisation technology patented by the CSIR and implemented by Gauteng-based engineering company Thuthuka Project Managers.

Namakwa Sands is in the process of replacing its neutralisation process with an integrated limestone/lime process developed by the CSIR.

The mine is currently using lime to neutralise its acidic effluent water, which is generated during the production of zircon and rutile from beach sand.

By replacing lime with limestone, significant cost benefits can be achieved because of the lower cost of limestone.

Approximately R8/m_ can be saved during limestone/lime treatment compared to lime treatment alone. The new CSIR technology will reportedly allow Namakwa Sands to realise cost savings, as the cost of limestone is lower compared to lime.

The CSIR has conducted experiments to determine the feasibility of neutralising the acidic effluent water with limestone and to identify a suitable source of limestone for Namakwa Sands.

CSIR laboratory studies showed that it was possible to reduce the acidity, iron- and sulphate-content of acid water by making use of calcium carbonate (limestone) neutralisation followed by pH adjustment with lime. With sufficient aeration, the water quality can be improved and re-use of the water is possible or, where compliant, the water can be released into the environment. The process involves collecting the acid effluent and treating it to acceptable standards, either for recycling as process water back to the plant, or to a standard suitable to return the water back to the environment.

"A big advantage of this process for Namakwa Sands is that it has the potential to reduce the fresh water demand as the recovered water can be re-used at various other areas inside the plant. This represents a huge saving in raw water intake for the plant, and at the same time addresses the environmental issue," the TPM project manager, Hennie Cronj said.

The design and construction of the new acid water neutralisation plant for Namakwa Sands is being project managed by Thuthuka Project Managers as a turnkey project. Thuthuka is also responsible for obtaining process guarantees from the CSIR. The plant is expected to be up and running by mid 2005.

Increasing demand for the CSIR-patented technology from all types of industry as the process keeps on proving itself and as end-users realise the potentially huge cost-savings inherent in the process."10

[10] http://www.miningweekly.co.za/print_version.php?a_id=62521 (01 July 2007)

## Appendix 3: Annotated List of References and Resources

Catchment-scale modelling of European water resources - Enabling technologies from Framework 5; Abstract by R. V. Moore: Participatory Scenario Development and Sustainable Water Policies; Abstract by C. Pahl-Wostl: An Integrated Framework for International Scenario Analysis of Europe's Waters; Abstract by J. Alcamo.

COS as part of ERA-Net ForSociety (03-12-04) *Discussion paper on the foresight workshop on transnational water management and policies* http://www.cos-toekomstverkenningen.nl/foresightconference/workshops/3/0c.doc

Discussion inputs from participants.

COS as part of ERA-Net ForSociety (26-08-04): *Report from the foresight workshop on transnational water management and policies* http://www.cos-toekomstverkenningen.nl/foresightconference/workshops/3/0b.doc

Information on the importance of the topic as well as threats and challenges and the role of foresight European country comparison.

European Commission, DG research (07-03): *Abstracts of scenarios on European water from the Mediterranean see to central asia.* http://ec.europa.eu/research/water-initiative/pdf/water-scenarios_abstracts_en.pdf

European Commission, DG research (19-03-06): *Knowledge generation and innovation technologies for sustainable water management - concepts and tools developed and applied by the EC DG research for the 4th WWF* http://www.wwf4europe.org/index.cfm/site/B6F37B86-F605-374B-13337754D09CFCF3/pageid/032D8630-E0A5-52FC-579E78222482B849/index.cfm

Information on technologies developed and strategies implemented; quite interesting case study on waste water.

Governments of Norway and Sweden and the Stockholm international water institute : *Making water a part of economic development - the economic benefits of improved water management and services* http://www.siwi.org/downloads/Reports/CSD_Economics.pdf

*List of the varied benefits - health, econoimc development, ecosystems* etc; costs involved, economic cost-benefit analysis; conclusion: investing in water is good for business - very interesting, broad view of thing, stong business focus.

IWRM (Integrated Water Resource Management)-Net (10/11-01-07): *Report from the 1st international workshop on the state of water research and research gaps* http://www.iwrm-net.org/IMG/pdf/IWRMNet_London_wshop_rep_final-2.pdf

Presentations of the current state of research - challenges, technical issues, sustainable water resources management, social learning. Group work on: characterising the environment, environmental objectives, pressures and impact assessment, socio-economic issues, monitoring and indicators. *Strong WFD focus and its research needs; little by way of practical* recommendations; interesting list of participants.

OECD (2005): *Financing Water Supply and Sanitation in Eastern Europe, Caucasus and Central Asia,* http://www.oecd.org/dataoecd/29/46/36388760.pdf.

Proceedings from a conference of EECCA ministers of economy/ finance and environment and their partners – Review of guiding principles for reform of the urban water sector in EECCA, agreed upon in 2000.

OECD (2006): *Offprint of Infrastructure to 2030: Telecom, land transport, water and electricity – Chapter 5.*

The impacts of Change on the Long-term future Demand for Water Sector Infrastructure; http://www.oecd.org/dataoecd/49/8/37182873.pdf Develops on future expenditures of water infrastructure, compares EECCA countries and western industrial countries.

OECD (2007): *Business and the Environment - Policy Incentives and corporate responses,* http://213.253.134.43/oecd/pdfs/browseit/9707091E.PDF

An assessment of the effects of environmental policy and other factors on environmental management, performance and innovation. Empirical analyses of determinants of: having in place environmental management systems/ tools; undertaking investments to reduce environmental impacts; investing in environmental-related research and development and other. Very broad, no special water focus.

UNEP, GFC and varios Japanese ministries (2005): *Water and wastewater reuse - an environmentally sound approach for sustainable urban water management* http://www.unep.or.jp/Ietc/Publications/Water_Sanitation/wastewater_reuse/index.asp

Wastewater reuse and the environment - Requirements for wastewater reuse - Wastewater reuse applications - including in industry - Factors and capacity Section on industrial use of recycled water provides a good overview.

UNIDO (2000): *Economic transformation, industrial potential and current status of integration of the CIS countries: the role of science and high-technology.* http://www.unido.org/doc/4975

Deals with: economic transformation, industrial potential and current status of the CIS countries. The paper presents major trends in the CIS economic reforms, national similarities and differences, comparative analyses of the industrial potential (1992-1999), deals with the role of extrenal factors and elaborates on the critical state of relevant research and development in the countries concerned. It also identifies areas for UNIDO policy advice.

UNIDO (2000): *Foresight: A tool for pre-accession countries to face the challenges of globalisation and integration.* http://www.unido.org/en/doc/4976

A short overview and background information on the methods and experience of the various national foresight exercises from the viewpoint of less developed countries. The study lists challenges to be faced by transition economies of Eastern Europe and CIS, and offers recommendations for initiating national, regional and interregional foresight programmes and for possible supportive actions of international organizations.

UNIDO (2000): *Transboundary pollution and environment management in Europe and CIS region.* http://www.unido.org/doc/4978

The paper treats transboundary pollution and environmental management in Europe and CIS region. Looks at the Danube as a source of serious concern/ example, and into the necessary relevant legal instruments for environmental protection as well as an effective management of industrial process taking pollution cost into account. Different forms of governance which can be applied to environmental protection are dealt with.

Water Supply and Sanitation Technology Platform (2005): *European Vision for water supply and sanitation in 2030*, http://www.wsstp.org/Shared%20Documents/WSSTP%20report%20for%20public%20consultation/Vision%20documents%20(comments%20to%20Kiwa)/Draft%20merged%20Vision%20document/Vision%202030%2007-10-05.pdf

Paints a picture of what could be achieved by 2030 if resources for research and development would be made available and targeted to respond to the issues and challenges that the European water sector is facing. Conceived and drafted by five working groups, consisting of water sector experts and representatives of water sector stakeholders.

Water Supply and Sanitation Technology Platform (2006): *Strategic research agenda - water research: a necessary investment for our common future*, http://www.wsstp.org/Shared%20Documents/WSSTP%20report%20for%20public%20consultation/Strategic%20Research%20Agenda%20documents/Strategic_Research_Agenda_2006_WSSTP_final.pdf

Identification of major challenges, Identification of research areas, Integration of pilots (including in industry).

Water Supply and Sanitation Technology Platform (2007): *Implementation plan of the water supply and sanitation technology platform.* http://www.wsstp.org/Shared%20Documents/WSSTP%20report%20for%20public%20consultation/Strategic%20Research%20Agenda%20documents/Strategic_Research_Agenda_2006_WSSTP_final.pdf

Using a systems approach, which encompasses water supply, sanitation, water use in agriculture and industry and river basin management, the Implementation Plan to develop solutions for the global water market. In an increasingly water stressed world, the Water Supply and Sanitation Technology Platform (WSSTP) will deliver major advances in the efficiency of water use, environmental protection and balancing the competitive demands for water resources.

Water Supply and Sanitation Technology Platform, Thematic working group 3 (2007): *Water in industry - vision document and strategic research agenda,* http://www.wsstp.org/twg3/Shared%20Documents/TWG3%20final%20draft%20VDSRA-JAN2006.doc

Rationale and methodology; details of the visions developed by the working group, including drivers, challenges, needs and goals; strategic research agenda of topics per sector.

World Business Council for Sustainable Development (2005): *Water facts and trends*

World Business Council for Sustainable Development (2006): *Water scenarios to 2025 - Business in the World of Water*

Differing scenarios for hydro, rivers and oceans with different foci (efficiency, cooperation, regions etc.); Strong focus on the role of business and on certain regions; interesting shaping factors.

World Water Council (2000): *The World Water Vision*

*Chapter 3: Water futures* http://www.worldwatercouncil.org/fileadmin/wwc/Library/WWVision/Chapter3.pdf Development of scenarios, key drivers etc, broad view of things.

*Chapter 4: Our vision for water and life in 2025* http://www.worldwatercouncil.org/fileadmin/wwc/Library/WWVision/Chapter4.pdf The vision

*Chapter 5: Investing for the water future* http://www.worldwatercouncil.org/fileadmin/wwc/Library/WWVision/Chapter5.pdf ,closing the resource gap, role of financial institutions, activities for the implementation of the vision - strong financial focus.

World Water Council (2006): *Report on Europe from the 4th World Water Forum, Mexico 2006* http://www.worldwaterforum.org/home/home.asp

On Europe – IWRM - Innovations in risk management - Sanitation as a challenge for the region - Innovative technologies and their implementation - Access for all - solidarity among water users - Strong focus on the situation in Europe and what other regions in the world can learn.

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