



**Emerging New Technologies
for Clean Production and Water Treatment**
Supporting the Development and Market Introduction of ESTs

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Background: ETAP, EU Environmental Technology Action Plan, 2004-

- "Innovative environmental technology for competitiveness"
 - Encouraging the development and wider use of environmentally sound technologies (ESTs)
 - Facilitating sustainable developments in the broad sense
- => Need for improved testing, performance verification and standardisation

Defining Environmentally Sound Technologies

ETAP/Agenda21

- **ESTs protect the environment**
 - being less pollutive
 - using resources in a sustainable manner
 - recycling, handling residual wastes
- **ESTs cover products, processes and services, as well as systems incl. managerial and organisational procedures**
- **Emphasis in technologies that generate less pollution and waste**
- **End-of-the-pipe technologies covered as well**

Environmental Technology Verification:

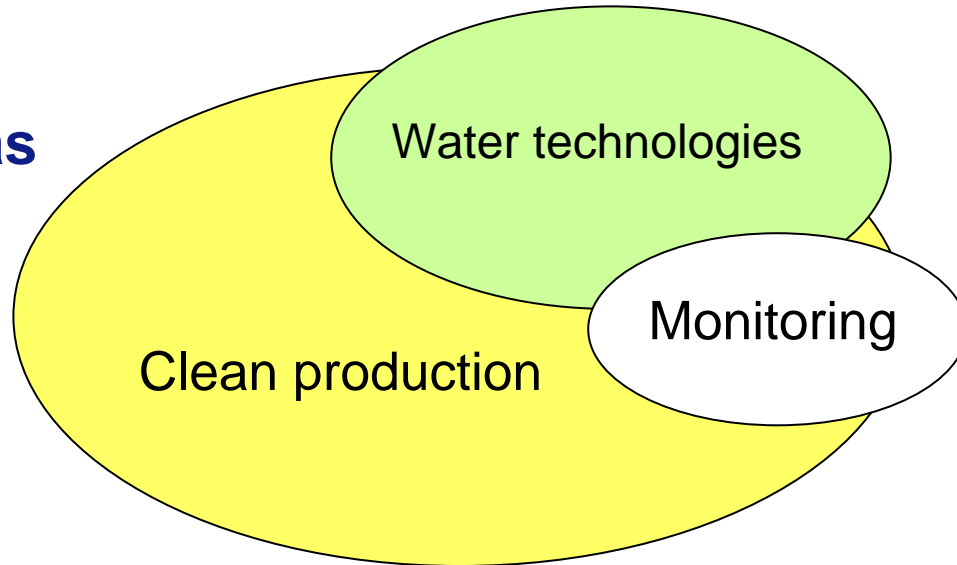
One of the tools for pursuing the ETAP targets

- **The objective of an ETV system is to enhance the application of innovative ESTs**
- **Provides reliable performance information to**
 - purchasers and permittees
 - vendors and developers
 - policy makers and regulators
- **Examples:** U.S. EPA ETV Program, Canadian ETV program, ...
- **European ETV system under consideration in several EU research and demonstration projects:** EURODEMO, TESTNET, PROMOTE, AIRTV, LIFE-projects,...

TESTNET

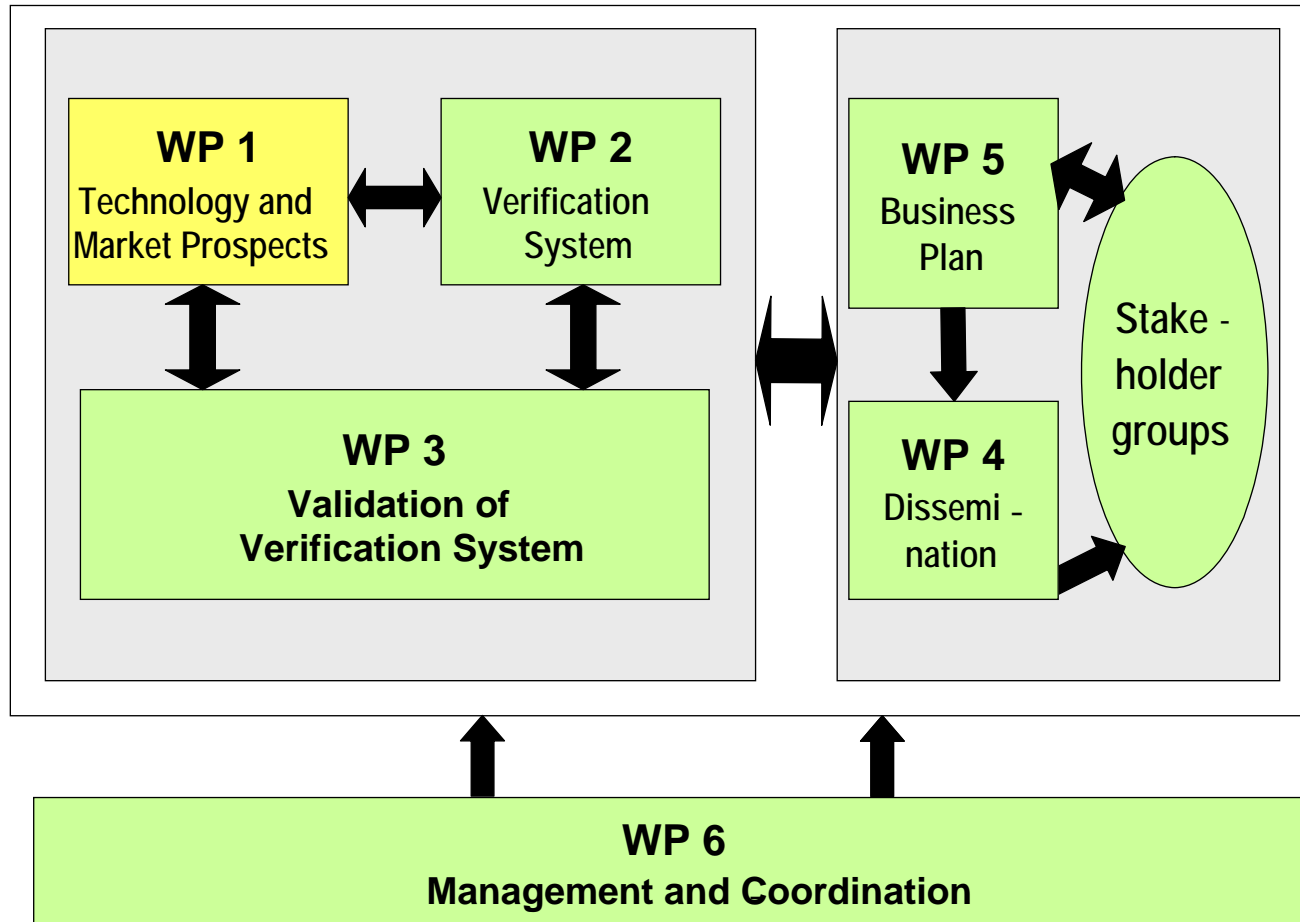
" Towards European Sectorial Testing Networks for ESTs"

- **Technology focus areas**



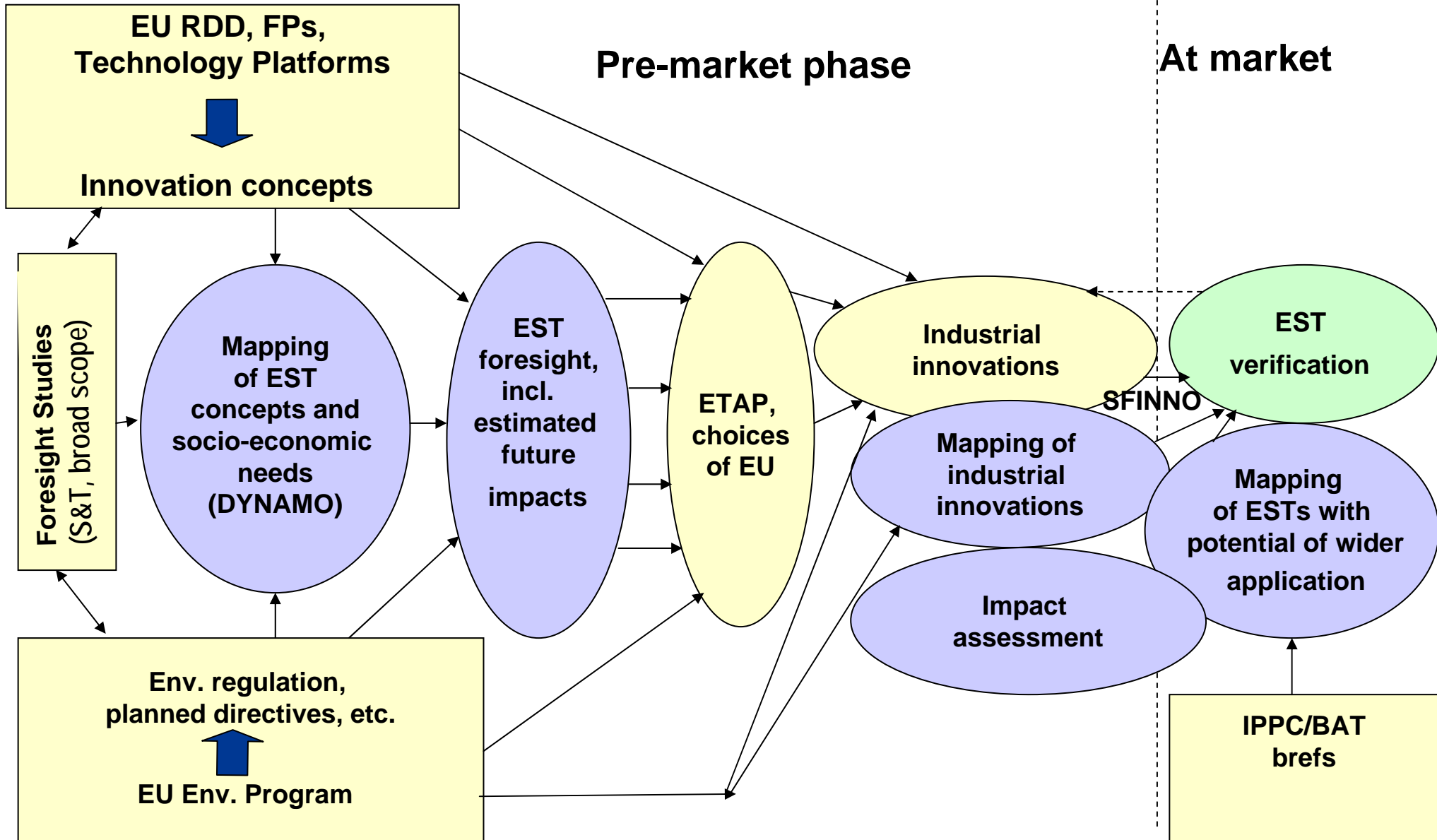
- **Project partners:** TNO (cordinator), ADEME, DHI, EUCETSA, EXERA, GIG, Inasmet, IVL, IPTS, KIWA, NCSR, VTT (WP1 leader)
- Project website: www.est-testnet.net

Contents and structure of the TESTNET project



CONTENTS OF TESTNET WP1

WP2, WP3



Three levels of WP1 contribution

1) Providing information for the other TESTNET WPs

- prospective information on the types of ESTs to be verified
- cases to be selected, arguments for selection
- material for seminars and newsletters

2) Facilitating the market introduction of the European Verification System

- illustrating the potential of ESTs with the help of structured reports
- informing stake-holders in relevant terms
- supporting the development of a reasonable business model for European ETV

3) Serving the European decision makers in a wider sense

- outlining the essential features of the future technological developments
- highlighting their potential environmental, economic and societal impacts
- providing well-grounded information for ETAP (Environmental Technology Action Plan)

Case “Water Quality Monitoring”

Future challenges and drivers (WSSTP, 2005)

- Climate change and extreme events
- Globalization and urbanization
- Increasing water stress
- Rural and underdeveloped areas in need

Potential solutions (WSSTP, 2005)

- Integrated water resource management
- Balancing demand and supply
- Ensuring quality and security
- Reducing negative environmental impact
- Novel approaches to the design, construction and operation of water assets
- Establishing an enabling framework

=> Development of environmentally sound technology, incentives, regulation, norms, standards, voluntary agreements, ETV systems....

VTT Roadmap for Water Technology Research

PESTE analysis

- Political and regulatory challenges
- Economic challenges
- Social challenges
- Technological challenges
- Environmental challenges

for shorter and longer term developments (5,10 and >10 years)

Identifying promising technologies

- sensors
- measurement technologies
- monitoring systems

within 5, 10 and >10 years

Table 1. Water quality monitoring related societal challenges identified in the VTT Water Research Roadmap 2006.

Challenges	Short-term (5-10 years)	Mid-term (5-10 years)	Long-term (over 10 years)
Political and regulatory challenges	<ul style="list-style-type: none"> • More stringent regulations and requirements (REACH, water directive, CPD/EAS), impacts on the use of existing chemicals and on environmental monitoring 	<ul style="list-style-type: none"> • More stringent regulations and requirements • Tighter requirements on pretreatment and reuse of waste • Emphases on product responsibility 	<ul style="list-style-type: none"> • More stringent regulations and requirements, target levels on emissions and pollution • Need for closed cycles • Limitations on energy and clean water use
Economic challenges	<ul style="list-style-type: none"> • Higher water treatment costs • Limited resources for maintenance and of infrastructure • Asset management 	<ul style="list-style-type: none"> • Economical and energy efficient production processes 	<ul style="list-style-type: none"> • Infrastructure maintenance
Social challenges	<ul style="list-style-type: none"> • Risk management and security of water services • Environmental monitoring 	<ul style="list-style-type: none"> • Reduction of waste production and need for sorting and re-use and re-cycle of waste. • Environmental monitoring, environmental security, especially unusual situations (environmental/political/industrial) • Sufficiency and access to clean water resources • Development of household and waste water treatment. 	<ul style="list-style-type: none"> • Ageing infrastructure, maintenance of infrastructure, and the improvement of efficiency • Environmental monitoring, new methods. • Monitoring of old land fields • Sea traffic risks and monitoring.
Technological challenges	<ul style="list-style-type: none"> • Lean processing • Improvements in process chemistry and application of molecular biology. • Process optimization (on line- measurements and control • Water treatment optimization • Lifecycle management of network components, new methods for monitoring and condition evaluation • The systems for decision making and asset management, integration of modeling and measurements • Monitoring of new toxics and other harmful compounds 	<ul style="list-style-type: none"> • Improvements in lean processing • Process optimization (on line measurements, monitoring and management) • Closed cycles • Security and safety • Fast and sensitive detection methods for problematic microbes (PCR) • New tools for decentralized monitoring and control • Comprehensive maintenance systems • ICT and GIS applications and risk management 	<ul style="list-style-type: none"> • Functionally optimized process technology for production control • No waste processes, use of by-products • Comprehensive monitoring and control of the quality of process waters • New process solutions for less production phases • Energy saving technologies • Process optimization (online measurements and management) • Efficient methods for environmental monitoring, integrated continuous control, alarm and management within the water chain. • Intelligent integrated control systems and decision making tools, e.g. programs and maintenance data bases and application of real option theory • New treatment and cleaning methods
Environmental challenges	<ul style="list-style-type: none"> • Environmental issues • Monitoring and reduction of harmful compounds and their impacts, substitution • Environmental safety and security • Reduction of negative environmental impacts 	<ul style="list-style-type: none"> • Need for environmental sound and energy efficient technologies • Changes in the quality of disposal waste. • Water cycles and their vulnerability 	<ul style="list-style-type: none"> • Improved monitoring and management of the state of the environment • Access to drinking water global problem • Extreme weather conditions emerging from climate change, dry and wet seasons. Flooding and other challenges for infrastructure.

Table 3. Water quality monitoring and related technologies identified in VTT Water Research Roadmap 2006

Technology areas	Short term (< 5 years)	Medium term (5–10 years)	Long term (> 10 years)
Sensors and measurement technologies	<ul style="list-style-type: none"> • Nanosensors • Wireless measurements for decentralised control systems • Wireless sensors, micro sensors, diverse applications of sensors • Alarm systems • Selective fast measurements • Computational sensors (soft-sensors), along the advances in chemistry more accurate data for computation • On line –measurements • The development of reactive walls • decentralized measurement techniques for the removal of nutrition • Online toxicity tests for sludge process monitoring • Continuous sampling and treatment to define chemical parameters for the process development • Reliable and noise-free sample technologies, clean surfaces • pH, redox and conductivity measurements 	<ul style="list-style-type: none"> • Inexpensive tags for underground tubes and components • Online sensors for microbiological parameters based on molecular biology and nanotechnology • Fast and accurate leaking detectors for municipal infrastructure and real estate networks. • Reliable computational sensors (soft-sensors) based on the automation data • The use of tag networks technology • Chemical online measurement tools for process control • Decentralized monitoring based on online measurements • Remote control based on online measurements • pH measurements, continuous high temperature • Biosensor applications, nanotechnology, membrane techniques, immobilization techniques, enzyme techniques • Continuous online sampling and sample treatment to define chemical parameters for the process development and control • Noise-free and continuous water Ion measurements • Measurement of coagulates and sample requirements 	<ul style="list-style-type: none"> • Integration of monitoring and water treatment • Risk management based on data collected with measurement sensors • Water quality and condition monitoring sensors integrated in components • Intelligent biosensors (improved robustness with numerical and statistical methods) • Use of tag network technology • Biosensors • Wireless self-controlling measurement methods
Monitoring systems	<ul style="list-style-type: none"> • Models for chemical conditions (multi-phase models for dynamical chemical equilibrium (thermodynamics, surface phenomena, multiphase chemistry) data-mining • Models for follow-up of the changes in the soil and groundwater environment • Utilization of models for the follow-up of air and water emissions • Fast monitoring and diagnostic technologies for the foresight of low processes (corrosion, microbiological processes) • Bioreactor techniques, the recycling of infiltration water and the integration of monitoring and modeling • The use of sensor measurement data in the development of risk management systems and analysis. 	<ul style="list-style-type: none"> • Dynamic models and their validation with dynamic measurements • Onsite modeling (e.g. trouble-shooting) • Application of fuzzy modeling methods • Improvement of the reliability of models • Monitoring tools to measure water quality and tube component interactions • Real estate and process specific reliable and inexpensive water quality monitoring methods • In-situ monitoring and GPS systems for decentralized control • Integrated monitoring and measurement methods • Automated control and follow-up systems • Electrochemical walls • Effluents • Online monitoring of effluents and sludge computation models • Specific online definitions on harmful substances • Intelligent control systems • Integration of monitoring and water treatment • Integration of sensor systems in risk management systems and analysis 	<ul style="list-style-type: none"> • Follow-up models integrated in risk management systems • Simulation methods in the continuous monitoring and control • Integrated intelligent solutions to control security and safety of network components during their lifetime by the optimization of water quality and the application environment • Automatic monitoring of old land fields • Monitoring of the decomposition of harmful substances and their toxicity • automated control and monitoring systems integrated in the processing of measurement data • Electrochemical walls in wide use • Automated processing of data and linkages between databases. • New optimized process automation technology that use reliable and online measurements and advanced simulation

Linking ETV and Technology Foresight

- **Creating shared understandings between stakeholders**
- **Facilitating sustainable developments**
- **Stimulating environmentally sound innovations (ESTs)**

Developing appropriate approaches and practices for **information gathering, stakeholder consultation** and **prospective reporting** within the framework of the TESTNET project

www.vtt.fi