APPROACH FOR TWI (TECHNOLOGICAL WATER INNOVATION) IDENTIFICATION

PIANO PROJECT WORK PACKAGE 2

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P.I.A.N.O.
Policies, Innovation And Network for enhancing Opportunities for China-Europe water cooperation
中欧水源合作机会增进政策，创新和联网

PIANO WP 2 Objectives

Identify & **prioritize** European **technological water innovations (TWIs) with potential for application in China;**

Identify **water challenges** where no/few suitable technologies exist resulting in **opportunities for joint development** of technological solutions.

Agriculture

Municipal

Industrial

RBM

Energy

PIANO WP 2: output overview

- **Chinese Water Challenges document covering main water issues in China within the 5 water domains.**

- **5 European and 5 Chinese gross lists containing up to 40 TWIs per domain.**

- **2 EU Inventories**
  - **Inventory I - Full inventory containing up to 20 European TWIs per domain**
  - **Inventory II - Targeted inventory** containing up to 10 innovative European TWI solutions. Result of **scoring/ranking procedures** to determine which TWIs have highest potential for implementation in China.

Gross list of TWIs

	Category	Sub-category	?	Description of TWI	Examples of	TRL
2	water use technologies	irrigation technologies		No. 15 Fruit gauge, based on a linear potentiometer which, interfaced to a wireless data-logger system. The fruit sizes are used as a growth indicator to predict optimal irrigation schedule		7
3			Monitoring tools	No. 22 Wireless Sensor Network to monitor water salinity by measuring electrical conductivity of water in rice paddies, irrigation channels, pumping stations and drainage channels	SMART-PADDY	8
4				No . 19 Automated single ring infiltrometer with a differential pressure transducer to quantify the cumulative infiltration into the soil, thereby allowing a quick field estimate of saturated soil hydraulic conductivity and soil sorptivity.		7
5				No. 29 Capacitive sensor to continuously monitor soil water content to schedule irrigation management in real time	HygroLog	7
6			Integrated irrigation and fertigation system	No. 32 Smart fertigation system: irrigation and fertilization approach with sensor and software to meet actual crop demands	SIFA	4
7				No. 10 Irrigation Advisory Service DSS, including fertilization, supported by a network of automatic weather stations and user information input (location, soil, crop, irrigation technology and seeding date)		7
8			Decision Support System (DSS)	No. 1 DSS: Integrated systems of irrigation management. Irrigation based on crop water demand determined in real-time from rainfall and estimated evapotranspiration, run-off and infiltration.	IRRIFRAME	8
9				No 20. DSS: estimation of national and regional irrigation demand based on geographic information system (GIS) for collective planning	SIGRIAN	8
10				No. 8 DSS: SCADA remote control system, based of the qualitative parameters of treated water to be used for irrigation purpose		8
11				No. 6 Real-time estimation of irrigation demands from remote sensing products (satellites). Real-time reporting to farmer and water managing institutions via web and text messaging	Irrisat (www.irrisat.it Italian website, www.irrieye.com English website)	8
12				No. 16 DSS: Ground-based multisensory platforms, equipped with soil and plant sensors (geophysical sensors -EMI, GPR-, passive hyperspectral sensor and active radiometric sensor connected to a DGPS) for improving irrigation water use efficiency		7
13				No.3 DSS- Integrated Irrigation Management Systems: sensors and software. Estimates irrigation water demand from measurements of soil water content, local weather and estimated evapotranspiration.	WiSense Basic, WiSense Multisense,	9
14				No. 27 integrated micro-irrigation platform - centralized platforms (sensors and software) for crop management	Netafim uManage™	8
15			Precision irrigation technologies	No. 28 Sub-surface irrigation dripper with precise distribution of water and nutrients along the underground pipes.	UNIRAM™ AS	9
16				No 26. High precision irrigation system which can be apply a user specified irrigation rate to the field		8
17				No. 4 Water delivery systems (as automated and integrated systems) for water supply from precision irrigation plants	DWS System™	9
18				No. 2 Automated and integrated precision irrigation systems with irrigation scheduling based on modelling tools.	HYDRIP®	9
19			Others	No. 31 Ground Penetration Radar (GPR) technology to detect the amount of water contained in the soil, and create GIS maps of soil		8
20		production of fit-for-use waters		TWIs needed		
21	water management technologies	groundwater management and pollution	Monitoring tools	No. 17 Multi-parameter probe and software for monitoring groundwater quality		7
22				No. 34 Real-time monitoring, modelling and controlling system to prevent or reduce groundwater aquifer depletion, including meters on groundwater pumps		9
23				No. 35 Precise, sensor-controlled nozzle switching based on chlorophyll detection, to reduce spraying pesticides on bare soil	AmaSpot sensor nozzle system (incl. GreenSense infrared sensor, nozzle switching	9

A-Agricultural domain | B-Municipal domain | C-Industry domain | D-River Basin Mng& Flood | E-Water for energy

LANDSCAPING OF TWI (scoring & ranking)

Comprehensive landscaping of TWIs, across 5 water domains, assigned to 1 of 5 classification Scheme from DOA. Based on Delphi survey.

A. PIANO Scoring A, two basic criteria:

- Technology Readiness Level (TRL) (0-9)
- Meet China water challenges (0-5)

B. PIANO Scoring B, five criteria:

- Technology readiness level (0-9)
- EU Technological Leadership (0-5)
- Novelty to China (0-5)
- Meet China water challenges (0-5)
- Meet China water policies (0-5)

C. PIANO Scoring C, four criteria:

- EU Technological Leadership (0-5)
- Novelty to China (0-5)
- Meet China water challenges (0-5)
- Meet China water policies (0-5)

Scoring B - Top 5 industrial domain in Europe

TWI	Subcategories	Categories	Technology readiness level:	European Technological Leadership: 0-5	Novelty to China: 0-5	Meet China water challenges: 0-5.	Meet China water policies: 0-5	Scoring results
TWIEU, C25. Ultrasound based disinfection technology with combination of ozone	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal	9	4	4	5	5	27
TWIEU, C29. Dynamic Vapour Recompression to concentrate salt and carbonate rich liquids up till concentration level	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal	9	3	5	5	5	27
TWIEU, C6. High-rate anaerobic reactor for wastewater treatment (primarily organic constituents) and biogas production	Bioprocesses for C (and more) removal	Used Water Collection, Treatment, Disposal	9	3	4	5	5	26
TWIEU, C11. Hybrid aerated activated carbon filtration technology, developed to add accurate and efficient amount oxygen (from air) to a classic activated carbon contactor	Bioprocesses for C (and more) removal	Used Water Collection, Treatment, Disposal	9	3	4	5	5	26
TWIEU, C13. Periodical Air/water cleaning of spiral wound membrane modules to control membrane fouling to reduce use of chemicals. Lower energy, less operational intervention needed. Longer membrane lifetime.	Solids Separation/Filtration (incl. membranes)	Used Water Collection, Treatment, Disposal	9	3	4	5	5	26

Technological water innovations in a Europe-China context

Innovative

Sector	Category 1	Category 2	Category 3	Category 4	Category 5	Total
Agricultural water management	-	-	15	5	-	**20**
Municipal water management	2	-	14	15	-	**31**
Industrial water management	-	-	18	11	-	**29**
River basin management	-	-	6	12	-	**18**
Water for energy	-	-	5	13	-	**18**
Total	**2**	**0**	**58**	**56**		**116**

EU / PRC **EU / -** **- / PRC**

PIANO WP 2 outputs (1/4)

3 Recommended TWIs : Inventory II

Agricultural water domain:

TWIEU, A36. Groundwater sampling system with passive samplers measuring volatile organic compounds such as chlorinated solvents and constituents of petroleum fuels in groundwater, including sampler analysis. It could be used for extraction of soil-water from dry boreholes in contaminated site investigation.

TWIEU, A8. DSS: SCADA remote control system, based on the qualitative parameters of treated water to be used for irrigation purpose.

TWIEU, A30. Software for nitrogen budgeting for each crop based on estimates of crop demand and nitrogen availability from various fertilizers.

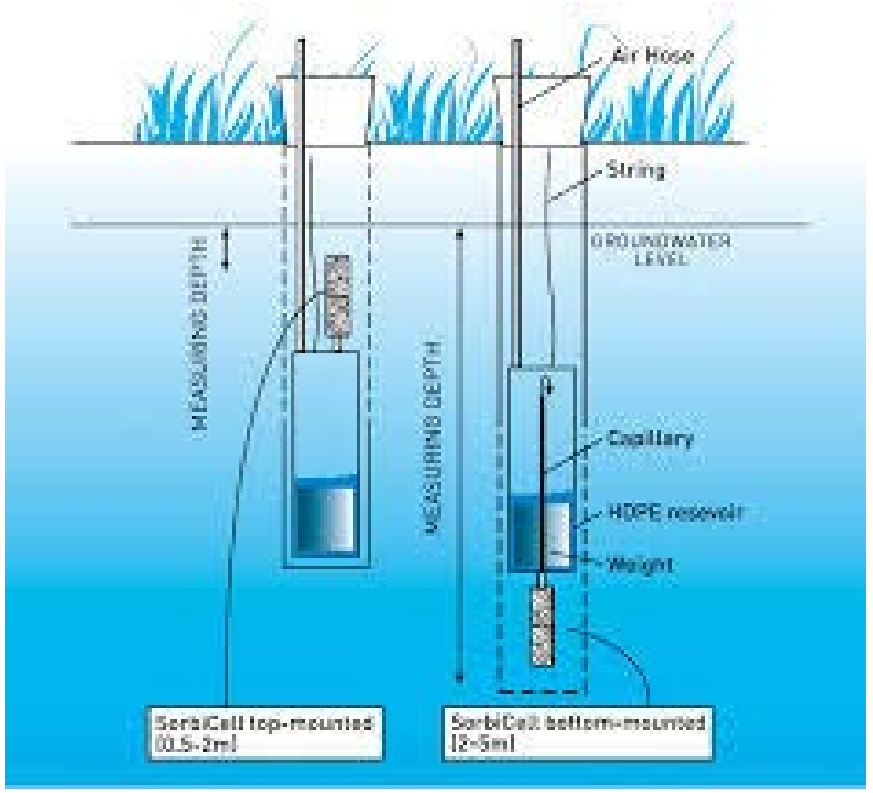
Municipal water domain:

TWIEU, B50. Technology for monitoring of coliform bacteria and E. Coli in drinking water. The principle of the technology is measurement of colour or fluorescence produced by the bacteria through cleavage of specific substrates added to the water. The technology is based on a chemical reaction between a substrate in the growth medium and enzymes produced by the coliform bacteria.

TWIEU, B63. Vertical Sequencing Batch Reactor System for reducing cost and space of plant.

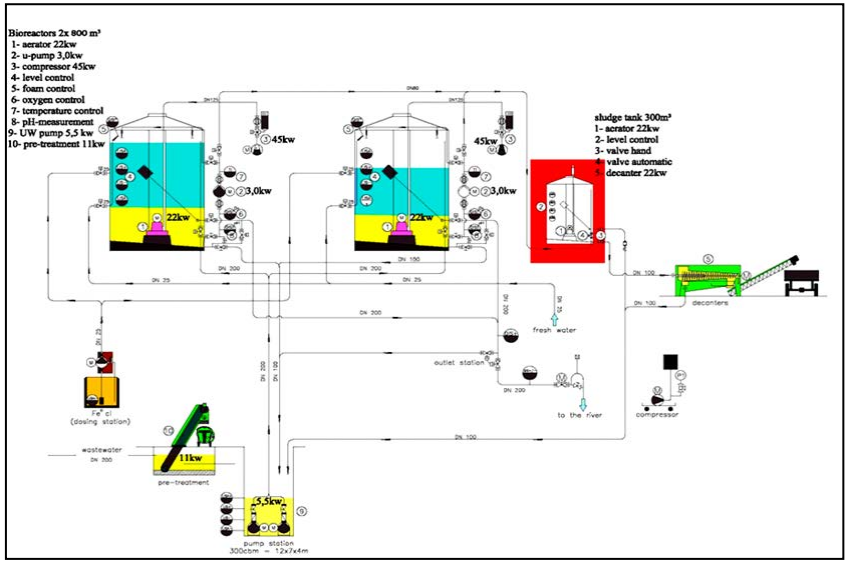
TWIEU, B52. UV-VIS multiparameter based measurement sensor for the measurement of nitrate and nitrite in wastewater.

WATER DOMAIN	**Agricultural water management**
WATER CHALLENGE	**Agricultural water management**
Type of TWI	**Irrigation Technologies**
TECHNOLOGY	**TWIEU A36 Groundwater sampling system**
SUBCATEGORY	**Monitory Technologies**
CATEGORY	**Groundwater technologies**
DESCRIPTION	Groundwater sampling system with passive samplers measuring volatile organic compounds such as chlorinated solvents and constituents of petroleum fuels in groundwater, including sampler analysis



Sorce: [www.**sorbisense**.dk](http://www.sorbisense.dk)

WATER DOMAIN	Municipal water management
WATER CHALLENGE	wastewater management
Type of TWI	Wastewater treatment Technologies
TECHNOLOGY	TWIEU B63 Vertical Sequencing Batch Reactor
SUBCATEGORY	Bioprocesses – for Carbon (and more) removal
CATEGORY	Water treatment
DESCRIPTION	Wastewater treatment plant for the biological purification of industrial and municipal sewages with high content of nutrients (N, P). The process implement the **Sequencing Batch Reactor technology (SBR)** and produces effluents highly purified which can be discharged or recycled for: • Drinkable water production (Direct and Indirect Potable water reuse) • Agricultural purposes • Industrial processes • Other water reuse Due to the **vertical development of the reactor**, compared to a traditional basin, the retention time of the oxygen, provided for the aerobic purification processes, inside the reactor is strongly increased and the degree of utilization of oxygen is maximized. The automatic control system (SCADA) regulates the operative parameters optimizing the system and facilitating the microorganisms' activities responsible for the purification phases. steps of one week.



source: *IMR E&T S.r.l. (Trieste)* http://www.imr.it/

PIANO WP2 outputs (2/4)

3 Recommended TWIs : Inventory II

Industrial water domain:

TWIEU, C25. Ultrasound based disinfection technology with combination of ozone.

TWIEU, C29. Dynamic Vapour Recompression to concentrate salt and carbonate rich liquids up till concentration level.

TWIEU, C54. Combined Biologic process for removal of organic matter, sulphate and others nutrients in industrial wastewater.

River Basin water domain:

TWIEU, D2. Smart and sand engines (sensors that relay real-time status reports on the condition of the dike). Use of new natural materials (flexible concrete, durable grass) to bolster flood defences.

TWIEU, E14. Smart buoy to monitor in-situ water quality (like dissolved oxygen, pH, conductivity, temperature, redox potential, total dissolved solids and turbidity) and web platform to receive the information provided by the buoy.

TWIEU, D16. Bio-inspired dams for ecosystem degradation management (sustainable ecosystem restoration in semi-arid regions).

WATER DOMAIN	INDUSTRIAL WATER MANAGEMENT
WATER CHALLENGE	Industrial wastewater trreatment
Type of TWI	Treatment technology
TECHNOLOGY	TWIEU, C25. Ultrasound based disinfection technology with combination of ozone
SUBCATEGORY	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)
CATEGORY	Used Water Collection, Treatment, Disposal
DESCRIPTION	USO3 utilizes an advance oxidation process (AOP) that combines the advantages of ozone with ultrasound to apply in the areas of wastewater and water disinfection, improvement of wastewater plant performance and aeration along with disinfection/cod reduction, EDC + PCPP degradation, tank disinfection, rinse water disinfection, and ultra-pure water.

WATER DOMAIN	**RIVER BASIN MANAGEMENT AND FLOOD CONTROL**
WATER CHALLENGE	**RIVER BASIN FLOODING ABATEMENT / URBAN FLOODING ABATEMENT**
TYPE OF TWI	**PREVENTATIVE TECHNOLOGIES**
TECHNOLOGY	**TWIEU, D2. Smart and sand engines (sensors that relay real-time status reports on the condition of the dike). Use of new natural materials (flexible concrete, durable grass) to bolster flood defenses**
CATEGORY	**INTEGRATED RIVER BASIN MANAGEMENT TOOLS (FLOOD PROTECTION)**
DESCRIPTION	To give nature a helping hand, Dutch researchers are working on new dike materials like flexible cement to attach energy-absorbing stones, geotextiles that prevent internal erosion — a major cause of breaches — and super-strong grass that dampens wave action. One intriguing process strengthens dikes with “bio grout” produced by bacteria fed a substance that makes them excrete calcium. So far, it only works on a small scale. The new designs provide a longer-term solution than barriers. One new dike is protected by a widened beach and concealed beneath a pedestrian-friendly esplanade which combine ecological, recreational, and economic functions with flood control. Devices like Smart Dikes are expensive, and haven’t yet proven their worth.

source: https://www.deltares.nl/en/projects/smart-dike-reinforcement-using-smooth-block-revetments/

source:

http://e360.yale.edu/feature/to_control_floods_the_dutch_turn_to_nature_for_inspiration/2621/)

PIANO WP2 outputs (3/4)

3 Recommended TWIs : Inventory II

Water for Energy domain:

TWIEU, E19. Geothermal energy pump to harvest geothermal energy.

TWIEU, E23. Micro-hydro generators: systems that do not require a dam or storage facility to be constructed. Instead they divert water from the stream or river, channel it in to a valley and drop it in to a turbine via a pipeline called a penstock. The turbine drives a generator that provides the electricity to the local community.

TWIEU, E12. Behavioural fish barrier (using a strobe light, sound and a bubble curtain as stimuli) to e.g. divert fish from turbine blades of hydroelectric structures.

WATER DOMAIN	**WATER FOR ENERGY**
WATER CHALLENGE	**NOVEL ENERGY PRODUCTION TECHNOLOGIES**
TYPE OF TWI	**OTHER SOURCES / GEOTHERMAL ENERGY**
TECHNOLOGY	**TWIEU, E19. Geothermal energy pump to harvest geothermal energy**
CATEGORY	**ENERGY PRODUCTION TECHNOLOGIES**
DESCRIPTION	Across Europe, there are plentiful sources of geothermal energy: heat stored in the ground which can be tapped to provide a renewable and inexhaustible energy supply. Using the right technology to access this power at varying depths and temperatures, we can use this heat to reduce our dependence on imported and climate-damaging fossil fuels. Until recently, the technology to exploit geothermal energy in a cost-effective way has remained under-developed. However, in response to the growing economic and policy pressures to cut CO2 emissions and improve energy security, one company set out to change this state of affairs, with remarkable results. Klima and its parent company Mayekawa in Belgium designed the compressor, with unexpectedly good results: for each kW of energy consumed, the pump delivers 6.4kW of heat. The project had delivered a world-class result.

Source: http://www.eurekanetwork.org/content/e-4117-hth-pump

PIANO WP2 outputs (4/4)

Areas for potential collaboration in developing joint European-Chinese technological:

- **Agricultural water domain:**
  - Reduce surface water pollution (<5 TWIs);
  - Reduce groundwater mining (<10 TWIs)
- **Municipal water domain:**
  - Alternative water supply (<5 TWIs);
  - Sponge City concepts (<5 TWIs);
  - Water use efficiency: network (<10 TWIs);
  - Water use efficiency: consumer (<10 TWIs)
- **Industrial water management:**
  - Water saving technologies/processes (<10 TWIs);
  - Industrial water re-use (<10 TWIs)
- **River Basis water domain:**
  - River basin scale pollution abatement/control (<5 TWIs);
  - Urban flooding abatement (<10 TWIs);
  - River basin monitoring (<10 TWIs)
- **Water for energy domain:**
  - Expansion of small-scale hydropower production capacity (<5 TWIs);
  - Retrofitting schemes (<5 TWIs);

FOR FURTHER INFORMATION OR THANK YOU

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Classification scheme- From slide 7

Comprehensive landscaping of **TWIs**, across 5 water domains, assigned to 1 of the following the 5 D.O.A categories:

1. **Established** technology solutions available both in EU and China
2. **Established** technology solutions available in EU, but not in China
3. **Similar innovative solutions available in both EU and China**
4. **Innovative solutions available in EU, but not in China (Recomended TWI´s)**
5. **Innovative** solutions available in China, but not in EU

Table with the sub-categories of TWI´s

A- Agricultural (9 sub-categories)	Precision irrigation technologies Tools for parameter estimation & optimization (e.g. sensors, kits, GPR, etc.);Novel materials & assessment methods; Integrated systems for irrigation/fertigation managment (DSS + sensors);Groundwater remediation technologies (incl. DSS) + others
B- Municipal (26 sub-categories)	Extraction/Collection from Water Source (incl. well construction & maintenance); Water treatment – biological; Water treatment-chemical (incl. advanced oxidation, disinfection, etc); Water treatment – physical (incl. membranes, ion exchange, UV, etc..); Monitoring/Sensors during Water Treatment; Control/DSS + Others
C- Industrial (23 sub-categories)	Water treatment - biological; Water treatment- chemical (incl. advanced oxidation, disinfection, etc); Water treatment – physical (incl. membranes, UV, etc..); Water monitoring/Sensors; Control/DSS; Distribution/Leakage Management; Efficiency (incl. water savings, usage, minimization); Other (not really about water use); Collection/Separation; Other
D- River Basin mg and flood control (4 sub-categories)	Preventative technologies; Reactive; technologies; Sensors & other devices; Integrated systems (monitoring tools + DSS); Stand-alone DSS
E- Water for Energy (7 - sub categories)	Turbines and components; Monitoring; technologies; Drilling technologies; Decision support systems (DSS);Other sources; Mitigation technologies; Tools to predict and map resource flows and assessing trade-offs between resources uses