Water - Energy Linkages and Technology Challenges

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Mother Earth -- our home

It has water, oxygen and a hospitable climate
Energy - Environment - Economics
Content

Water – there are no substitutes

• The water – energy linkage
• Energy in the water industry
• Monitoring
• Energy to produce clean water
• The systems approach
The Challenge: Sustainable Energy
The Challenge: Water Security

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Impact - Human Systems

Sensitive Systems
- Water resources
- Agriculture, forestry, fisheries
- Human settlements
- Industry, energy, financial services

Vulnerabilities
- Food and water security
- Incomes and livelihoods
- Human health
- Infrastructure
The Growing Water, Energy and Sanitation Crisis

1.2 billion (10^9) people do not have water within 15 minutes walk

The weight of water that women in Africa and Asia carry on their heads is commonly 20 kg
Water Demand Increasing Water Supply Decreasing

• **Europe - precipitation**
  – Precipitation has decreased 20% 1900 - 2000
  – Additional 1% reduction every 10 years expected
  – Summer rains decreasing 5%

• **Desalination**
  – Mediterranean area - 18 % annual increase
  – Saudi Arabia - 17% annual increase
The "Drivers"

- Climate change
- Infrastructure is aging and deteriorating
- Globalisation and population growth
- Drives towards sustainability

The growing water and sanitation crisis
Svante Arrhenius
(Swedish physicist, Nobel Prize winner) 1919

“Until the outbreak of the (first) world war (1914-1918) we lived in a time of feverish development. During ten years we burnt as much coal as during all the previous years of mankind, some 100 000 years. There is a similar fact about a large number of other raw materials. Therefore it has been questioned how all of this will end up if we continue like this. Like mindless wasteful humans we destroy what we have inherited from our parents. Our children will judge us since we have wasted what should belong to them.”
The main Focus of World Leaders

- Fresh water
- Renewable energy

Poverty
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Energy and Water are Inextricably Linked

Energy production and generation require water

Water pumping, treatment, and distribution require energy
Water to get Energy

We eat 2000-3000 kcal each day to get energy.

To get the food 2000 – 3000 liters are needed.
Energy for Water – a key Challenge

- having the **energy to extract** water from underground aquifers
- **transport water** through canals and pipes
- manage and treat **impaired water for reuse**
Desalinate brackish and sea water to provide new fresh water sources.
Water for Energy Production

Depending on the availability of water:
- Hydropower
- Cooling of thermal power plants
- Fossil fuel production and processing
- Hydrogen economy
Energy to Pump and Clean Water

Example Sweden

1% of all *electric* power consumption is used for water supply and wastewater treatment

With more advanced water treatment we need more energy
Water/Energy – Indirect Linkages

- **Energy production** - potential contamination of underground and surface water supplies
- **Competing water uses** - limit use of waterways – water for cooling
- **Water and energy are the critical elements of sustainable economic development** – we need both
Water/Energy – Other Linkages

• On a global basis, neither water nor energy are in short supply
• What is in short supply is energy and water at a price that people can afford to buy
• Priority #1 is wise, efficient use of available supplies
• Then, focus on new supplies that meet sustainability and environmental requirements

Dr. Allan R. Hoffman
U.S. Department of Energy
WATER FOR ENERGY

Extraction & Refining
Fuel Production (Ethanol, hydrogen)

Hydropower
Thermo electric Cooling

Extraction and Transmission

Wastewater Treatment

Energy Associated with Uses of Water

Drinking Water Treatment

ENERGY FOR WATER
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Clean Water Requires Energy!

- **Pumping**
  - Having efficient pumps for adequate flows
  - Operating at dynamically changing flows and pressures

- **Aeration in wastewater treatment**
  - Controlling the air flow for variable loads
Water Reclamation Plant

Biogas production

Biological reactors
Biological nitrogen removal
Controlling oxygen

Ammonia removal

Nominal load
High load
Low load

Aeration zone

Ammonia conc mg/l

Nominal
High load
Low load

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Sustainability – Technology Challenges

• **Saving energy**
  – By more efficient **equipment**
  – By better control
  – By better coordination of many unit processes

• **Saving chemicals**
  – By better **control**

• **Producing more biogas energy**
  – By better **control**
Sustainability – Technology Challenges

- Detect leakages
- Detect pollutants and pathogens
- Integrated water management
  - Supply, sewers, treatment, receiving water

Sustainability is a business opportunity
Water Reuse

Wastewater treatment ought to become facility for

Water Reuse and Energy Recovery

– Water reuse
– Saving energy consumption
– Maximizing energy production
Anaerobic Digestion – Making Biogas

- AD uses only 20% of the energy content of the sewage
- AD often perceived as being unstable
- Traditional: operate at low capacity

- With close monitoring and control: better use of capacity – better stability – handling of disturbances
European Project - WSSTP

Water Supply and Sanitation Technology Platform

”Water for people”
The WSSTP Strategy

• Do not address singles issues in isolation
• Adopt a systems approach
• Develop integrated solutions
• Interdisciplinary!
Research Needs (1)

- Water saving techniques
  - Early detection of leakages
- Water quantity should be controlled
  - Smart irrigation
- Smarter & lower cost treatment of alternative water resources
- Storage - aquifer storage & recovery
- Decision support systems
Research Needs (2)

• Improved (automatic, on-line) monitoring and management of the effects of water supply and sanitation
• Reduced inputs and wastage
• Efficiency in power and chemical use
• Better re-use and recovery of materials from water and wastewater treatment
Research Needs (3)

- Relationships between level of service, costs and willingness to pay
- **Benchmarking** tools and framework for referencing costs
- **Monitoring and integrated control** of processes and activities
- **Systems adaptability**
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Monitoring (1)

• Using on-line instrumentation
• “The computer is awake all the time”
• Check all around the clock
  – water quality
  – water quantity
Water Supply - Pipe Failure

Automatic detection and localisation
Water Supply Failure Monitoring

- **Continuous monitoring**
- **Detection and location of bursts**

Flow rate

Pressures
Content

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The World at Night

1.6 billion people lack access to electricity
More than 1 billion people lack access to clean drinking water
3 billion people live on less than $2 per day
Energy Security-What Does It Mean?

Broad themes associated with energy security:

– Physical energy security
– Economic energy security
– Environmental externalities associated with energy use
Energy and Water

To reach the MDG:

• We have to find other solutions than those in industrialized countries
• Using sustainable sources of energy
  – Wind
  – Small scale hydro
  – Photo-voltaic ("solar")
Cost of Technologies

Source: IEA
Wind Power in Denmark
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Smart things everywhere
Information, sensors, actuators and ubiquitous computing

Transformation & Delivery Processes

Resources

Inefficiencies

Energy and Water

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Small – Applications of Nanotechnology everywhere

Resources → Transformation & Delivery Processes → Inefficiencies → Energy and Water
**Complex** – Interconnected and multilayered man-made artifacts with properties of natural systems and organisms.
Changes Required to deal with Water and Energy in light of Climate Change and Sustainability

Rates of Change

- Technology
- Business
- Social
- Political

Time

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Conclusions (1)

- Clean water is a human right
- We need
  - national strategies for water and sanitation
  - increase international aid
Conclusions (2)

- Energy issues cannot be separated from water issues
- We can not take water resources for granted if energy security is not achieved
- If we are to achieve water and energy security, the linkage between the two must be explicitly recognized and acted upon
Challenges...

• We have a lot of technology
• We need to develop even more
• **BUT:** we need more than science and technology
• Act in an integrated manner
  Water supply, sanitation and hygiene
• The water sector too often fragmented – private and public
If you *don’t* want to do something, you can always find an excuse.

If you *do* want to do something, you can always find a way.

Old Polish Proverb
Thank you!
Please contact…

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