THE WATER-ENERGY NEXUS

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Outline

- 2015 Global Risk Landscape
- Climate Change
- Upstream Collision
- Productivity in Commerce

- On-Premise Nexus
- Downstream Collision
- Innovation Opportunities
- Key Take-Aways
GLOBAL RISK LANDSCAPE

- Economic Risks
- Geopolitical Risks
- Environmental Risks
- Societal Risks

World Economic Forum (2015)
April 20, 2015: Globally, March 2015 marks the highest March surface temperature since global temperature records began in 1880.
The future of food and farming: 2050s

By 2050, climatic impacts on food security will be unmistakable. There are likely to be 9 billion people on the planet, most people will live in cities and demand for food will increase significantly.

Widespread impacts on food and farming are highly likely

- Average decline in yields for eight major crops across Africa and South Asia
- Marine fisheries will also be affected
- Fisheries yields in high latitudes
- Fisheries yields in the tropics

Source: Climate Change, Agriculture & Food Security (ccafs.cgiar.org, 2014)
Upstream Energy-Water Collision

- **Thirst for Power**
  - electricity for one load of laundry, 3-10x more water than is used to wash the clothes.

- **Withdrawal Symptoms**
  - freshwater withdrawn to cool power plants is roughly the same as that for crop irrigation.

- **In Hot Water**
  - coal and nuclear plants report releasing water at peak temperatures of 100°F or more.

- **High and Dry**
  - water troubles shut down power plants, due to shortage or ambient water temperature.

- **Wet Renewables**
  - low C can mean low water - or not (CSP, biofuels, hydroelectric, geothermal)

- **MPG or GPM**
  - water footprint of biofuels- 20 GPM (corn ethanol), 1 GPM cellulosic, 0.1 GPM gasoline.

- **The Flip Side**
  - California uses 19 percent of its electricity and 32 percent of its natural gas for water.
Power Share - Freshwater Dependence

Share of power generation capacity with freshwater once-through cooling and hydro in selected countries, 2010

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Source: Union of Concerned Scientists (2010)
<table>
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<th>Water &amp; Energy in Cooling</th>
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<td><strong>a) Once-through cooling</strong></td>
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<tr>
<td>Energy</td>
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<tr>
<td>Process water</td>
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<tr>
<td>River</td>
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| **b) Closed-loop cooling** |
| Energy | Turbine | Condenser |
| Process water | Warm cooling water | Cold cooling water |
| Cooling Tower | Make-up water | Process water |
| River | **Source:** FAO Aquastat (2011) |
**Power Share - Withdrawal & Consumption**

Water intensity of energy production for selected regions of the world, if water efficient cooling methods are implemented.

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# Energy Production & Water Quality

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<th>Process</th>
<th>Connection to Water Quality</th>
<th>Connection to Water Quantity</th>
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<td>Oil and gas exploration</td>
<td>Impact on shallow groundwater quality</td>
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<td>Oil and gas production</td>
<td>Produced water can affect surface and groundwater</td>
<td>Large volume of produced, impaired water</td>
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<td>Coal and uranium mining</td>
<td>Tailings and drainage can affect surface water and groundwater</td>
<td>Mining operations can generate large quantities of water</td>
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<td>Refining &amp; Processing</td>
<td>Traditional oil and gas refining</td>
<td>Water needed to refine oil and gas</td>
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<td>Biofuels and ethanol</td>
<td>Refinery wastewater treatment</td>
<td>Water for growing and refining</td>
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<td>Synfuels and hydrogen</td>
<td>Wastewater treatment</td>
<td>Water for synthesis or steam reforming</td>
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ENERGY & WATER PRODUCTIVITY IN COMMERCE

Based on data reported to CDP Investor & Water (2014)
Water Use in Full-Service Lodging

- A full-service hotel has 300 rooms with 1.5 guests/room and 75% occupancy typically consumes 150 m$^3$ of water/day.
- A full-service hotel has a cooling tower (CT) and on premise laundry (OPL).

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**Source:** Sydney Water, 2001
Ecolab’s **Aquanomic/ Ensure Laundry Programs** deliver clean, white, and soft results while saving water and energy. Both the Smart Wash process and best-practice optimization reduce the number of rinse cycles, and low temperature chemistry reduces the wash water temperature to 40°C.

**Performance Factors (water and energy savings per unit solid product)**
- 33 m³ of water savings per 4 x 9 lb case
- 1,700 kWh of energy savings per 4 x 9 lb case

@0.575/m³ $19 in water savings  @4.4c/kWh $75 in energy savings

Source: Ecolab eROI case studies (2012-2015)
Ecolab’s **Apex Warewashing System** delivers superior results with sustainable low phosphorus products and non-corrosive, color-coded chemistry to enhance user safety. The Apex controller also reduces rewashing, saving water and energy.

**Performance Factors (water and energy savings per unit solid product)**
- 0.9 m$^3$ of water savings per 4 x 6.5 lb case
- 103 kWh of energy savings per 4 x 6.5 lb case

@ $0.575/m$^3$ $\rightarrow$ $0.52$ in water savings

@ $4.4c/kWh$ $\rightarrow$ $4.53$ in energy savings

*Source: Ecolab eROI case studies (2012-2015)*
Ecolab’s Wash’n Walk® Floor Cleaner uses cool water dilution and a “no–rinse” formula to reduce slips and falls due to greasy floors. It also saves large amounts of rinse water and the energy needed to heat normal floor wash water.

Performance Factors (water and energy savings per unit solid product)

- 6 m$^3$ of water savings per case
- 363 kWh of energy savings per case

@$0.575/m^3$ $3.45$ in water savings

@4.4c/kWh $16$ in energy savings

Source: Ecolab eROI case studies (2012-2015)
Optimizing Water and Energy Use

It Matters to our Customers that we can leverage our chemistry beyond core outcomes-

Process water is Valuable ‘Energy-Rich’ Water: heated, chilled, filtered, treated, conveyed, ....disposed

Big leverage: Water + Energy Spend >> chemical spend

- 300-Room Hotel:
  - $667K/yr water & energy spend, 33K/yr chemical spend
  - Cooling: $165K, 44x chemical spend
  - Rooms: $48K, 9x chemical spend
  - Laundry: $24K, 3x chemical spend
  - Kitchen: $24K, 2x chemical spend
  - Pool: $7K, 1x chemical spend
  - Other: $399K, no chemical spend
OPPORTUNITIES FOR INNOVATION

Pre-use Management - Engineered Delivery Systems

Natural Systems

Post-use Management - Wastewater Treatment & Discharge

Water Use & Potential Resuse

Overarching Innovation
Data, Water System Management, Water/Energy Nexus, Water Quality
Key Take-Aways

• **Upstream Nexus**
  - Primary Energy
  - Power Purchase
    • Water in Energy- Quality and Quality Impacts
    • Energy in Water- Climate Change Impacts

• **In-Stream Nexus**
  - Utilities: Facility Cooling
  - Services: Laundry, Warewashing, Facility Care
    • Quantify and Monetize Value of embedded energy in water savings

• **Downstream Nexus**
  - Water Reuse
    • Consider energy implications of point of reuse
    • Impact of green and grey infrastructure
DISCUSSIONS