• Opportunity Overview
• Company Overview / Management
• Water Desalination Market
• Desalination Technology
• NanoPur Advantage
• Desalination Cost
• Customers
• Membrane Scale-up
• Competitive Landscape
• Roadmap
The Opportunity

- Commercializing a carbon nanotube (CNT) membrane for use in water desalination
  - Rapidly growing commercial desalination market
    - 15+% CAGR projected globally† (2005-2018)
    - $10B water membrane market by 2018
    - Opportunity to retrofit installed base
  - Our membrane could provide lower-cost water than any desalination plant today
    - Significant reduction in energy consumption over current technology (up to 30%)
    - Significant reduction in capital cost of new plants (smaller plant, same capacity)
    - Prototype membrane developed at Lawrence Livermore National Lab
    - Proprietary, low-cost continuous CNT process for manufacturing and scale-up invented by NanoPur co-founder John Hart

- Go-to-market strategy: manufacture brackish water desalination membranes for new plant installation and retrofits
  - Material R&D to improve ion exclusion performance to launch seawater membrane

† Source: European Commission: Environmental Technologies Action Plan & The MacIlvaine Company (membranes)
Business Overview

Management Team
- Founder, CEO
  Justin Ashton, MBA ‘08, MIT Sloan
  - Experience with Coal Gasification Startup
  - Wind energy development experience
  - Intern, Matrix Venture Partners
  - Former Air Force Officer
- Founder, COO
  Vanessa Green, MS Env. Eng.’08, MIT
  - Specialist in water supply technology
  - Water supply chain experience
  - Worked in Ghana developing water
  - Consultant at Monitor Group
- Founder, CTO
  John Hart, PhD MechE ‘06, MIT
  - Nanomaterials and machine design expert
  - 50+ publications on CNTs and growth
  - Patents pending on scaled CNT production
  - Assistant Prof. at Univ. of Michigan

Scientific Advisors from leading Institutions

Lawrence Livermore National Laboratory
- Olgica Bakajin, PhD, Princeton
  - Physicist at LLNL
  - Membrane Co-Inventor
- Alexandr Noy, PhD, Harvard
  - Chemist at LLNL
  - Membrane Co-Inventor
- Jason Holt, PhD, Caltech
  - CNT Materials at LLNL
  - Membrane Co-Inventor
- Rohit Karnik, PhD, Berkeley
  - MIT Assistant Prof., ME
  - Nanofluidic systems

Strong Intellectual Property Portfolio
- Patent pending for use of CNT for fluid separation (LLNL)
- Patent pending on material and process for membrane scale-up (MIT)
Desalination Market

Large, rapidly growing market
- 15-20% CAGR... $10B in 2018 †
- Global population boom: 25% of people within 20 miles of coast †
- Energy costs driving up cost of desalination
- Industrial water use growing and climate patterns shifting

Significant opportunity for lower-cost desalination that:
- Reduces energy costs
- Reduces capital cost
- Increases water flow
- Scales to meet water demand

NanoPur meets these needs

Are there paying customers?
- Wealthy nations feeling the water pinch
  - Saudi Arabia - 26% of global capacity, $50B investment in desalination by 2020*
  - USA – 15% of global capacity, high growth in CA, FL and TX
  - Europe - 10% of global capacity with high Spanish investment projected

† Source: European Commission: Environmental Technologies Action Plan
*US Department of Commerce, Saudia Arabia Water and Wastewater
Desalination Technology

- **Reverse Osmosis (RO)**
  - Best available technology
  - Limited by membrane permeability
  - Mature technology = incremental improvements
  - Energy intensive (44% of total operating cost for seawater)

### Traditional Reverse Osmosis

- **Brackish / seawater**
- **Pressure**
- Economics dictate large capital/plant capacity
- Water flux is a critical limitation in RO
  - High pressure = high energy cost
- Incremental polyimide membrane improvements over last 20 years have reduced cost but, RO water cost still exceeds US average water cost of $0.51/m³

### NanoPur Advantage

- Low flow-resistance through CNTs enhances water flux; 10x better flux than RO demonstrated
- Smaller plant = less CAPEX & Energy use
- Demonstrated ion exclusion with brackish water
- Research needed to demonstrate seawater ion exclusion and anti-fouling

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†RO Plant Costs†

- Chemicals
- Maintenance
- Membrane
- Labor
- Electric power
- Fixed costs

Brackish water Seawater

^At same pressure; Source: LLNL; Science 312, 1034 (2006), Holt, et al.
†Source: Sandia Nat’l Lab
Desalination Cost

Reverse Osmosis Desalination Cost

**Seawater**

- SWRO
- SWRO (energy recovery)
- Ave US water (all sources)
- SW CNT

**Brackish**

- BWRO
- BW CNT

Assumptions:
- Brackish water reverse osmosis
- Plants have same water capacity (m³)
- High flow rate reduces capital cost by 1/3
- NanoPur energy savings of 30% over RO
- NanoPur has similar ion exclusion
- Similar pre-filtration system on both
- Higher cost of CNT membranes

<table>
<thead>
<tr>
<th>Typical BWRO</th>
<th>NanoPur</th>
</tr>
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<tbody>
<tr>
<td><strong>Total Cost/m³</strong></td>
<td>$0.36</td>
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<tr>
<td>Fixed costs</td>
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<tr>
<td>Electric power</td>
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<tr>
<td>Labor</td>
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<tr>
<td>Maintenance</td>
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<tr>
<td>Membrane</td>
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</tr>
<tr>
<td>Consumables</td>
<td>$0.04</td>
</tr>
</tbody>
</table>

Saves hundreds of thousands of dollars per year on energy (dependent on plant capacity)

†Source: Wagnick / GWI (2005)
Manufacturing scale-up

- NanoPur will manufacture membranes
- Scale-up is the critical issue for CNTs... but we have a solution
  - Continuous roll-to-roll production of aligned CNT membranes by thermal chemical vapor deposition (CVD) and matrix infiltration (J. Hart, U. Michigan)
  - Patents pending^; bench-scale CNT machine expected Q3 2008

- Addresses key scale-up issues:
  - Continuous production of aligned, free-standing CNT membrane layers
  - Densification of CNTs to further increase permeability
  - Fabrication of composite supporting structure for spiral wound architecture

- CNT production cost (est.): $200/kg
  - <0.2 kg CNTs per 40 m² membrane; CNT cost 10-20% of membrane manufacturing cost

Customers / Development

- Water desalination customers vary but are generally municipal, state or national governments or industrial users (power plants)
- Industry desalination plant contracts awarded to low-cost bidder
  - Water industry is risk-averse and price sensitive
  - Membrane manufactures provide membranes through system OEMs (majors like GE, Siemens are vertically integrated)

- Development Strategy
  - Early focus on membrane scale-up, manufacturing, and sales
  - Build pilot-scale (1000m$^3$/day) demonstration manufacturing line
  - Gain credibility and industry trust through series of independent third-party performance and durability tests
  - Target early membrane sales to OEMs to use their credibility as an ‘in’ to end users

NanoPur Expected Revenue Sources
- Brackish Water desalination membrane
- Seawater desalination membranes
• Incumbents (GE, Koch) and entrants (UCLA/Khosla-funded NanoH2o) focused on incremental RO membrane improvements

• NanoPur’s membrane *changes the desalination membrane game* – 10x+ flowrates of best RO membrane\(^2\) = lower energy consumption

– NanoPur anticipates similar ion exclusion to existing membranes

2. Source: LLNL; 100-1000x flow predicted with higher CNT pore density
Roadmap

- Q3 2008: Prototype on chip
- 2009: CNT Membrane R&D
- 2010: Membrane Scale-up
- 2011: Membrane Ion Functionalization R&D
- 2012: Manufacturing Process Engineering
- 2013: Pilot-scale BWRO Mfr’ing
- 2014: Sell BWRO Membranes

- Funding
  - A Round: $5M
  - B Round: $25-30M

- Projected Revenues (2014)
  - BWRO Membranes: $63M
  - SWRO Membranes: $44M
  - Total: $107M

- First revenue from BWRO membrane sales
- First SWRO membrane sales