

# A tale of two ventures



Frank van Mierlo

[www.bluefinrobotics.com](http://www.bluefinrobotics.com)

*Bluefin*

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**Show Saclant video**

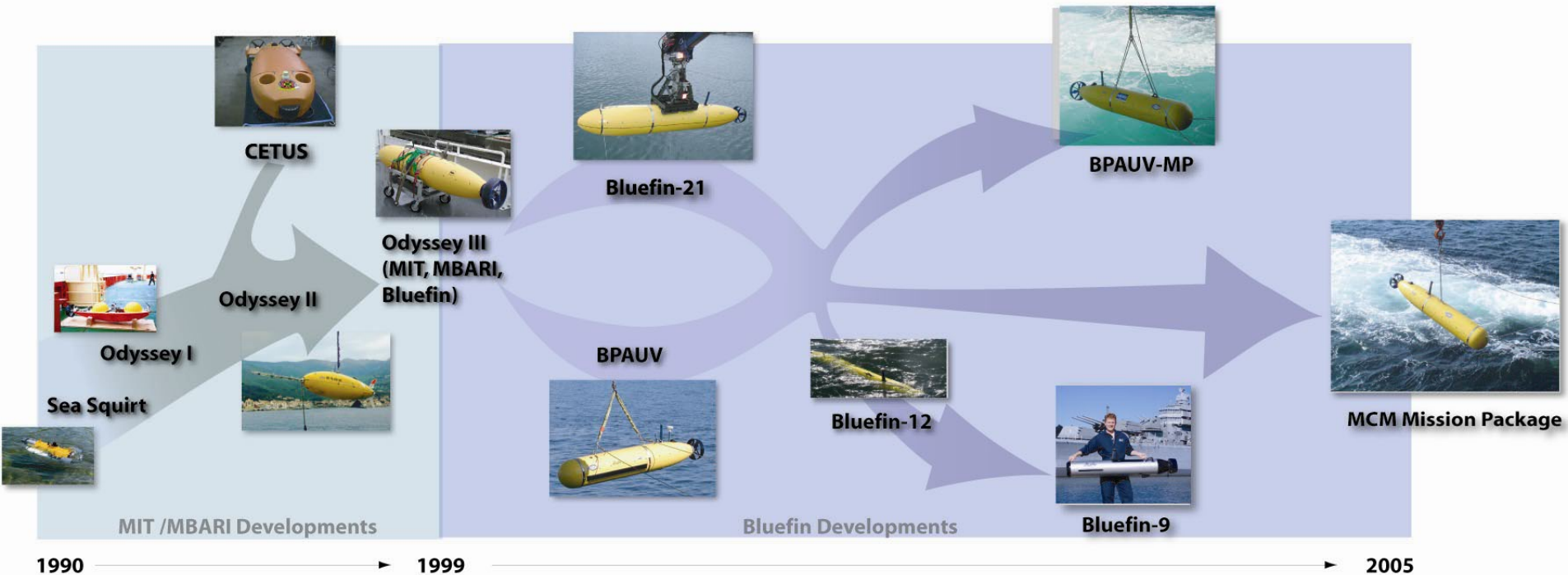
# The Start

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- **1991 - First business plan**
- **May 1997 - Jim & Frank sign three page shareholders agreement**
- **August 1999 - First order from ONR**
- **February 2000 – First payroll**
- **May 2000 - 2M\$ order from industry**

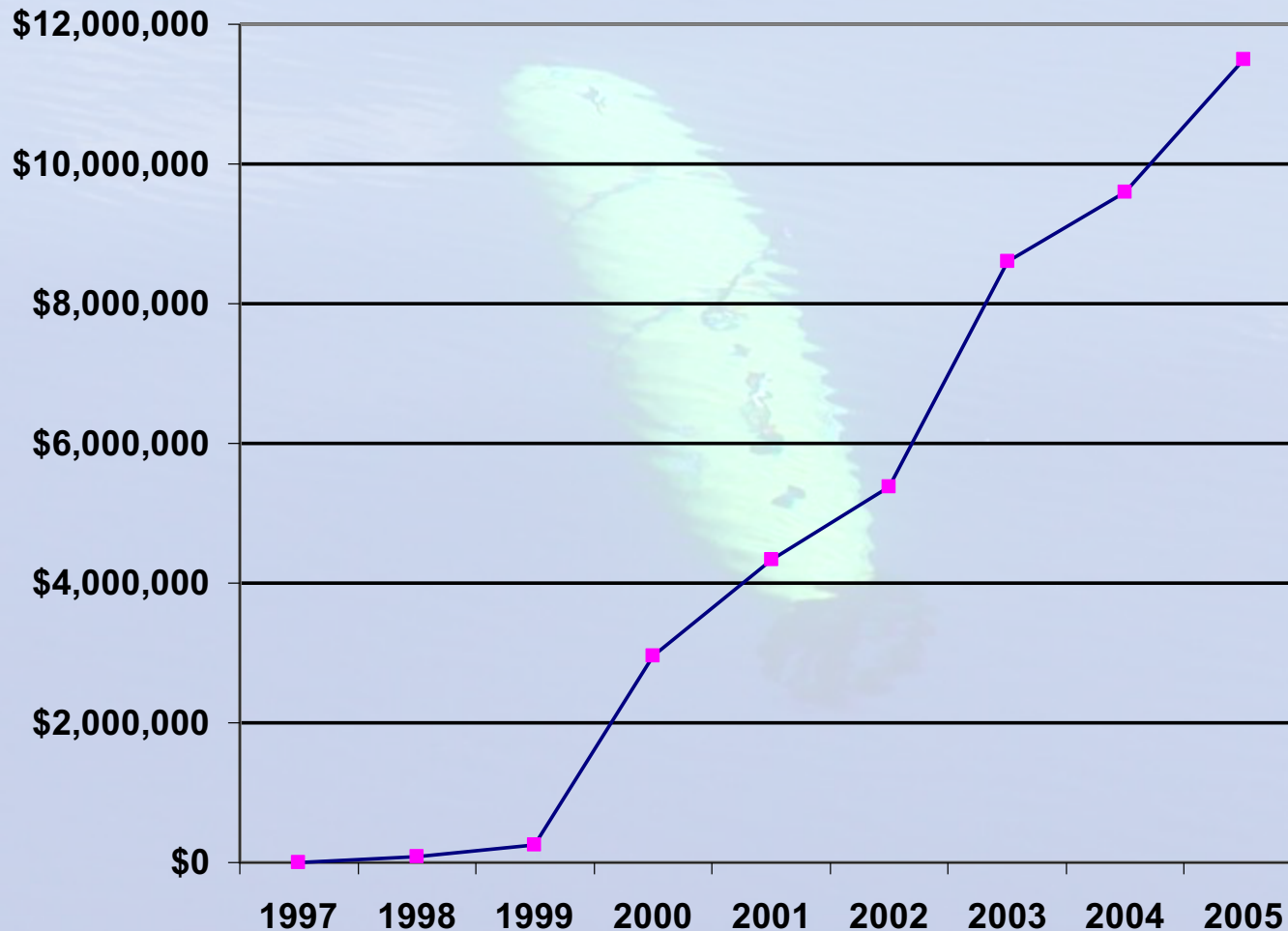
# Building Technology

## Development Chronology



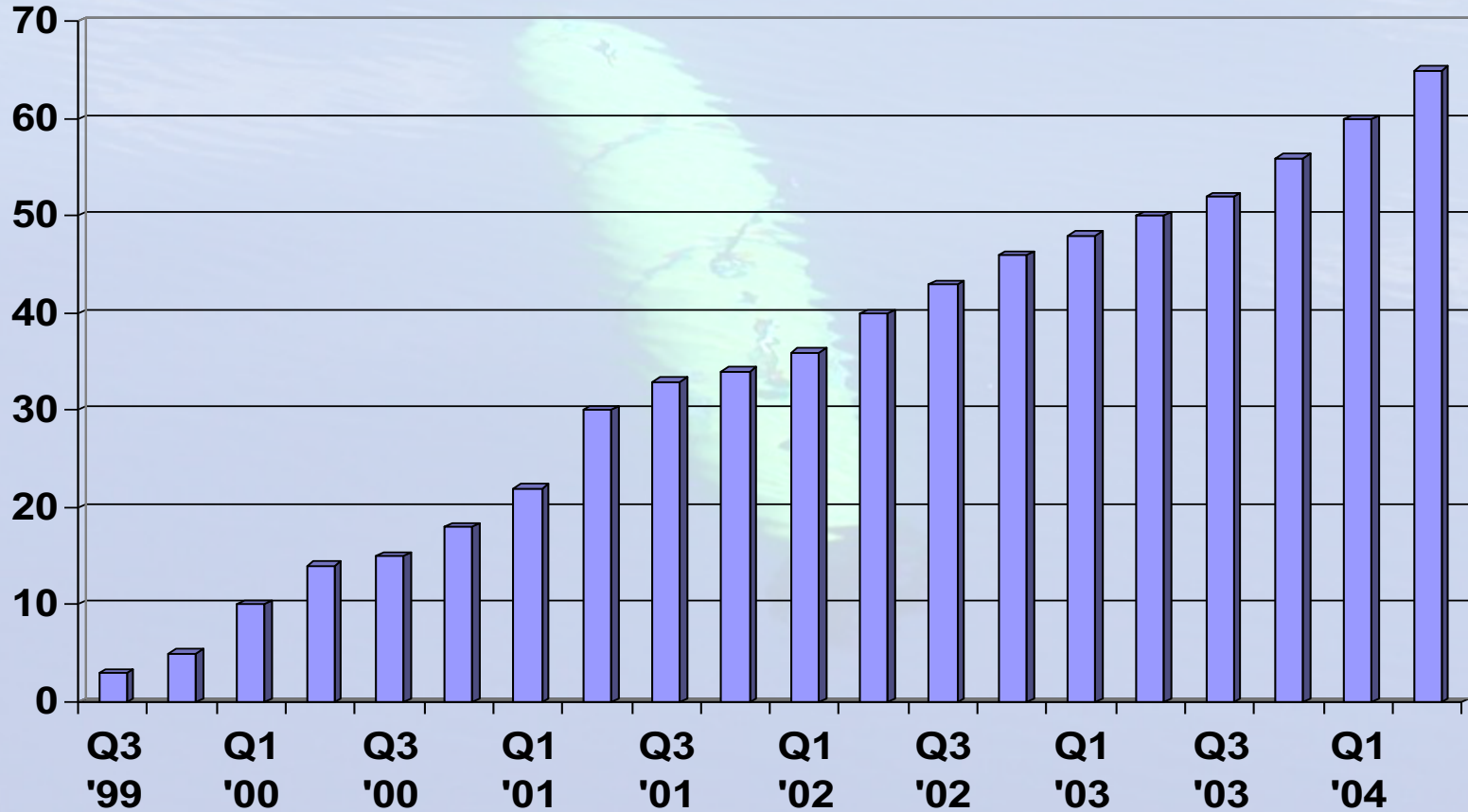
# Received Positive Customer Feedback

## Bluefin's Annual Revenue



# Ramped-up Resources And Capabilities

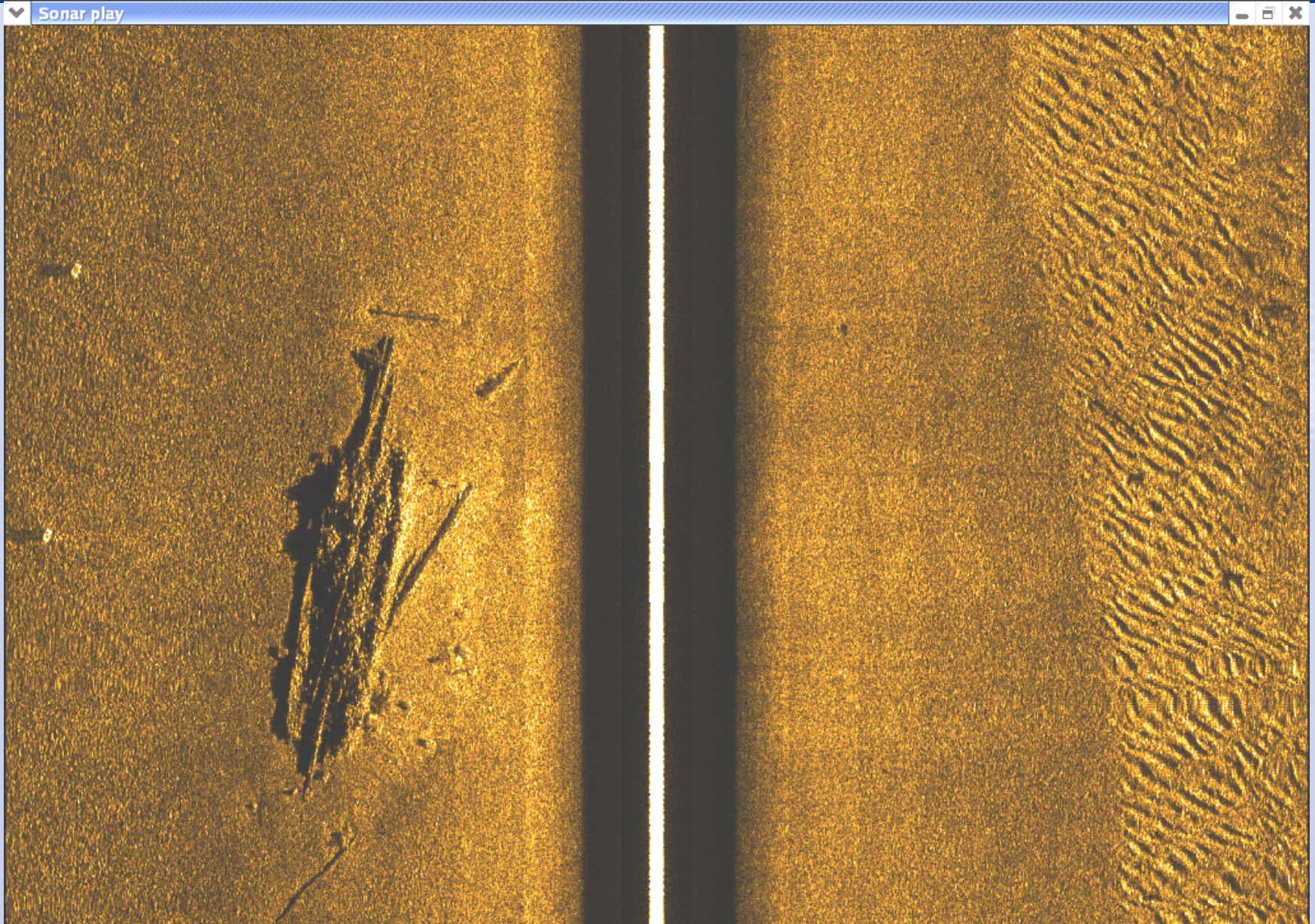
## Number of Employees





# **AUV Platform Technologies**

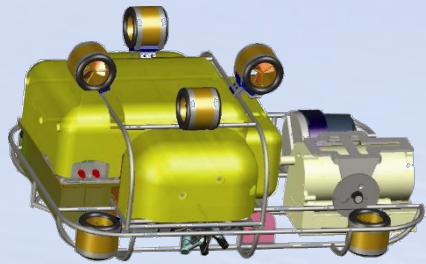
# Bluefin-21 Sidescan Data





# Bluefin AUVs

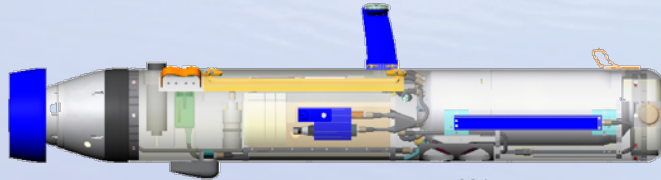
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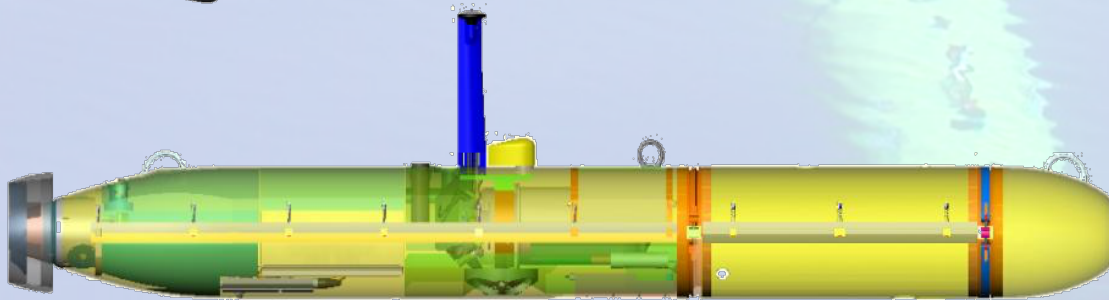
**HAUV (Hovering)**



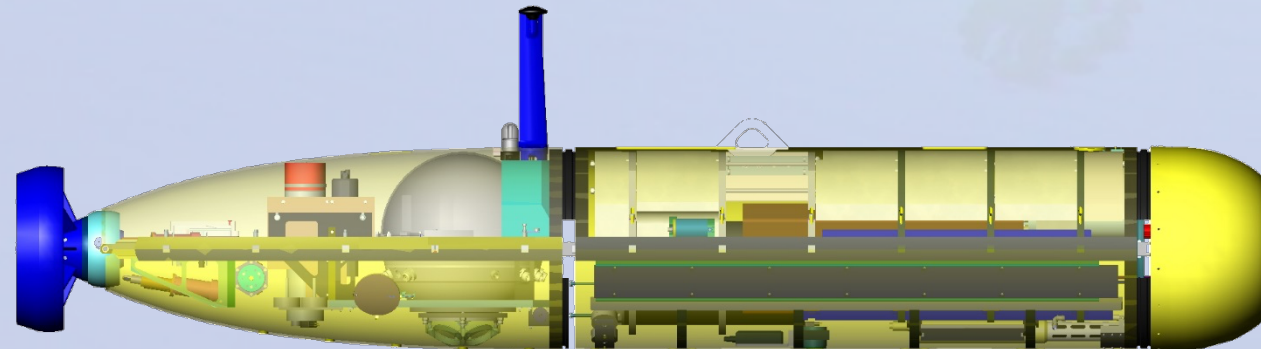
**Bluefin-SPRAY**



**Bluefin-9**



**Bluefin-12**



**Bluefin-21**

# Bluefin-9: Man-Portable, User-Friendly



- **Length: 65”**
  - **Diameter: 9”**
  - **Endurance: 12 hours**
  - **Depth Rating: 200 meters**
  - **Navigation: IMU, DVL, Compass, GPS**
  - **Sensors: Sonar, CTD, Turbidity**
- 
- **Proven Bluefin Architecture**
    - free-flooded design maximizes payload flexibility
  - **Accurate Navigation**
    - eliminates need for deployment of acoustic beacons in the VSW
  - **Ease of Use**
    - easy L&R from small boats (CRRCs)
    - field removable battery and data storage for quick turnaround

# Bluefin-21: Proven Workhorse



- **Length: 8 ft - 14 ft**
  - **Diameter: 21”**
  - **Endurance: 20 hours (with 200W payload)**
  - **Depth Rating: up to 3000m**
  - **Navigation: INS/AHRS, DVL, GPS, USBL/LBL**
  - **Sensors: Sonar, CTD, Turbidity, SVS**
- 
- **Field-Proven**
    - In operations in the United Kingdom, Greece, Gulf of Mexico, Italy, and Norway
  - **Bluefin-21 BPAUV**
    - gathers accurate bathymetry and bottom classifications for use in early stages of battlespace preparation
    - on-deck turnaround in under 2 hours thanks to Bluefin’s unique sub sea battery design
  - **Navigation Accuracy**
    - one-sigma navigation performance of 0.25% of distance traveled

A yellow inflatable boat is floating on a body of blue water. The boat is oriented vertically in the center of the frame. The text "So what did we learn ?" is overlaid in a bold, dark blue font across the middle of the image.

**So what did we learn ?**

# High Tech = High Tolerance



# Success came from

- **Commitment**
  - Set example
  - Equity, Options & Cash Bonus
  - Trust and give away authority
- **Conserve Cash**
  - Low Overhead
  - Raised 800 K\$ from customer
  - Negative working capital
- **Culture**
  - Engineers in charge
  - Keep ego **and pay** in check
  - Diversity is strength

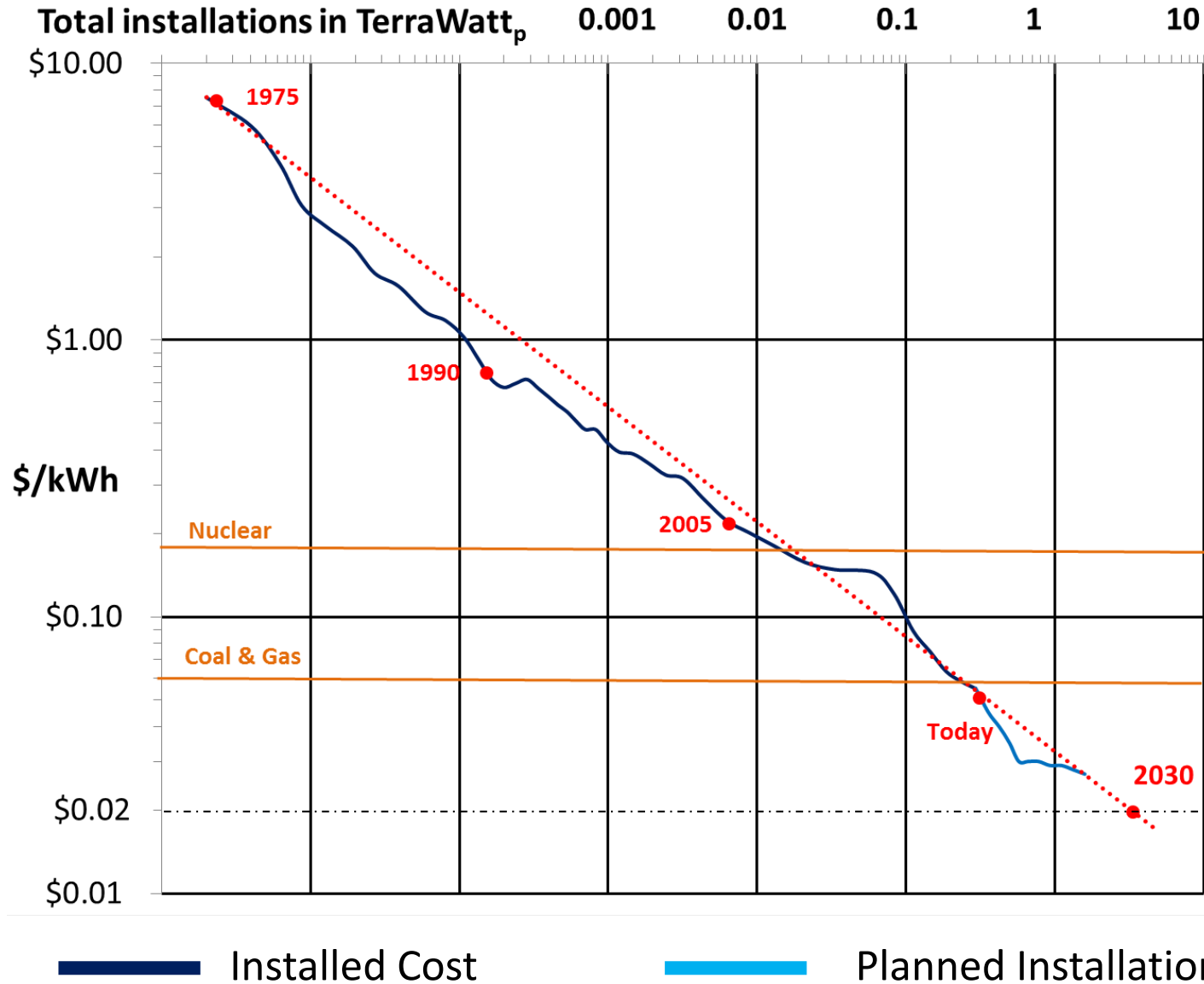


**An opportunity to build a  
\$10bn industry leader**

**and eliminate 6 Bn tons of CO<sub>2</sub>**

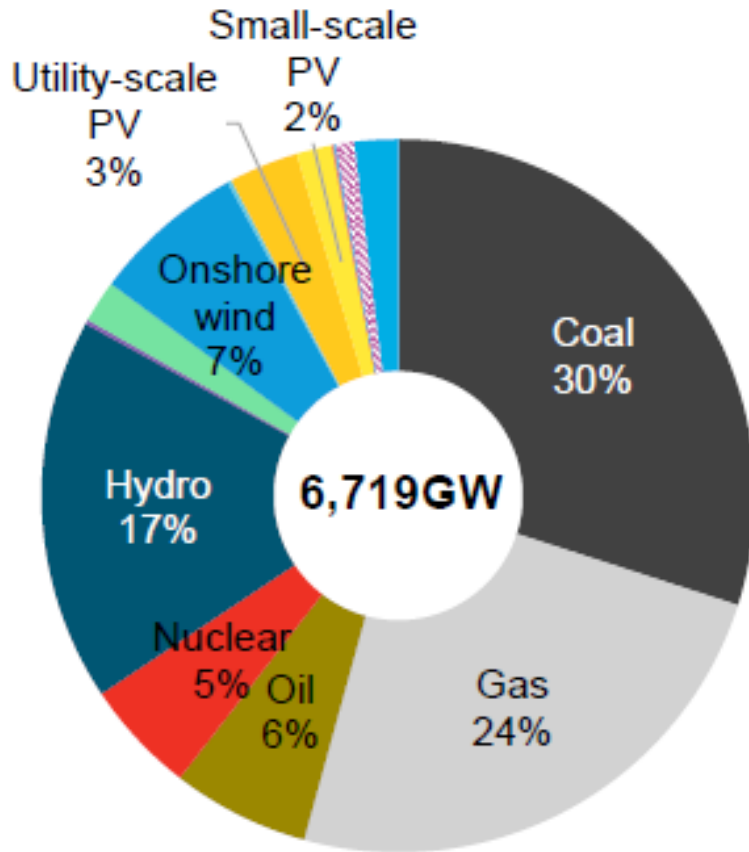


# SOLAR BY FAR THE CHEAPEST

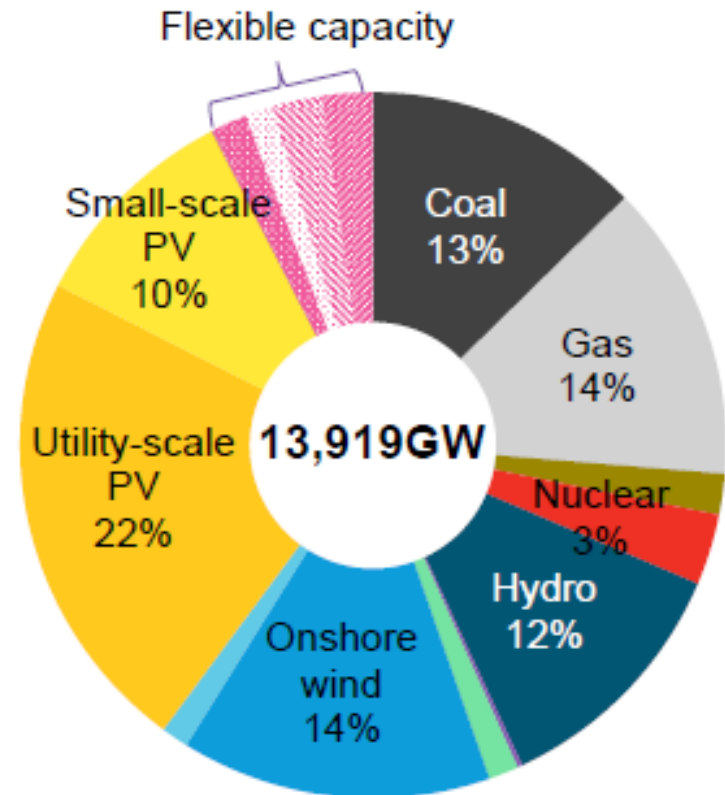




# 3 TRILLION INVESTMENT



**Global Cumulative  
Installed Capacity 2016<sup>(1)</sup>**



**Global Cumulative  
Installed Capacity 2040**

**Direct Wafer<sup>®</sup>**

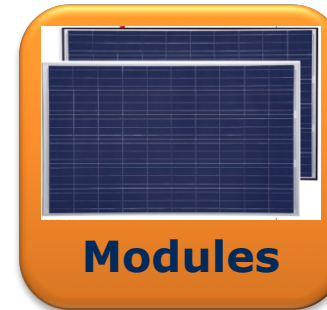
**High performance silicon  
wafers at half the cost**



# Process Video



# Key part of the supply chain



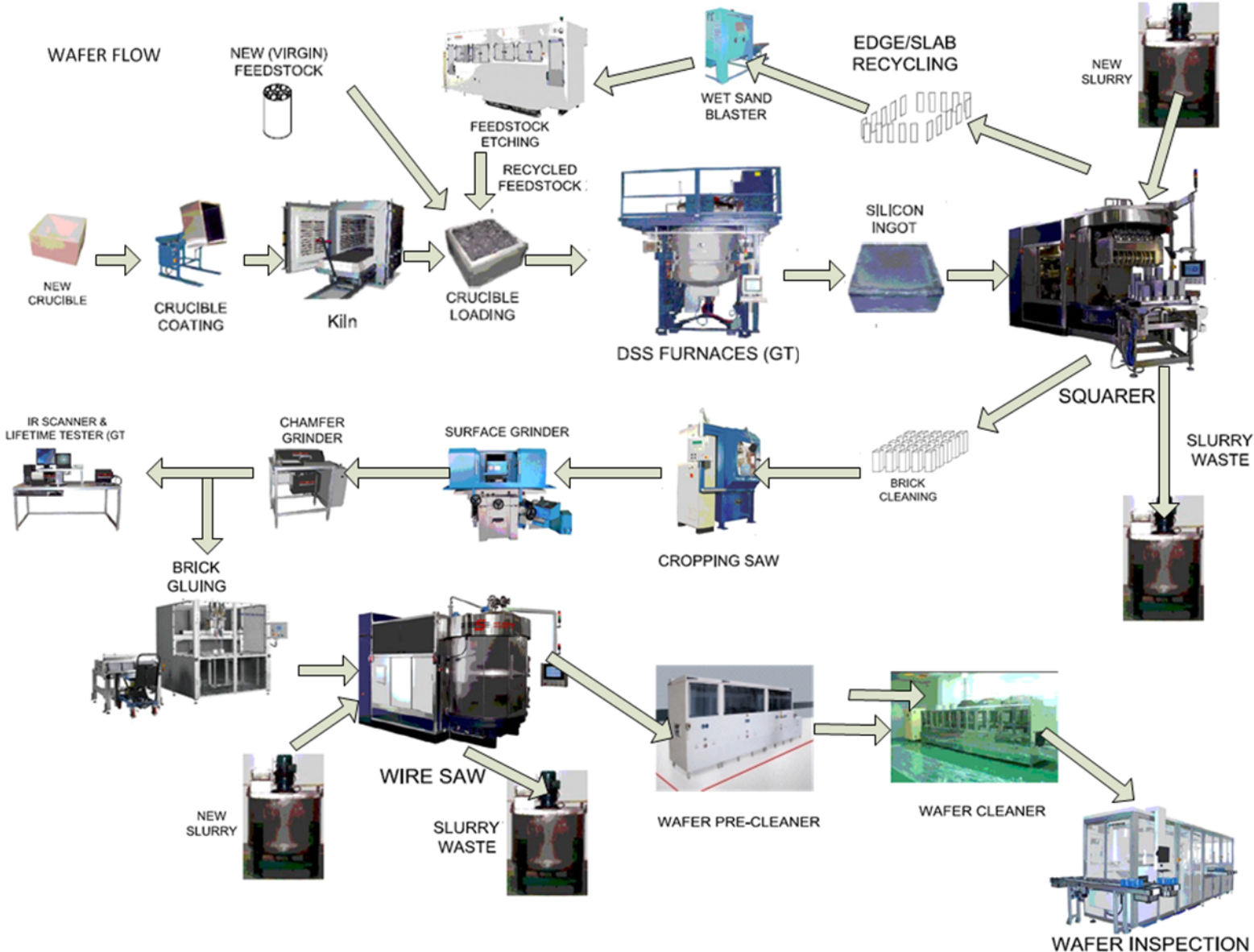
$\frac{1}{2}$  Labor

$\frac{1}{2}$  Materials

$\frac{1}{2}$  Consumables

**Silicon wafers are  
1/3 of the panel cost**

# Standard Wafer Manufacturing



# Next Breakthrough in Crystallization

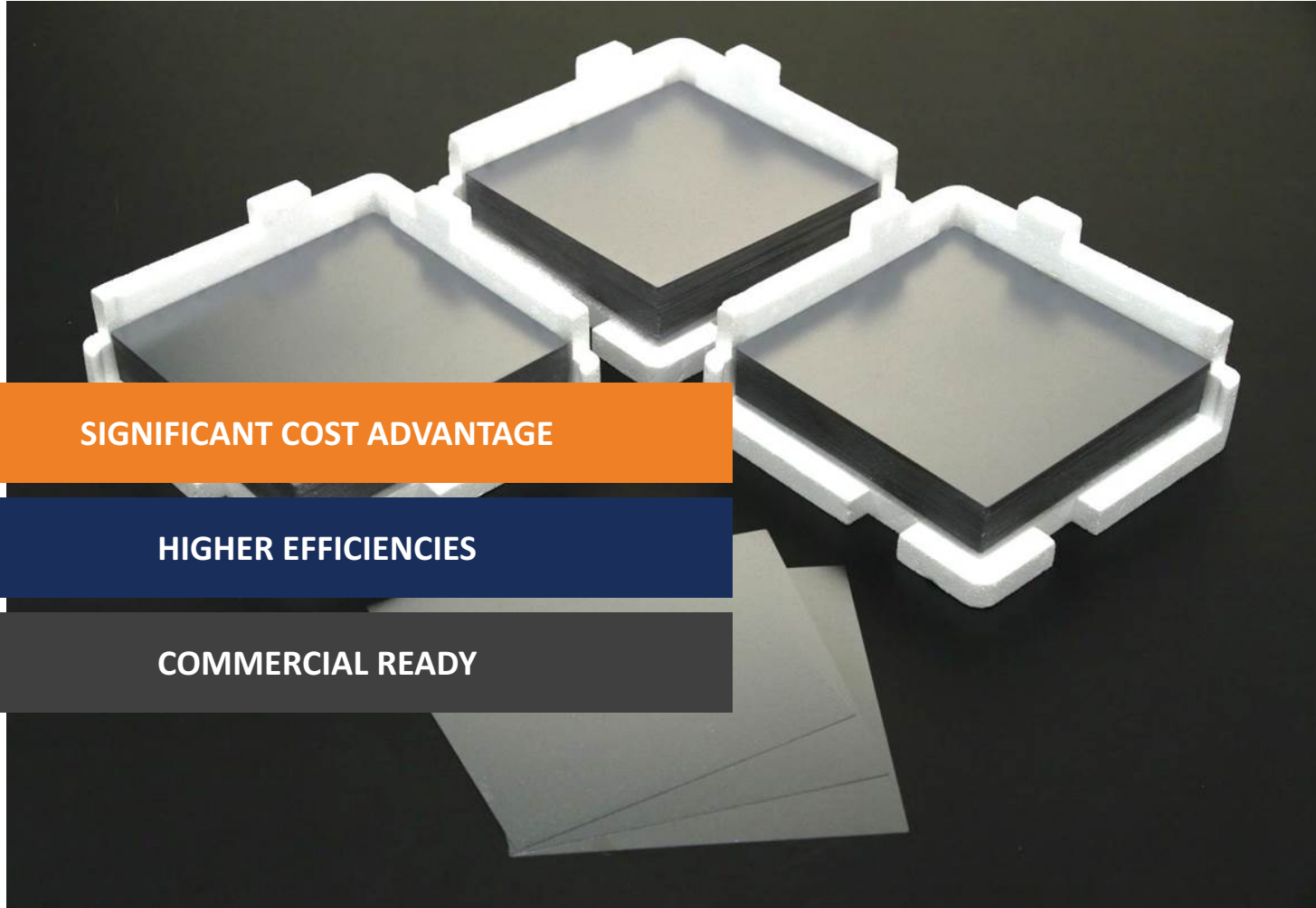


## Direct Wafer® Process (2009)



- Advanced manufacturing
- Delivers lowest LCOE
- 1/2 Cost
- 1/3 Energy
- 2x Si yield

# A GREAT PRODUCT BECOMES A SUPERIOR PRODUCT



**SIGNIFICANT COST ADVANTAGE**

**HIGHER EFFICIENCIES**

**COMMERCIAL READY**

# Energy Consumption




Sand/SiO<sub>2</sub>

24  
kWh/kg

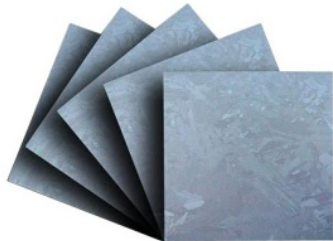


MG Si  
98%

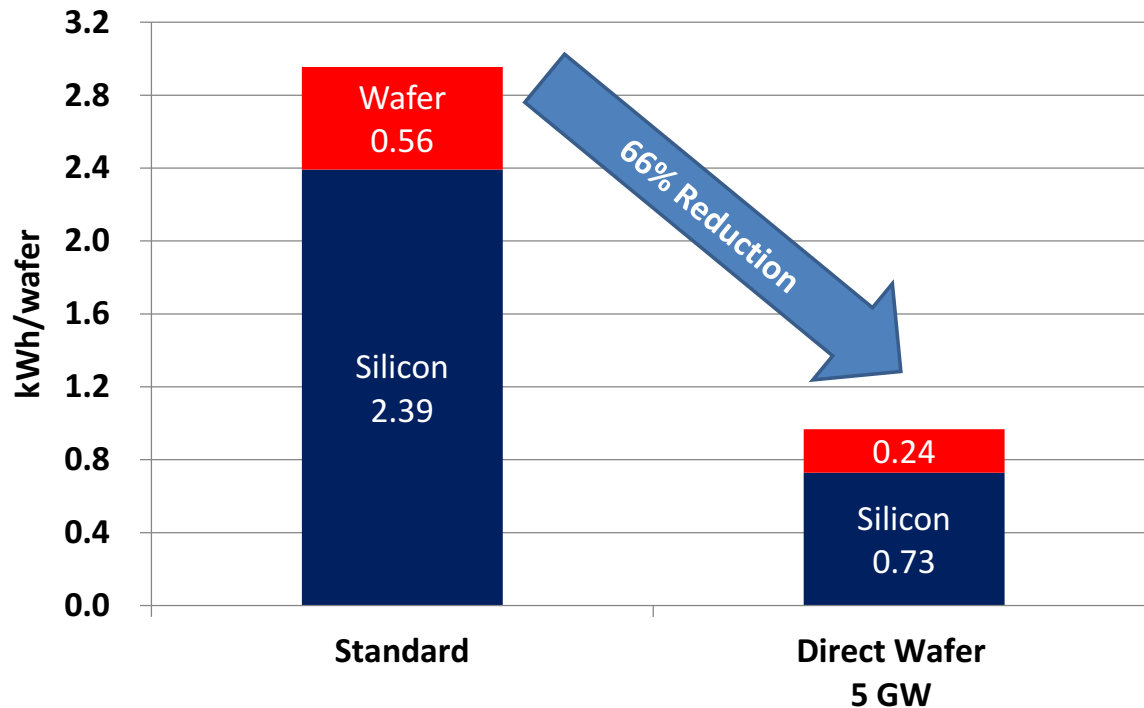
80  
kWh/kg



Solar Grad Si  
99.999999%

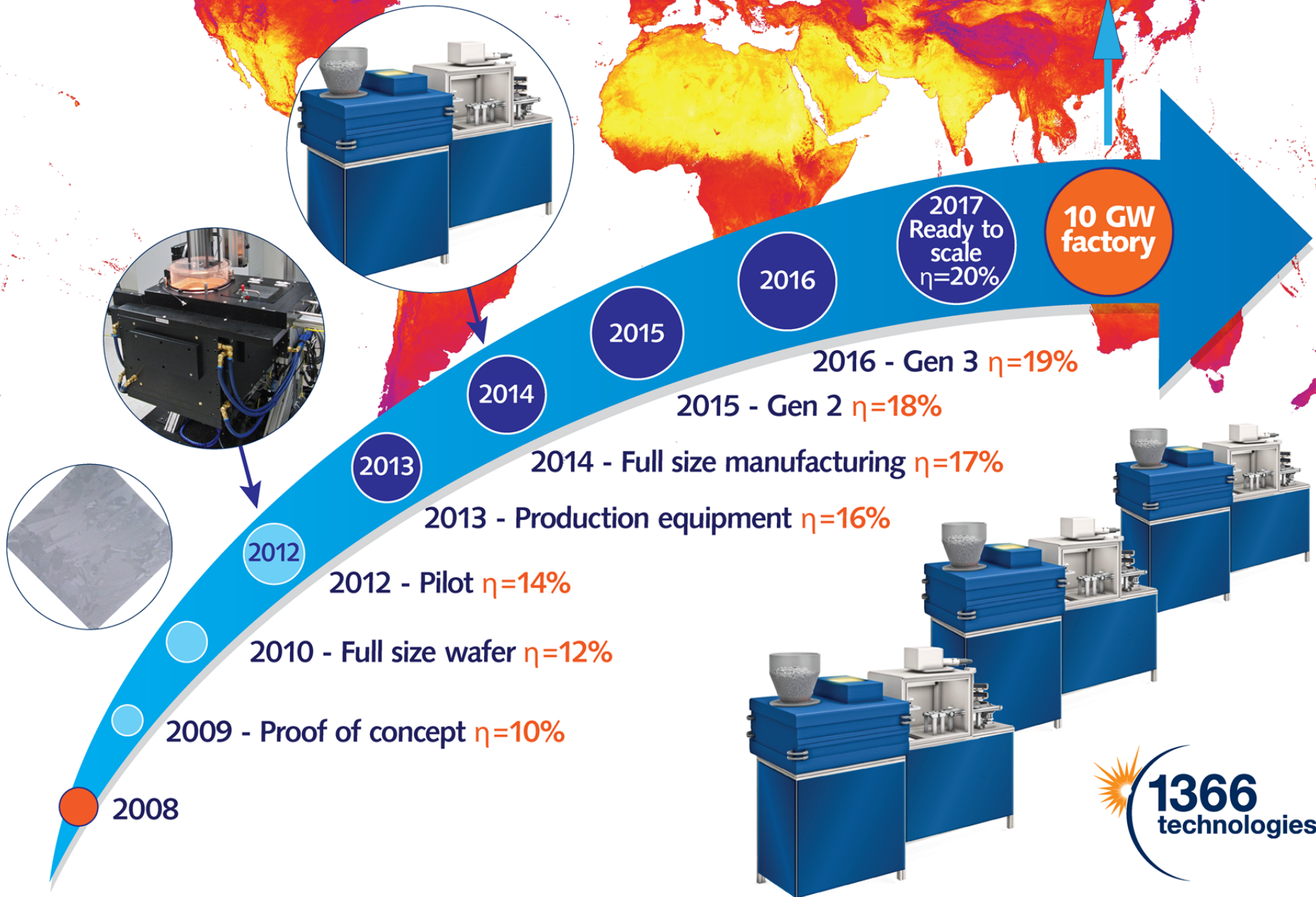


Wafer

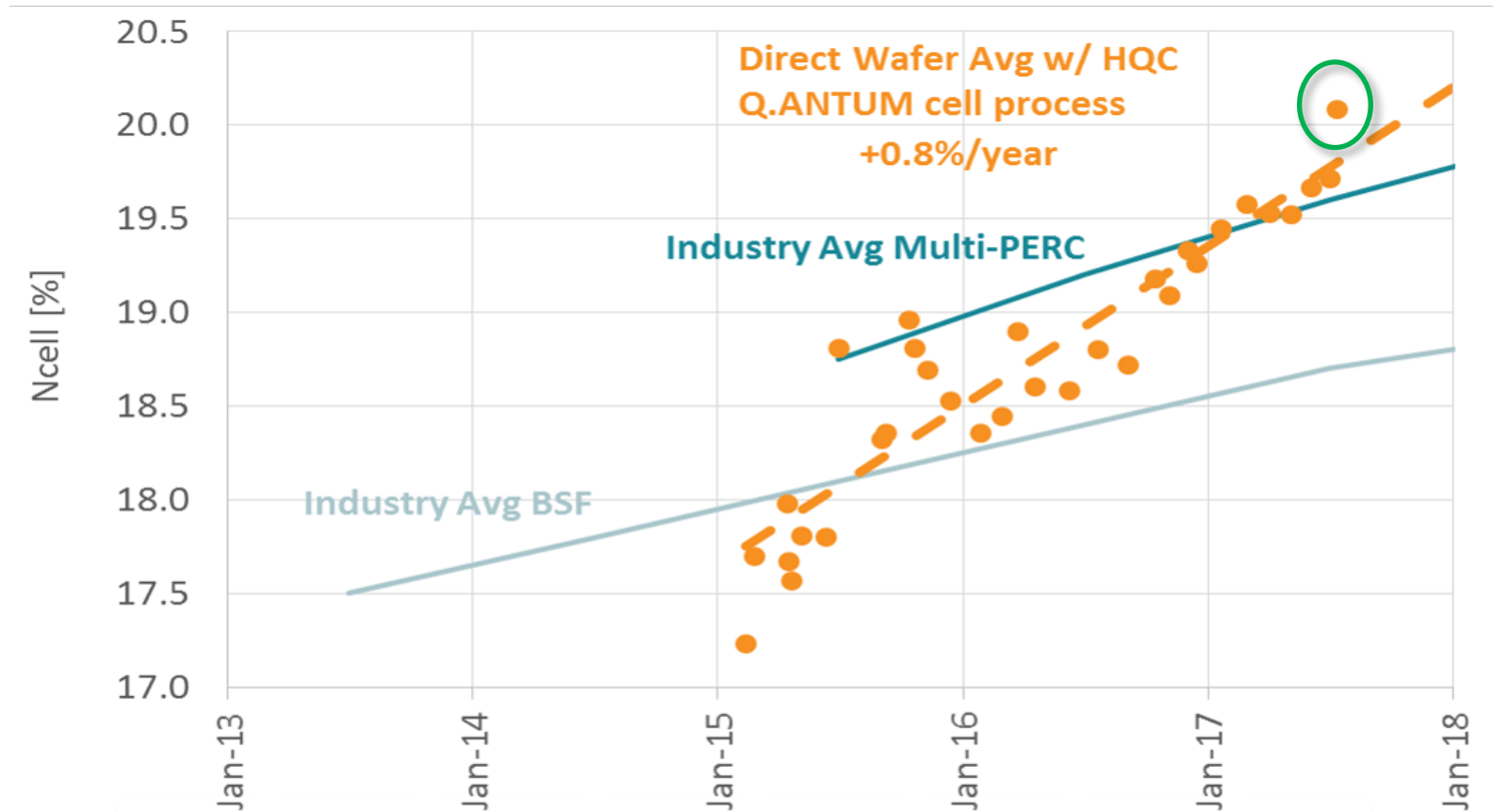




# Solar cheaper than coal



# A TECHNOLOGICAL ADVANTAGE IN ANY MARKET



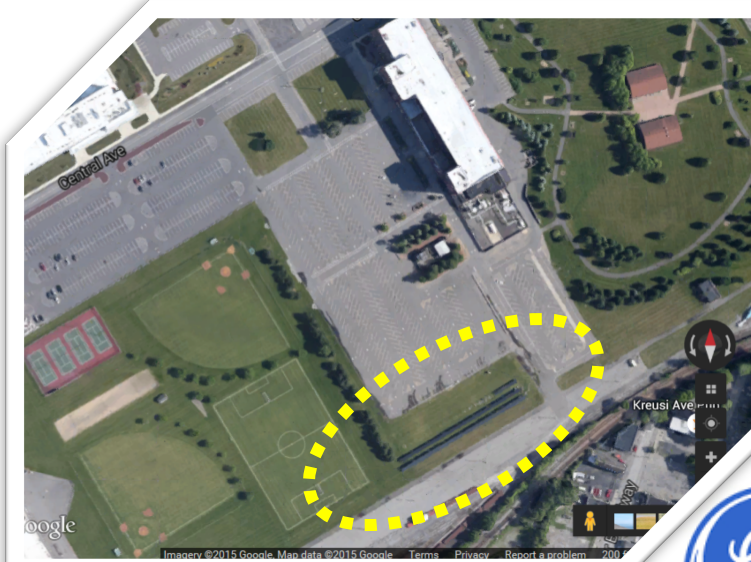
## EXCEEDED EFFICIENCY OF MULTI REFERENCE GROUP

- EFFICIENCY GAINS OF 0.8% PER YEAR
- DOPING GRADIENT +0.3%
- DARK ANNEAL +0.3%
- WINS ON COST

# Customer Projects



# GE Installation (New York)



Power	Energy today	Energy this month	Lifetime energy
4.97 kW	8.26 kWh	31.72 kWh	2.33 MWh

**solar edge**

**Site summary**

Site status: ✔

Id: 188556  
 Name: OTF - 1366 - Bid 40  
 Country: United States  
 State: New York  
 City: Schenectady  
 Address: 1 River Road  
 Installed: 11/12/2015  
 Last updated: 12/03/2015 10:03  
 Peak power: 49.9 kWp

**Weather**

Temperature 4.6 °C  
 Cloudy  
 Feels like -0.2 °C  
 Wind WNW, 27.5 kmh  
 Humidity 84.1 %  
 Sunrise at 07:08  
 Sunset at 16:22

☀️ Thursday 7 - 2 °C  
 Mostly Cloudy

☁️ Friday 8 - 2 °C  
 Mostly Cloudy

☀️ Saturday 9 - 2 °C  
 Mostly Sunny

**Power and Energy**

Week: Month: Year: 11/01/2015 - 11/30/2015

Solar Production: 2.19 MWh

Nov 2015 Apply Previous month Next month

**Site Image**

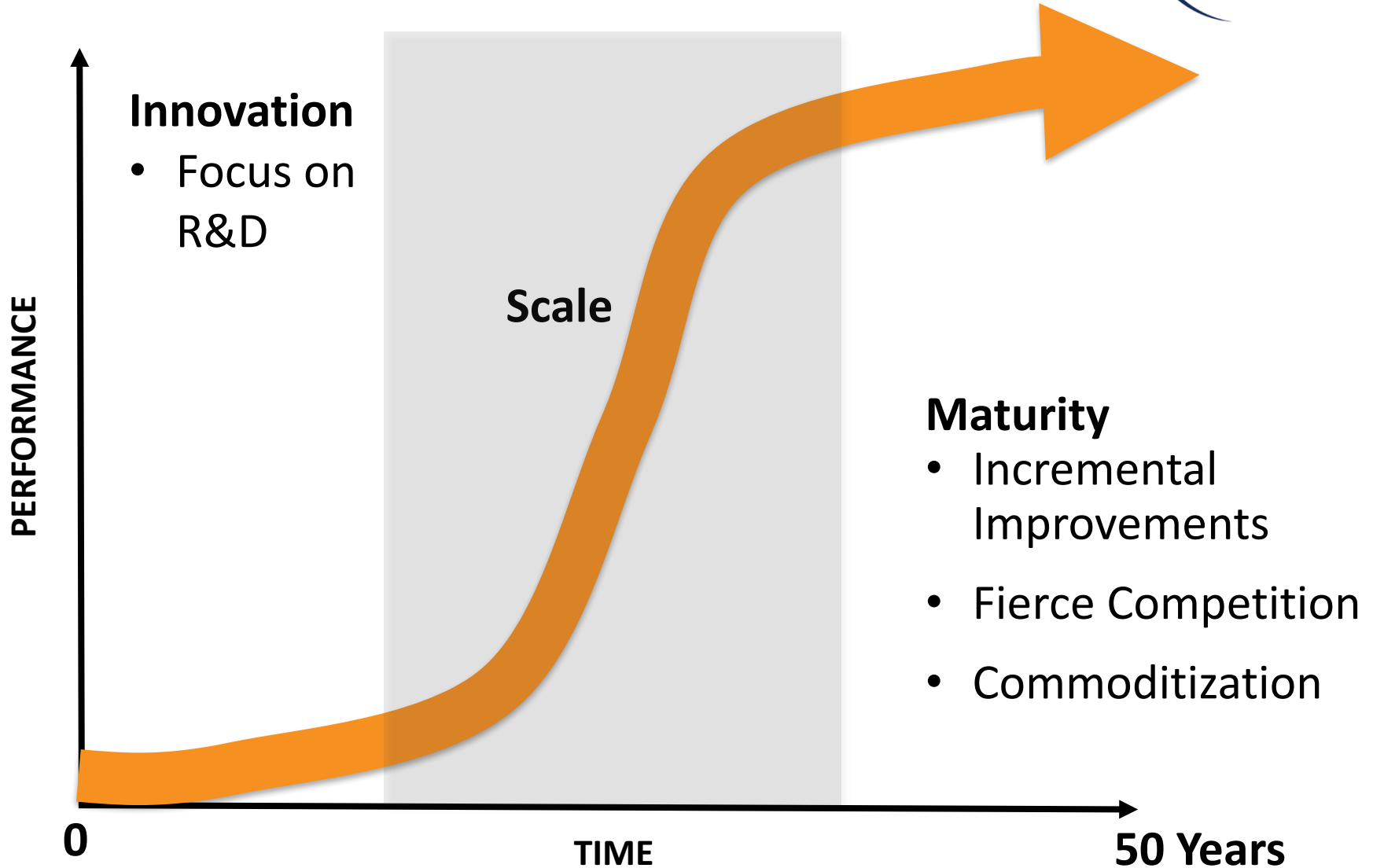
# 120k wafer shipment



# IHI 500kW project



# Innovation S Curve



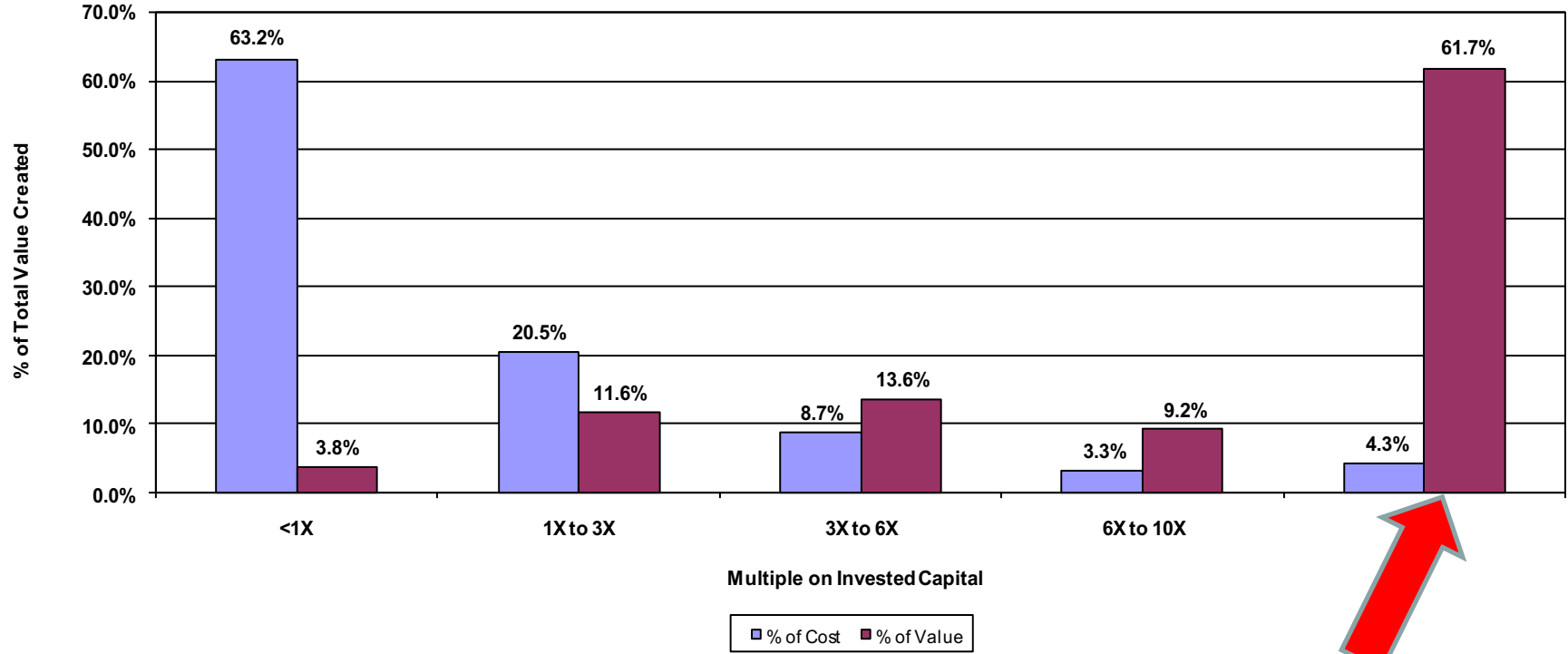
# So what did we learn?





# VCs need >10X return

Top-Quartile VC Fund Return Profile 1990 - 2006  
468 Investments  
\$1,305 MM Cost / \$3,338 MM Value - 2.56X

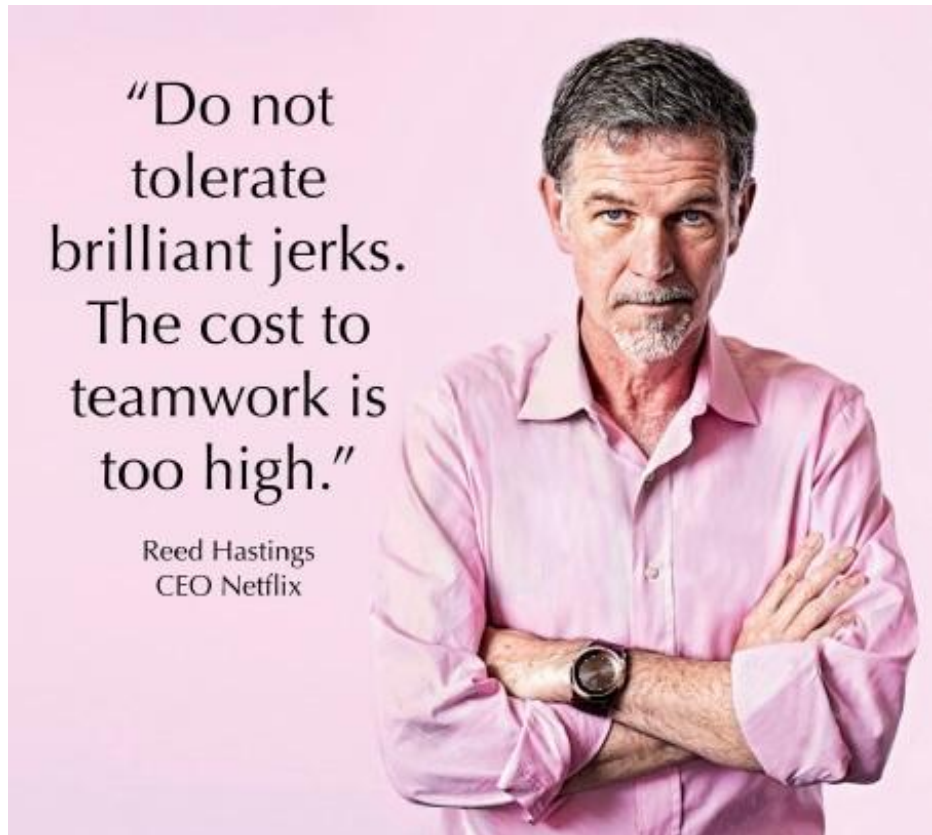


Data: Professor William Sahlman, HBS

Remember the Right-hand Tail

# Human Resources

## Make recruiting a core competence



- Talent attracts talent
- Full spectrum skills
  - Engineering
  - Marketing
  - Sales
  - Finance
- Diversity helps
- 60 > 40 & 80 < 60

# Pro & Cons of VC investments

- Ability to invest into the future
- Long time horizon
- Access to an amazing network
- Lay foundations for a very large venture

- Loose control
- Significant extra costs
  - Lawyers
  - Accountants
  - Investment Bankers
- Eliminates immediate pressure to make a profit

# Classic Yankee strengths

## Still matter

- Frugal (Make every \$ count)
- Hard work
- Build functioning technology