

ROI And HPC Research Pilot Study: ***Creating Economic Models*** ***For Financial ROI And Innovation*** ***From HPC Investments***

April 9, 23014

Earl Joseph, ejoseph@idc.com
Steve Conway, sconway@idc.com
Chirag Dekate, cdekate@idc.com

The authors thank DOE for its insights and guidance on and funding of this grant-based research project.

This study is based upon work funded by the U.S. Department of Energy Office of Science, Office of Advanced Scientific Computing Research, and the National Nuclear Security Administration, under award number DE-SC0008540.

DOE Program Managers:

Christine Chalk, 301-903-5152, christine.chalk@science.doe.gov, and Barbara J. Helland, 301-903-3127, barbara.helland@science.doe.gov, U.S. Department of Energy Office of Science, Germantown Building, 1000 Independence Avenue, S.W. Washington, D.C., 20585-1290.
and Bob Meisner in National Nuclear security Administration (NNSA).

Administrator/Contracting Officer:

Warren Riley, 630-252-2485, warren.riley@ch.doe.gov, U.S. Department of Energy Office of Acquisition and Assistance, 9800 South Cass Avenue, Argonne, Illinois, 60439

IDC Reporting:

- Principal investigator: Earl C. Joseph, Ph.D., 612-812-5798, ejoseph@idc.com
- Senior technical project manager: John Daly, 508-935-4643, jdaly@idc.com

A pilot study that describes how HPC investments are related to improved economic success and increased scientific innovation

The study included creating two unique models:

1. A macroeconomic model which depicts how HPC investments result in economic advancements in the form of ROI, growth and jobs
2. An "Innovation Index" that measures and compares innovation levels, based on the level of applying HPC computing resources towards scientific and technical advancement

The Financial ROI Models That Were Developed

The Financial ROI models include:

- 1. ROI based on revenues/GDP generated, divided by HPC investment**
- 2. ROI based on profits generated, divided by HPC investment**
- 3. ROI based on jobs created (and the HPC investment required per job created)**

The ROI models were tested for variances by:

- Industry sector
- Country
- Organization size

The Innovation Models That Were Developed

The Innovation models are of two main types:

- 1. Basic Research / Major Innovations**
- 2. Applied Research / Incremental Innovations**

These are captured as:

- Innovations in government & academia
- Innovations in industry

The Innovation models can be sorted for variances by:

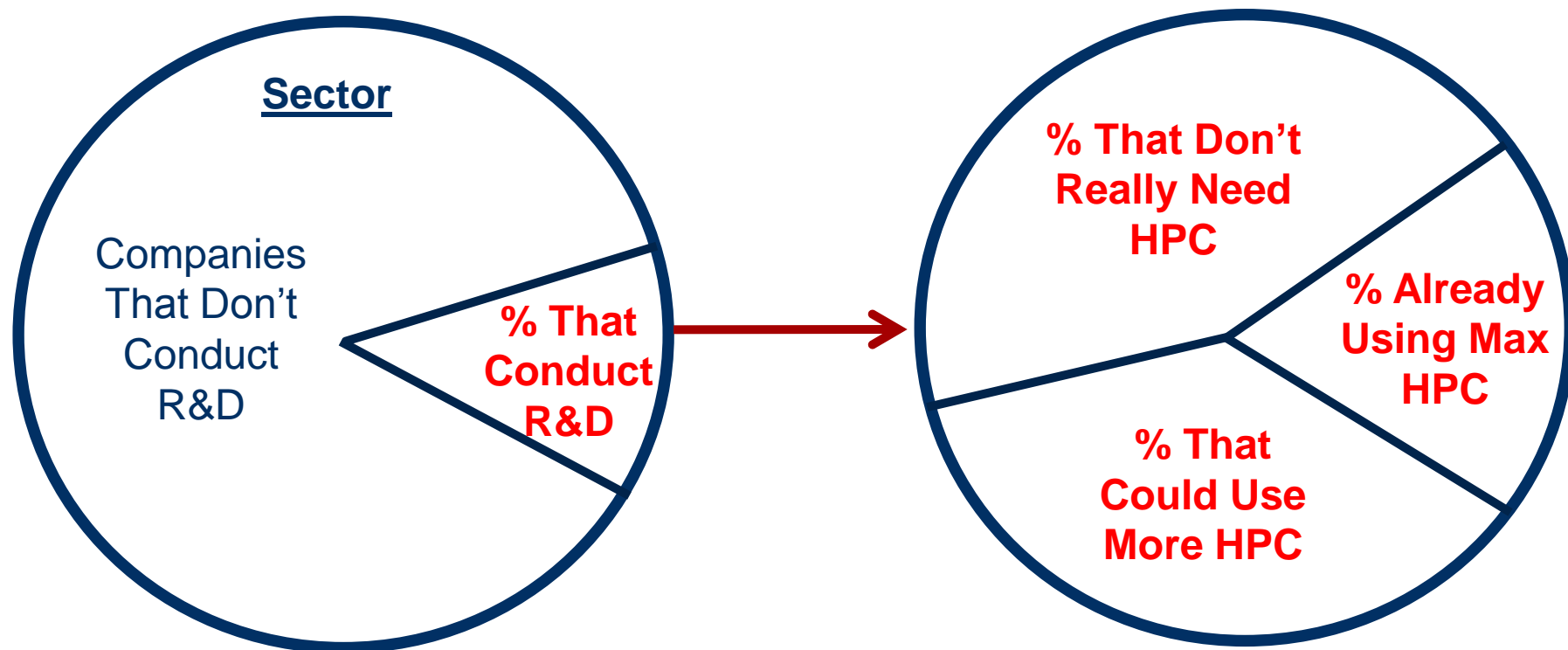
- Industry sector
- Country
- Organization size
- Government, Industry and Academia

- 10 = One of the top 2 to 3 innovations in the last decade**
- 9 = One of the top 5 innovations in the last decade**
- 8 = One of the top 10 innovations in the last decade**
- 7 = One of the top 25 innovations in the last decade**
- 6 = One of the top 50 innovations in the last decade**
- 5 = It had a major impact and is useful to many organizations**
- 4 = A minor innovation that is useful to many organizations**
- 3 = A minor innovation or only useful to 2 -3 organizations**
- 2 = A minor innovation or only useful to 1 organization**
- 1 = An innovation that is recognized ONLY by experts in the field**

- **IDC is able to collect the required data across a broad set of organizations, with enough detail to create the economic models and the innovation index**
- **Early results indicate very substantial returns related to investments in HPC, on average:**
 - **\$356.5 in revenue per dollar of HPC invested**
 - **\$38.7 of profits/cost savings per dollar of HPC invested**
 - **The average HPC investment per innovation was \$3.1M**
- **Note that an additional outcome of this research is an expansive list of HPC success stories**

Research Overview – Parameters Being Collected to Tie to Broader Economic Reports

For each sector we need 4 basic ratios



Note: IDC has conducted over 30,000 light phone calls for this data.
We will likely require 5x to 10x more surveys

Sample demographics:

- A total of 208 case study examples of ROI and innovations were collected as part of the study:
 - 67 financial ROI examples
 - 141 innovation examples
- In addition, a large number of micro-surveys were conducted to learn key ratios in order to eventually apply the results to large economic data sets.
 - Over 30,000 scientists and engineers were contacted, with over 1,500 completing the micro-survey.

Pilot Study Results: Financial ROI

Key Findings: Primary Financial ROI Results

1. IDC is able to collect the required data across a broad set of organizations with enough detail to create the two economic models and the innovation index
2. Early results indicate very substantial returns for investments in HPC:
 - \$356 dollars on average in revenue per dollar of HPC invested.
 - \$38 dollars on average of profits (or cost savings) per dollar of HPC invested.

Key Findings: The Financial ROI Model – By Sector

3	Organization Size: People	(All)	▼				
4	Organization Size in \$M	(All)	▼				
5	Organization Size (S,M,L)	(All)	▼				
6	Industry	(All)	▼				
7	Innovation Level	(All)	▼				
8	Country	(All)	▼				
9	Years Before 1st Return	(All)	▼				
10	Applied	(All)	▼				
11	Basic	(All)	▼				
12	Accomplishment Type	Financial R	▼				
13	Total R&D	(All)	▼				
14	Employee Growth	(All)	▼				
15	Organization Type	(All)	▼				
16	Total HPC Investment	(All)	▼				
17							
				Sum of	Years	Average of	Average of
				Employee	Before 1st	Revenue \$	Profit \$ per
19	Sector	▼	Count	Growth	Return	per HPC \$	HPC \$
20	Academic		12	2	1.8	37.4	70.8
21	Government		4	10	1.4	9.2	3.9
22	Industry		51	1,157	1.9	462.4	36.4
23	Grand Total		67	1,169	1.9	356.5	38.7

Key Findings: The Financial ROI Model – By Country

3	Organization Size: People	(All)	▼				
4	Organization Size in \$M	(All)	▼				
5	Organization Size (S,M,L)	(All)	▼				
6	Industry	(All)	▼				
7	Innovation Level	(All)	▼				
8	Years Before 1st Return	(All)	▼				
9	Applied	(All)	▼				
10	Basic	(All)	▼				
11	Sector	(All)	▼				
12	Accomplishment Type	Financial	▼	ROI			
13	Total R&D	(All)	▼				
14	Employee Growth	(All)	▼				
15	Organization Type	(All)	▼				
16	Total HPC Investment	(All)	▼				
17							
18							
19	Country	▼	Count	Sum of Employee Growth	Average Years Before 1st Return	Average of Revenue \$ per HPC \$	Average of Profit \$ per HPC \$
20	China		3	30	1.3	8.7	5.4
21	France		4		5.1	621.7	125.0
22	UK		31	896	1.6	366.5	26.7
23	US		27	243	1.8	373.3	49.8
24	Italy		2		1.0	10.0	7.5
25	Grand Total		67	1,169	1.9	356.5	38.7

Key Findings: Additional Financial ROI Results

- 3. The average number of years before returns started was 1.9 years.**

- 4. The overall average HPC investment cost for jobs created was \$93,000.**
 - 42 sites reported job creation. On average 29.8 jobs were created from HPC investments at these sites.
 - A total of 1,251 jobs were created from the 42 financial ROI examples

Pilot Study Results: Innovation

Key Findings: The Innovation Areas For The 141 Innovation Data Examples

Industry	(All) ▼		
Years Before 1st Return	(All) ▼		
Applied	(All) ▼		
Basic	(All) ▼		
Accomplishment Type	Innovation ▼		
Country	(All) ▼		
Total R&D	(All) ▼		
Organization Type	(All) ▼		

Primary Innovation / ROI Area ▼	Count	Sum of Total HPC Investment	Average Years Before 1st Return	Average of HPC \$M per Innovation
Better Products	54	\$114 M	1.9	\$4.2 M
Created New Approach	40	\$15 M	1.2	\$0.4 M
Discovered Something New	20	\$46 M	1.8	\$2.7 M
Helped Society	11	\$66 M	1.0	\$6.0 M
Cost Saving	6	\$180 M	1.3	\$2.1 M
Major Breakthrough	5	\$3 M	3.2	\$1.1 M
Helped Research Program	5	\$71 M	1.5	\$14.3 M
Grand Total	141	\$497 M	1.6	\$3.1 M

5. The average HPC investment per innovation was **\$3.1 million.**

- Overall \$497 million in HPC investments were made to generate the 141 innovations in the pilot study.
- With many at under \$1 million per innovation.

Key Findings: The New Innovation Index Scores

The average innovation rating = 5.0

- 4.4 for the 67 basic research/major innovations
- 5.5 for the 74 applied research/incremental innovations

10 = One of the top 2 to 3 innovations in the last decade

9 = One of the top 5 innovations in the last decade

8 = One of the top 10 innovations in the last decade

7 = One of the top 25 innovations in the last decade

6 = One of the top 50 innovations in the last decade

5 = It had a major impact and is useful to many organizations

4 = A minor innovation that is useful to many organizations

3 = A minor innovation or only useful to 2 -3 organizations

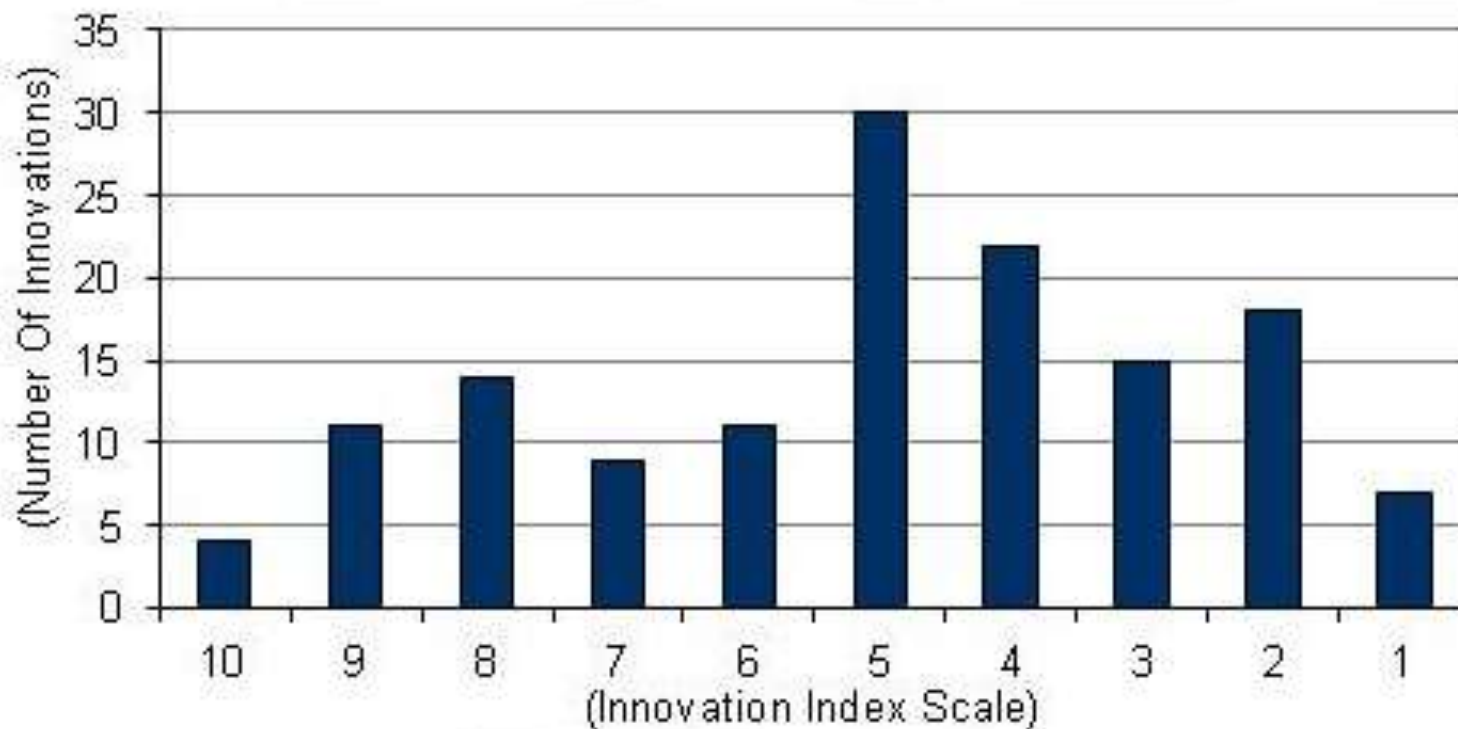
2 = A minor innovation or only useful to 1 organization

1 = An innovation that is recognized ONLY by experts in the field

Key Findings: The New Innovation Index Scores – For All 141 Innovations

FIGURE 12

HPC Innovation Index Scale Results: All Respondents



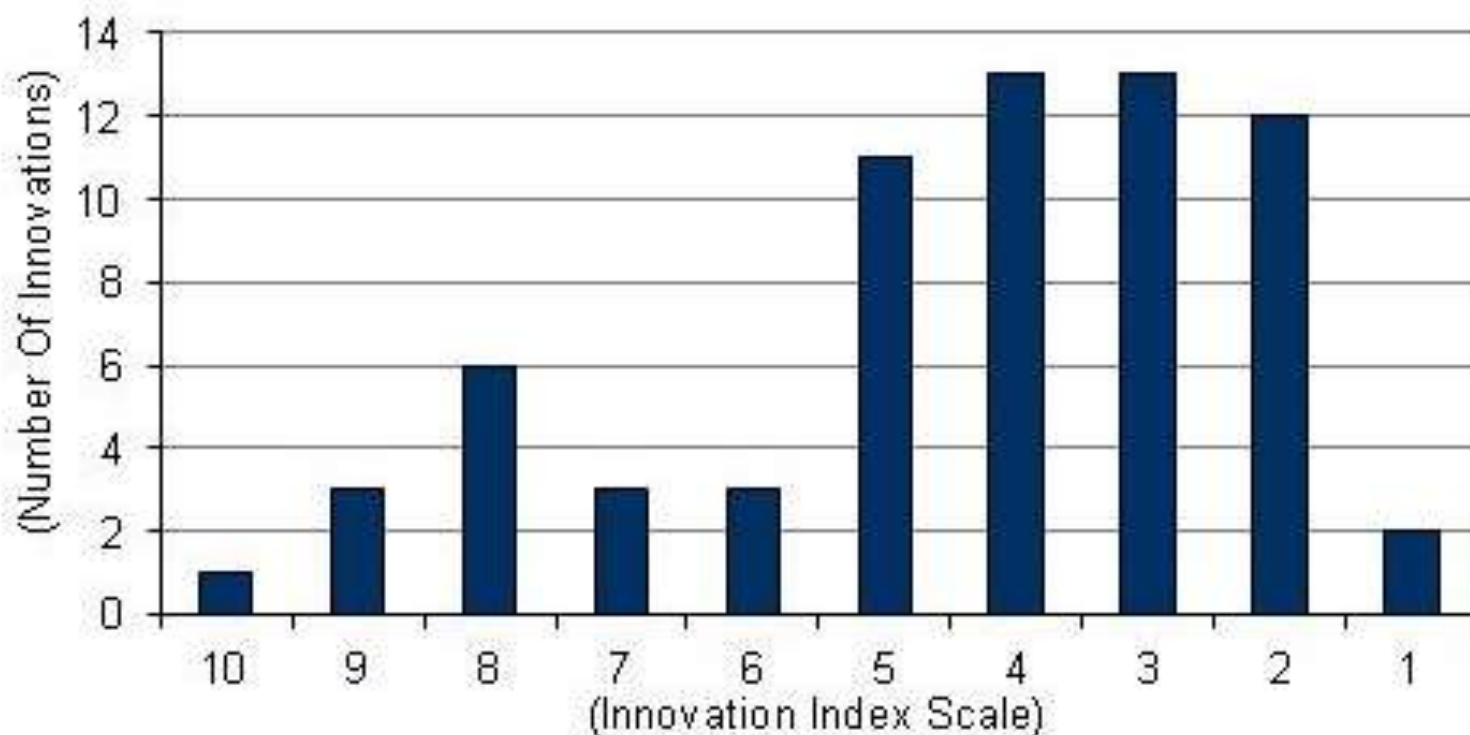
N = 141

Source: IDC 2013

Key Findings: The New Innovation Index Scores – The 67 Basic Research Innovations

FIGURE 13

HPC Innovation Index Scale Results: Basic Innovations



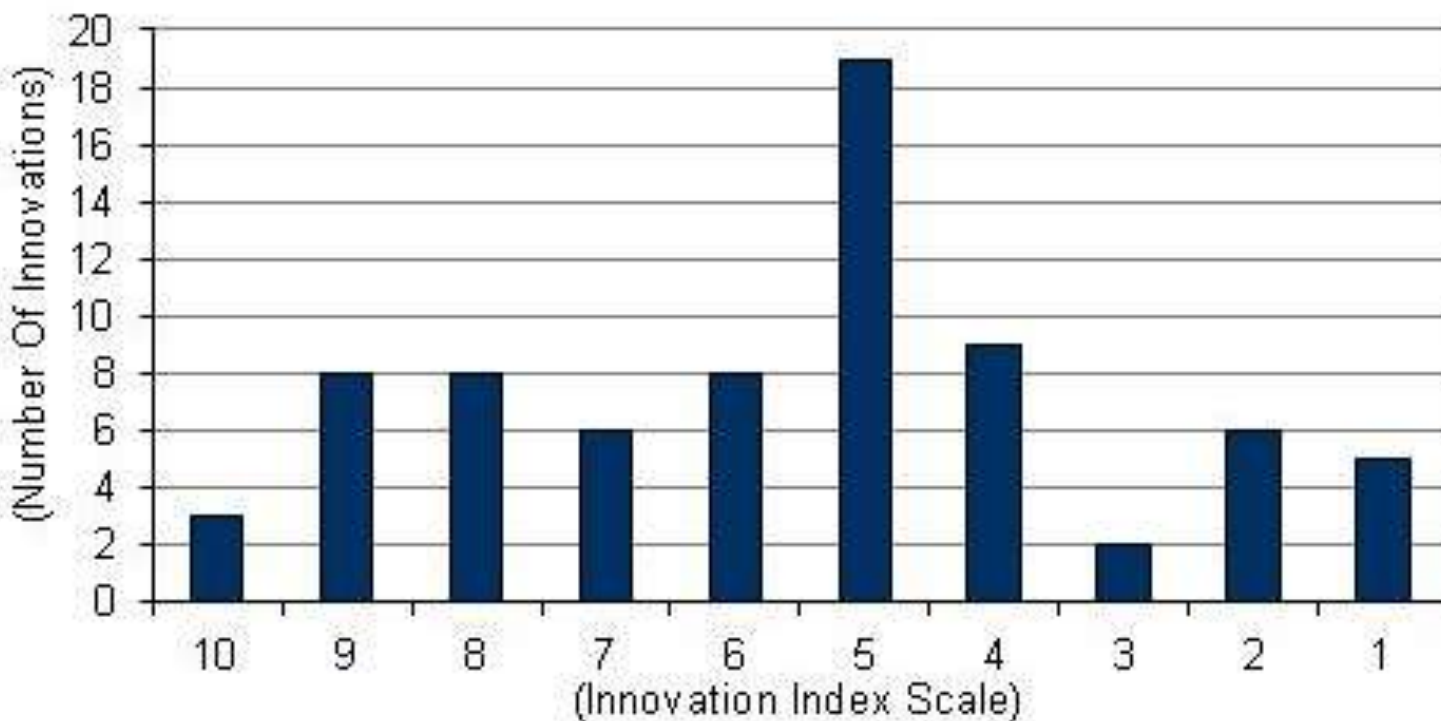
N = 67

Source: IDC 2013

Key Findings: The New Innovation Index Scores – The 74 Applied Research Innovations

FIGURE 14

HPC Innovation Index Scale Results: Applied Innovations



N = 74

Source: IDC 2013

Key Findings: The Innovation Index By Country

Sector	(All)	<input type="button" value="v"/>			
Accomplishment 1 Innovation		<input type="button" value="v"/>			
Years Before 1st R	(All)	<input type="button" value="v"/>			
Jobs Added	(All)	<input type="button" value="v"/>			
Total R&D	(All)	<input type="button" value="v"/>			
Employee Growth	(All)	<input type="button" value="v"/>			
Organization Type	(All)	<input type="button" value="v"/>			
Basic/ Applied	(All)	<input type="button" value="v"/>			
Innovation Level	(All)	<input type="button" value="v"/>			
Country	<input type="button" value="v"/>	Count of Basic	Count of Applied	Average Innovation Level	Average of HPC \$M per Innovation
China		3.0	10.0	6.8	12.0
France			4.0	8.5	17.1
India		1.0		8.0	
UK		43.0	7.0	3.5	1.1
US		20.0	48.0	5.6	2.4
Italy			5.0	4.0	0.1
Grand Total		67.0	74.0	5.0	3.1

8. The total amount of HPC investments made in the sample was \$496.7 million.

- Government sites tend to invest more per innovation – at \$4.4 million in HPC on average.
- Academic sites invested less – averaging \$2.5 million in HPC per innovation.
- Industrial sites invested on average \$3.8 million in HPC per innovation.

Note: there were two sites with considerably higher returns that were removed from the dataset as outliers:

1. \$10,057 revenue dollars per dollar of HPC invested at a finance company

- If included, this raises the overall revenue ROI from \$365.5 to \$536.2

2. \$1,350 in profit dollars per HPC dollar invested at an oil & gas company

- If included, this raises the overall profit ROI from \$38.7 to \$65.5

Note that an additional outcome of this research is an expansive list of HPC success stories.

- These can be used to help explain the importance of HPC to funding bodies, key decision makers and the broader public.
- IDC is writing up a number of them for broader dissemination.

Questions?

Please email:
hpc@idc.com

Or check out:
www.hpcuserforum.com

