IDC HPC ROI Research Update:

Economic Models For Financial ROI And Innovation From HPC Investments

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New Findings: The ROI Is Very High

New results indicate higher ROI returns related to investments in HPC, compared to the pilot study

- On average, from the latest data:
  - $**514.7** in revenue per dollar of HPC invested
  - $**43.2** of profits/cost savings per dollar of HPC invested
  - The average HPC investment per innovation was $**3.0M**

- From the 2013 pilot study:
  - $357 in revenue per dollar of HPC invested
  - $39 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

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Grant References

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Background: Three-Year Research Plan

- **2013 pilot study:**
  - Tested 3 approaches and set the models
  - Populated the models with 208 cases of scientific innovation and industrial ROI (it now exceeds 325)
  - Created the innovation index
- **Three-year study: sponsored by DOE Science/NNSA**
  - Refine the models to move from association towards causation
  - Collect thousands of cases:
    - Dense collection in the U.S.
    - Sparser collection elsewhere (but still large)

Background: Project Overview

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

The study includes large scale data collection to populate 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. **Two** Innovation Indexes that measures and compares innovation levels, based on the level of applying HPC computing resources towards scientific and technical advancement

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The Financial ROI Models Used

The Financial ROI models:

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 show variances by:

- Industry sector
- Country
- Organization size

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The Updated Innovation Models Used

Two innovations indexes are now being used:

1. **Based on the importance of the innovation**
2. **How broadly the innovations impact different organizations**

The innovations are also sorted by the primary area:

1. Better Products
2. Major Scientific Breakthrough
3. Cost Saving
4. Created New Approach
5. Discovered Something New
6. Helped Society
7. Helped Research Program

The Two Innovation Index Scales

The IMPORTANCE this innovation compared to all other innovations in this field over the last ten years

5. One of the top 2 to 3 innovations in the last decade
4. One of the top 5 innovations in the last decade
3. One of the top 10 innovations in the last decade
2. One of the top 25 innovations in the last decade
1. One of the top 50 innovations in the last decade

The IMPACT of this innovation to multiple organizations

5. An innovation that is useful to over 10 organizations
4. An innovation that is useful to 6 to 10 organizations
3. An innovation useful to 2 to 5 organizations
2. An innovation only useful to 1 organization
1. An innovation that is recognized ONLY by experts in the field

The Innovation Models Used

Plus the innovations are sorted by:

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

The Innovation models can be sorted for variances by:

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

Sample Characteristics

Sample demographics:

- As of July 30th, 2015 we are at **329** case study examples of ROI and innovations:
  - **114 financial ROI examples**
  - **215 innovation examples**

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Study Results:
The Financial ROI From HPC

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New Findings:
Primary Financial ROI Results

Results continue to indicate very substantial returns for investments in HPC:

- **$515 dollars on average in revenue** per dollar of HPC invested.
- **$43 dollars on average of profits** (or cost savings) per dollar of HPC invested.

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New Findings: Financial ROI Model – By Sector

Industry	(All)
Country	(All)
Years Before 1	(All)
Applied	(All)
Basic	(All)
Accomplishme	Financial R
Total R&D	(All)
Employee Gro	(All)
Organization T	(All)
Total HPC Inve	(All)

Sector	Sum of Employee Growth	Average Years Before 1st Return	Average of Revenue $ per HPC $	Average of Profit $ per HPC $	Count of Accomplishment Type
Academic	6	1.8	16.7	54.6	12
Government	12	1.5		7.4	8
Industry	1,775	2.0	523.2	44.7	94
Grand Total	**1,793**	**2.0**	**514.7**	**43.2**	**114**

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Previous Results (From the Pilot Study): Financial ROI Findings

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)				
19	Sector	Count	Sum of Employee Growth	Years Before 1st Return	Average of Revenue $ per HPC $	Average of Profit $ per 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**

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New Findings: Financial ROI Model – By Industry

Industry	Sum of Employee Growth	Average of Revenue $ per HPC $	Average of Profit $ per HPC $
Academic	6	16.7	54.6
Defense		75.0	5.3
Financial	600	834.0	80.5
Government	12		7.4
Insurance	5	71.4	
Life Sciences	4	238.2	55.5
Manufacturing	257	91.2	21.8
O&G	65	418.6	60.9
Retail	49	30.3	12.3
Telecomm	420	10.0	10.0
Transportation	375	1,804.3	15.6
Grand Total	**1,793**	**514.7**	**43.2**

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New Findings: Job Creation

1,733 jobs were created at 57 sites, from their Financial ROI projects

The overall average HPC investment cost per job created was $201,060

- 57 sites reported job creation -- On average 31.5 jobs were created from the HPC projects at these sites

Study Results: Innovation

New Findings: The Mix Of Innovation Types (For The Financial ROI Projects)

Primary Innovation / ROI Ar	Count of Primary Innovation / ROI Area	Sum of Total HPC Investment	Average Years Before 1st Return	Average of HPC $M per Innovation
Better Products	50	$263 M	2.1	$12.2 M
Cost Saving	3	$172 M	1.7	$1.8 M
Created New Approach	43	$147 M	1.9	$3.0 M
Discovered Something New	8	$1 M	2.1	
Helped Research Program	2	$6 M	2.0	$2.0 M
Helped Society	7	$43 M	1.3	$0.2 M
Major Breakthrough	1	$1 M	3.0	
Grand Total	**114**	**$633 M**	**2.0**	**$7.7 M**

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New Findings: The Mix Of Innovation Types (For The Innovation Projects)

Primary Innovation / ROI Are	Count of Primary Innovation / ROI Area	Sum of Total HPC Investment	Average Years Before 1st Return	Average of HPC $M per Innovation
Better Products	68	$136 M	1.9	$3.8 M
Cost Saving	8	$181 M	1.4	$1.9 M
Created New Approach	84	$83 M	1.7	$0.9 M
Discovered Something New	21	$67 M	1.9	$3.6 M
Helped Research Program	9	$76 M	1.3	$9.6 M
Helped Society	18	$92 M	1.2	$5.7 M
Major Breakthrough	7	$5 M	3.5	$1.0 M
Grand Total	**215**	**$640 M**	**1.8**	**$3.0 M**

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New Findings: Investments Per Innovation

The average HPC investment per innovation was:

- **$7.7M for financial ROI projects**
- **$3.0M for Innovation projects**

- Overall $640 million in HPC investments were made to generate the 215 innovations in the study
- $633 million in HPC was invested in 114 financial ROI projects in the study
- With many at under $1 million per innovation (~60% are under $1 million)

New Findings:
Innovations – Basic vs. Applied

Basic/ Applied	Count of Basic	Count of Applied
Applied		122
Basic	93	
Grand Total	**93**	**122**

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New Findings: Innovations – By Sector

Sector	Count of Basic/ Applied	Sum of Total HPC Investment	Average of HPC $M per Innovation
Academic	97	$200 M	$2.4 M
Government	21	$53 M	$4.0 M
Industry	97	$387 M	$3.6 M
Grand Total	**215**	**$640 M**	**$3.0 M**

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New Findings: Innovations – By Industry

Industry	Count of Basic	Count of Applied	Total Innovations
Academic	63	34	97
Defense		1	1
Financial	3	7	10
Government	11	10	21
Life Sciences	5	9	14
Manufacturing	9	43	52
O&G	1	9	10
Research		1	1
Telecomm		1	1
Transportation		1	1
Digital Content Creation		1	1
Agriculture		1	1
Environmental Safety		1	1
Entertainment		4	4
Grand Total	**92**	**123**	**215**

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New Findings: Innovations – By Country

Country	Count of Basic	Count of Applied	Average of HPC $M per Innovation	Total Innovations
China	3	11	12.3	14
France	1	10	4.6	11
India	1			1
UK	53	20	1.4	73
US	31	71	2.9	102
Italy		6	0.1	6
Germany	1	2		3
Canada	1			1
Slovenia		1	0.1	1
Netherlands		1		1
Australia	1	1		2
Grand Total	**92**	**123**	**3.0**	**215**

Note: The data set today isn't complete enough to make country-to-country comparisons. There are also differences by country on how sites calculate returns and costs, that causes variations in the data.

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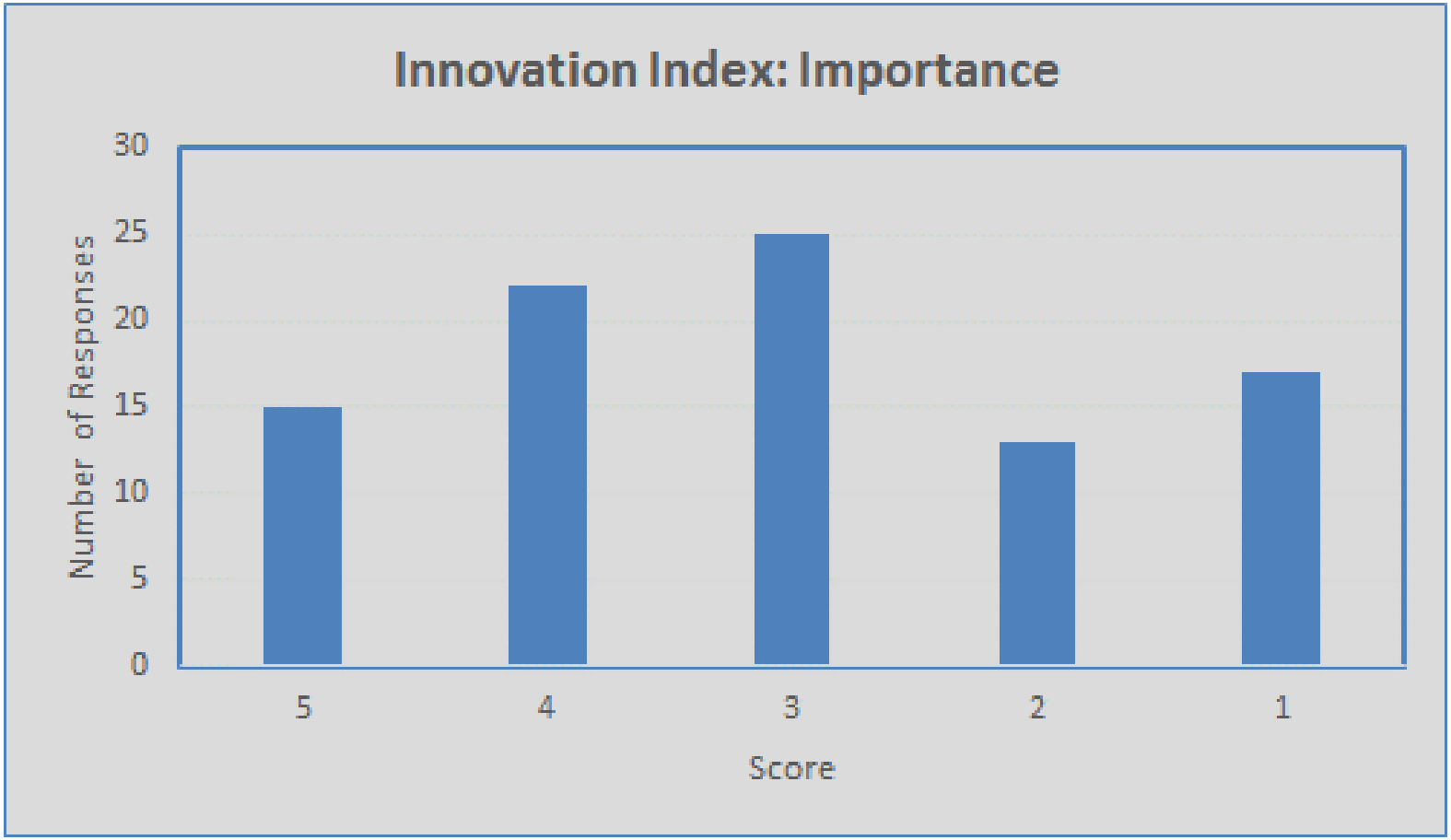
New Findings: The Innovation IMPORTANCE Index



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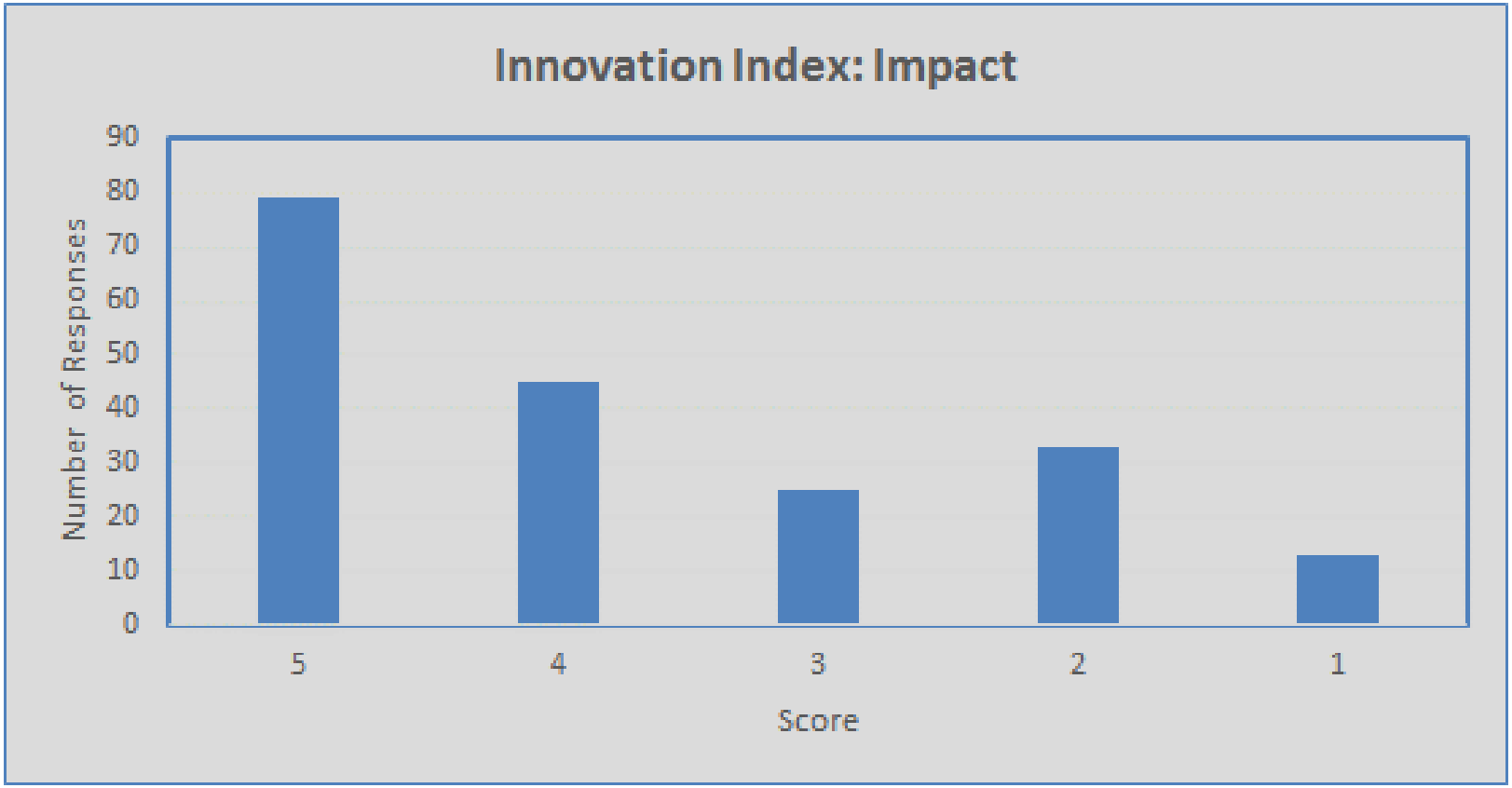
New Findings: The Innovation IMPACT Index



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New Findings: Size Of the HPC Investments

The total amount of HPC investments made in the sample was $1,273 million

- Government sites invested an average of $2.3M per project
- Academic sites invested an average of $1.9M per project
- Industrial sites invested an average of $5.3M per project

Sector	Sum of Total HPC Investment	Count of Accomplishment Type	Average HPC $ Per Project
Academic	$203 M	109	$1.862 M
Government	$66 M	29	$2.292 M
Industry	$1,003 M	191	$5.254 M
Grand Total	**$1,273 M**	**329**	**$3.869 M**

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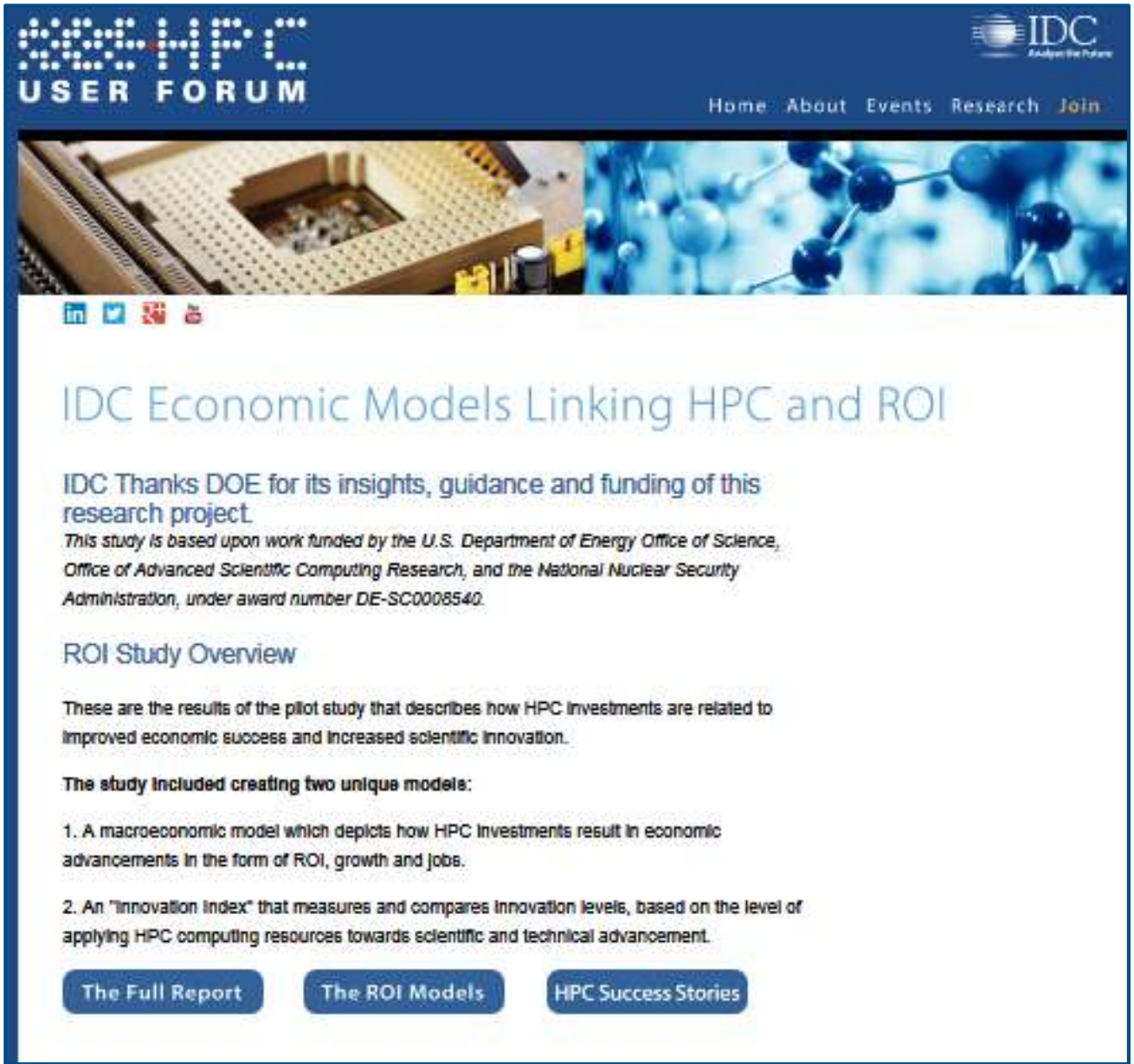
Some Notes About The Data: Outliers

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

- **$11,600 and $9,333 revenue dollars per dollar of HPC invested at two finance companies**
  - If included, this would raise the average revenue ROI by over $250

Current Web Page – Any Suggestions?

www.hpcuserforum.com/ROI



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Questions?

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