

February 9, 2009

### **Evaluation of Potential Technologies for King Saud University.**

#### ***Technology Evaluations***

As requested, the attached Excel workbook provides a revised look at the recommended technologies that includes explicit ratings against the criteria. We rated each technology on a scale of 10 as the highest to 0 for each criterion, with the 6 criteria weighted equally. The brief written descriptions of the technology areas have been updated to better explain the rationale that led to the rating. This list also includes the additional technology areas that you are discovering in your conversations with TCG members for a total of 56 technology areas.

We used the following criteria in order to focus on the most attractive opportunities. We hope you will recall that we arrived at this criteria based on our telephone conversations, the SRI report, public sources reporting on RTV and King Saud University, and our best judgment.

- Become commercialized in the next 2 to 4 years
- Produce research of scientific significance
- Have global research and markets
- Produce social benefits in the Middle East and the world as a whole, such as employment opportunities, upgrading the labor force, national prestige, etc.
- Produce scholarly publications, conferences, and other prestigious academic activities
- Produce an attractive return on an investment

Of course, we limited the technology areas to fit within one or, preferably, more sub-clusters from the SRI list.

We took a number of approaches to analyze the technology areas using these criteria. Worksheets in Excel show the same list of 56 technologies -- sorted alphabetically; ranked within each core cluster; and ranked across all the clusters. We will refer later to another worksheet that shows synergies by sub-cluster.

### Highest Rated Technology Areas

When we analyzed these data, the following 36 technology areas were highest rated. We also looked at the number of sub-clusters each technology area would interact with, which is the column on the right in the table.

Rank	Technology Area	Rating	Sub-Clusters
1.	Desalination	8.2	5
2.	Modular Homes	8.2	2
3.	Smart Sensors	8.2	9
4.	Eco-system design	7.8	6
5.	Sea-water farming	7.8	4
6.	Speech recognition	7.8	3
7.	Carbon sequestration	7.7	4
8.	Power storage	7.7	6
9.	Virtual education	7.7	2
10.	Advanced batteries	7.5	4
11.	Cellulosic bio-fuels	7.5	3
12.	Energy conservation	7.5	4
13.	Biometrics	7.5	4
14.	Photovoltaic cells	7.3	4
14.	Precision farming	7.3	6
16.	Wireless	7.3	3
17.	Solar utilities	7.2	5
18.	Wind turbines	7.2	4
19.	Nanomedicine	7.2	5
20.	Organic farming	7.2	3
21.	Personalized medicine	7.2	5
22.	Waste recycling	7.2	8
23.	Language translation	7.2	3
24.	Robotics	7.2	4
25.	Polymers	7	2
26.	Synthetic biology	7	7
27.	Anti-aging medicine	7	1
28.	Aquaculture	7	3
29.	Diabetes Drugs	7	5
30.	Algae energy	6.8	5
31.	Composites	6.8	2
32.	Hydrogen fuel cells	6.8	4
33.	Smart power grids	6.8	5
34.	Intelligent materials	6.8	4
35.	Regenerative medicine	6.8	4
36.	Nanochips	6.8	4

### Top Ranking, By Sub-Cluster

You specifically asked whether our top-rated technology areas crossed the sub-clusters. We see a great amount of synergy, as demonstrated in this table.

<b>Highest Rated Technology Areas Within Sub-Cluster</b>				
<b>Chemicals and Materials</b>				
Petrochemicals	Desalination (8.17)	Carbon sequestration (7.67)	Synthetic biology (7.00)	Algae energy (6.83)
Materials	Power storage (7.67)	Advanced batteries (7.5)	Photovoltaic cells (7.33)	Solar utilities (7.17)
Chemicals	Desalination (8.17)	Power storage (7.67)	Carbon sequestration (7.67)	Advanced batteries (7.5)
Energy	Desalination (8.7)	Power storage (7.67)	Carbon sequestration (7.67)	Advanced batteries (7.5)
<b>Agro-Bio-Environmental</b>				
Agriculture	Eco-system design (7.83)	Sea-water farming (7.83)	Cellulosic bio-fuels (7.5)	Precision farming (7.33)
Pharmaceuticals	Nanomedicine (7.167)	Personalized medicine (7.167)	Anti-aging medicine (7.00)	Regenerative medicine (6.67)
Environmental	Modular homes (8.17)	Eco-system design (7.83)	Sea-water farming (7.83)	Cellulosic bio-fuels (7.5)
<b>Information and Communication Technologies</b>				
Communication Technologies	Smart sensors (8.17)	Speech recognition (7.83)	Virtual education (7.67)	Biometrics (7.5)
Informatics	Smart sensors (8.17)	Speech recognition (7.83)	Virtual education (7.67)	Biometrics (7.5)
Security Technologies	Smart sensors (8.17)	Speech recognition (7.83)	Biometrics (7.5)	Wireless (7.33)

Of all these, only those rated below 7.167 – anti-aging medicine and regenerative medicine – would appear in the lower 18 rated technology areas.

### Sub-Cluster Synergies

In the attached Excel worksheet, “Sub-Cluster Synergies” maps these important synergies among sub-clusters by indicating how our entire list of technologies involves R&D work in the 10 sub-clusters.

The total figures at the top of the attached worksheet reflect the extent to which each sub-cluster is connected to the technologies being studied. It shows that all clusters are fairly well-represented. The selection of different technologies to study should be done with an eye to ensuring that sub-clusters are connected equally in rough terms.

To summarize the worksheet, we looked at the Top 18 and All 36 technology areas we recommend. There is a broad distribution among the sub-clusters. The Top 18 technology areas directly or indirect interact with a large number of the sub-clusters.

Number of Sub-Clusters Touched Within	Top 18	All 36
<u>Chemicals and Materials</u>		
Petrochemicals	6	9
Materials	6	15
Chemicals	10	23
Energy	13	19
<u>Agro-Bio-Environmental</u>		
Agriculture	6	11
Pharmaceuticals	2	8
Environmental	14	21
<u>Information and Communication Technologies</u>		
Communication Technologies	8	16
Informatics	12	21
Security Technologies	5	10

To get a better sense of synergies across sub-clusters, TechCast mapped linkages among the strongest candidate technologies and found three distinct interdisciplinary “programmatic areas” listed below. Programmatic areas often cut across the 3 academic core clusters in the SRI report to focus on integration and applications of R&D programs.

The 3 programmatic areas are tentatively called the “Advanced IT” area, the “Sustainability” area, and the “Energy” area. The names, of course, could be identified later by RTV.

**Advanced IT** Biometrics, Computer-Brain Interface, Electric Cars, Intelligent Drug Delivery, Language Translation, Power Storage, Precision Farming, Robotics, Speech Recognition, Sensors, Smart Grids, Virtual Education, Wireless, etc.

**Sustainability** Algae, AI, Cellulosic Bio Fuels, Carbon Sequestration, Desalination, Ecosystem Design/Industrial Ecology, Energy Conservation, Modular Homes, Precision Farming, Smart Sensors, Smart Grids, etc.

**Energy** Advanced Batteries, Electric Cars, Hydrogen Fuel Cells, Ocean Thermal and Tidal, Photovoltaic Cells, Power Storage, Wind Turbines, Solar Utilities, Smart Grids, Synthetic Biology, etc.

As RTV grows, it may be advantageous to consider setting up Centers of Excellence corresponding roughly with these 3 programmatic areas. The centers would cut across the traditional academic disciplines to integrate scholars and researchers into multidisciplinary projects, offer management development programs, conduct consulting work, and possibly offer their own degrees in multi-disciplinary fields.