Human Centered Engineered Systems for Holistic Living

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Outline

- Personal Communication
- Personal Power
- Personal Mobility
- Holistic Living
- Research: Human Centered Engineered Systems
- Education
- Economic Development
- Conclusion

PERSONAL COMMUNICATION

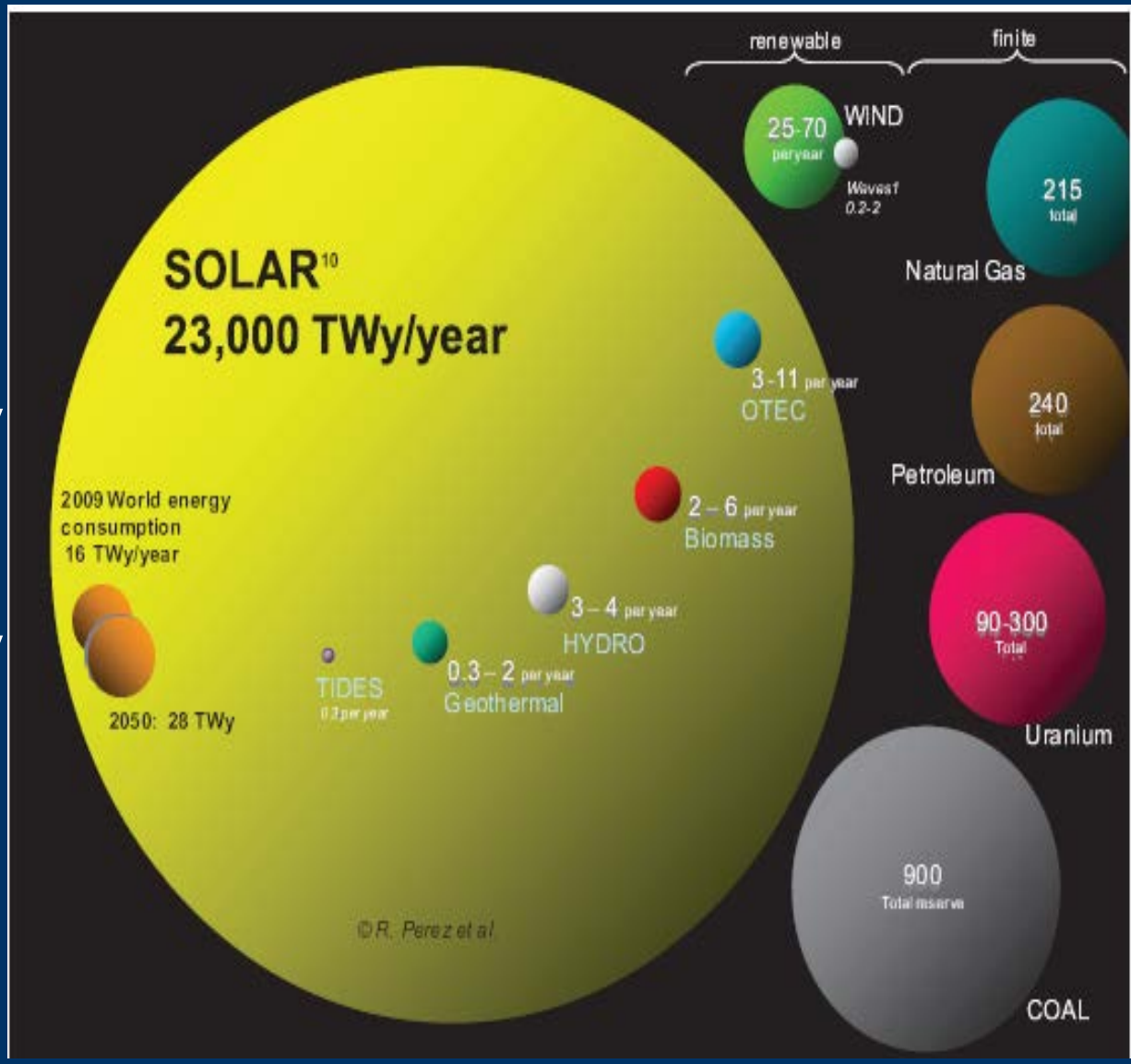
Personal Communication

- Phenomenal progress of hardware and software leading to paradigm sift in computation and communication has led to “Personal Communication”
- 10 nm computer chips in manufacturing, 7 nm to be introduced soon
- Artificial intelligence will dominate progress in every field

PERSONAL POWER

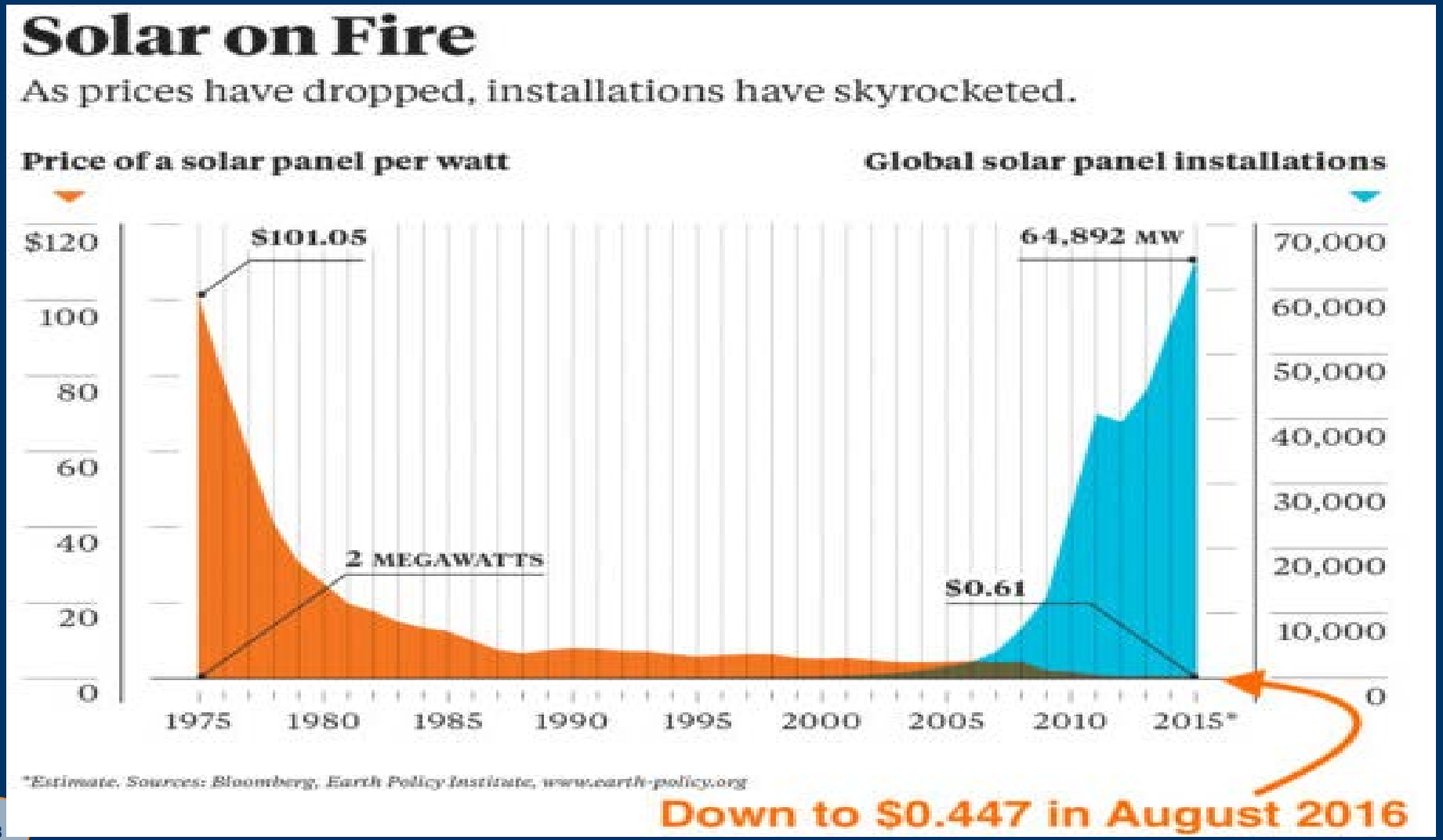
Free Solar Energy: More Than the Needs of Mankind

- One Hour of Solar Energy = Energy Used in one Year by All on Planet Earth
- All Crude oil = 15 Hours of Solar Energy Hitting Earth
- All Natural Gas = 24 Hours of Solar Energy Hitting Earth
- All coal = 80 Hours of Solar Energy Hitting Earth



Cost and Installation of PV Systems
70 % Drop from 2010

http://cleantechnica.com/2016/08/17/10-solar-energy-facts-charts-everyone-know/



PV Electricity at 2.42 cents/KWH : Lowest for Any Electricity Generation Technology (No Subsidiary)

http://c1cleantechnicacom.wpengine.netdna-cdn.com/files/2016/09/lowest-solar-price-bids.png

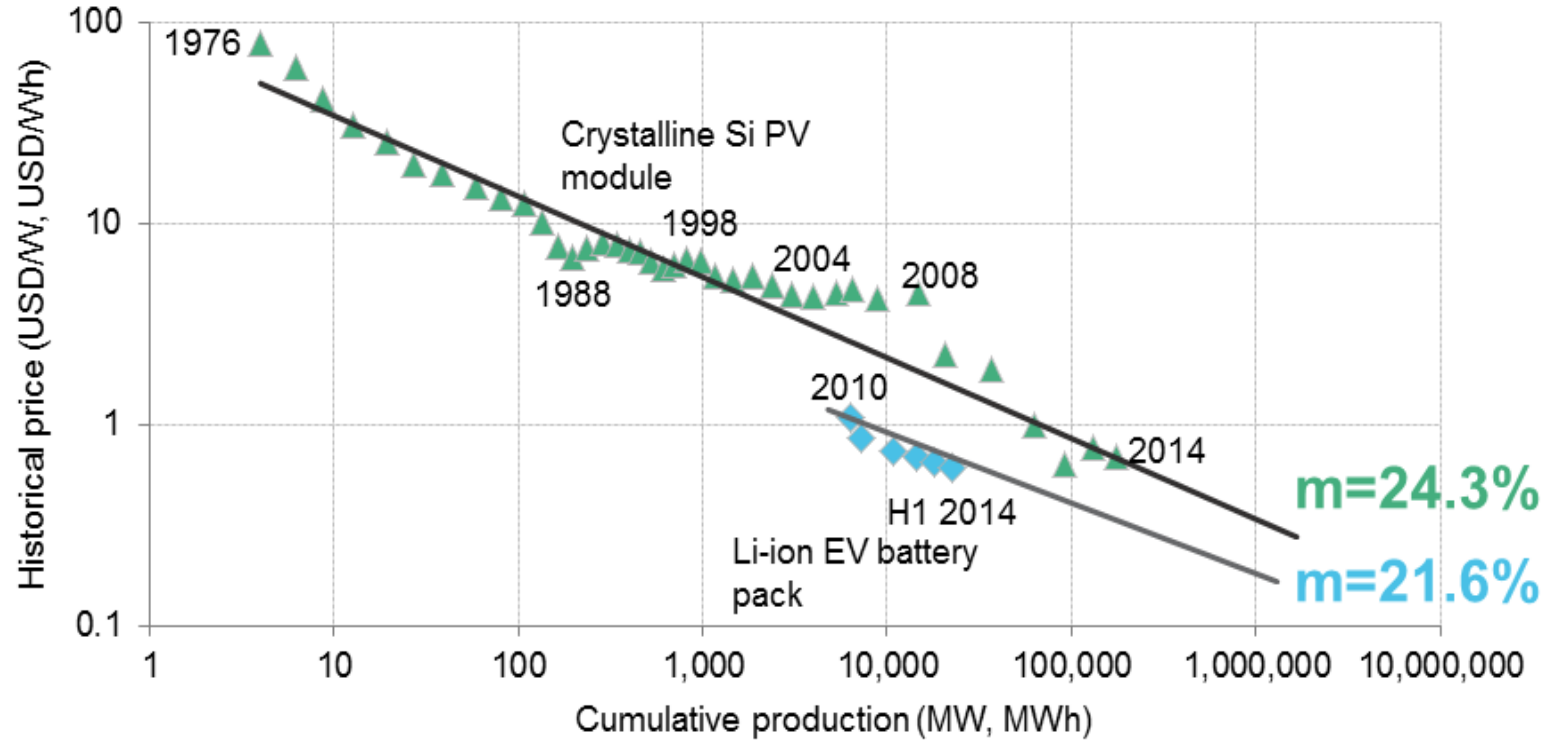
- The “Solar Singularity”, is the point where photovoltaics is so cheap in most countries of the world that photovoltaics is the default new energy source.
- https://www.greentechmedia.com/articles/read/the-solar-singularity-2017-update-ev-autonomous-energy-storage?utm_source=Solar&utm_medium=Newsletter&utm_campaign=GTMSolar

PV and Battery Cost Reduction Curve

http://www.greentechmedia.com/articles/read/why-moores-law-doesnt-apply-to-clean-technologies?utm_source=Solar&utm_medium=Picture&utm_campaign=GTMDaily

LITHIUM-ION EV BATTERY EXPERIENCE CURVE COMPARED WITH SOLAR PV EXPERIENCE CURVE

Bloomberg NEW ENERGY FINANCE



Note: Prices are in real (2014) USD.

Source: Bloomberg New Energy Finance, Maycock, Battery University, MIT

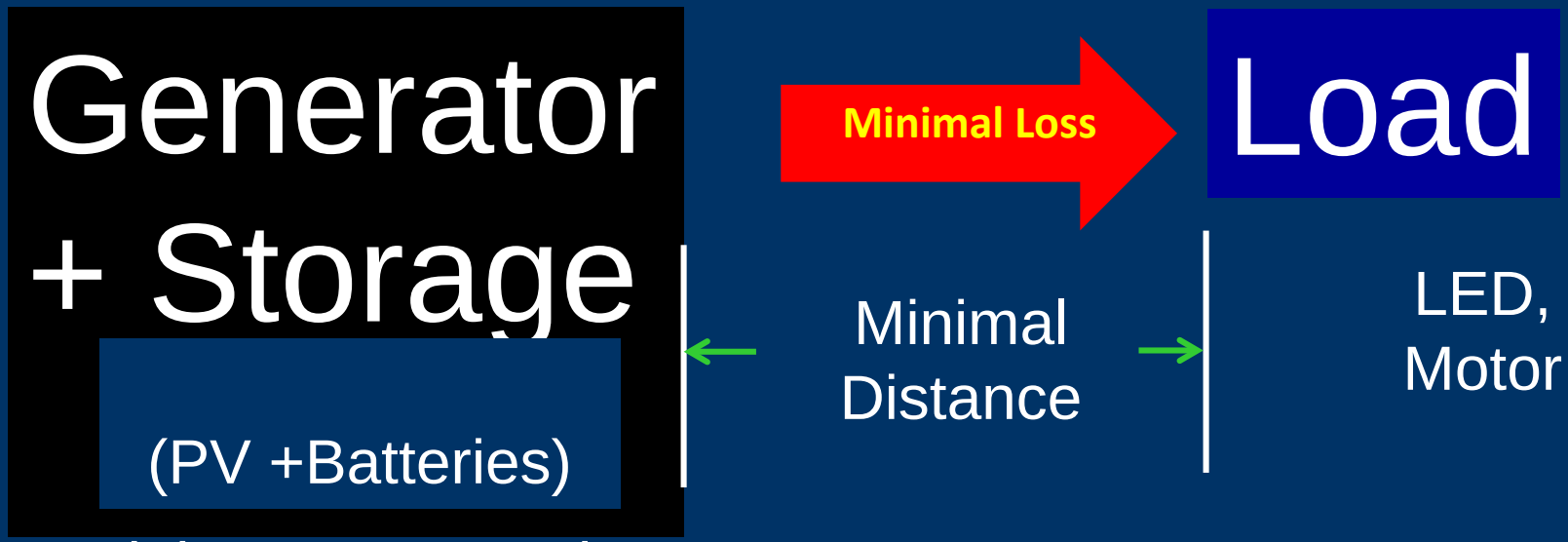
Battery Prices are Falling Very Fast

- Volume Manufacturing
- DC Power not AC Power
- 2020: < $100/kWH

Paradigm Shift by Local DC Power

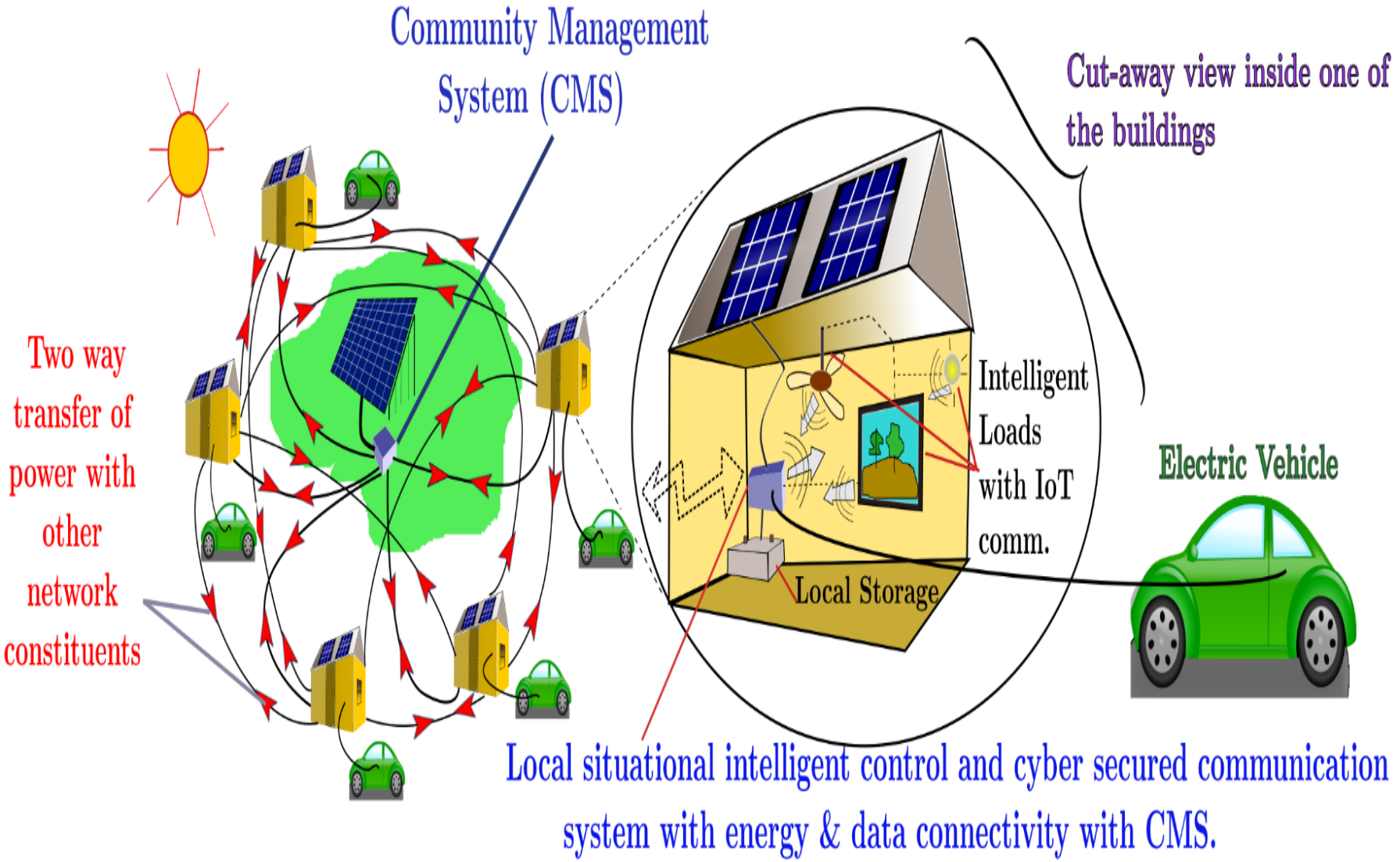
R. Singh and K. Shenai, IEEE Spectrum, Feb. 2014

Ihttp://spectrum.ieee.org/green-tech/buildings/dc-microgrids-and-the-virtues-of-local-electricityEEE Spectrum



- Minimum Conversion
- DC Power
- Maximum Efficiency : (More than 50 % energy saving as compared to centralized AC grid)
- AC Operated Loads: Provide Built in Inverter

Local Power Network



Why and How Photovoltaics Will Provide Cheapest Source of Electricity in the 21st Century

- R. Singh, G. F. Alapatt and G. Bedi
- FACTA UNIVERSITATIS
- Series: Electronics and Energetics, Vol., No 2, June 2014, pp. 275-298
- DOI: 10.2298/FUEE1402275S
- If the current trends of PV growth continue, we expect PV electricity cost with storage to reach $0.02 per kWh in the next 8-10 years.

PERSONAL MOBILITY

Four Drivers of Changes in Auto Sector

http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-the-convergence-of-automotive-and-tech-will-create-a-new-ecosystem

- *Electrification*
- *Autonomous Driving* : From driver assistance to fully autonomous driving
- *Diverse mobility*. As the sharing economy expands and consumer preferences change, the standard model will continue to evolve from outright purchase or lease to rentals and car sharing.
- *Connectivity.* The possibilities for “infotainment” innovations, novel traffic services, and new business models and services will increase

Complex Echo System in Auto Sector

http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-the-convergence-of-automotive-and-tech-will-create-a-new-ecosystem

In the future, cars will become computers on wheels as tech players move into the automotive sector to leverage their existing capabilities.

Vehicle hardware | Vehicle software | Alternative business models

Hardware

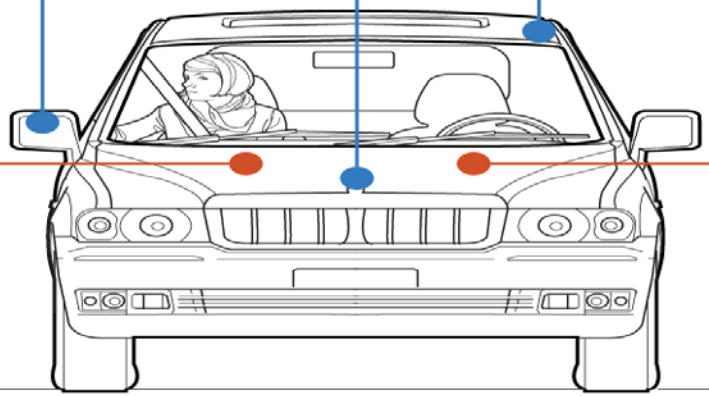
Corner modules, advanced sensors, etc

Drivetrain

Electric motors, power electronics, advanced batteries

Industrial design

Modular bodies, advanced user interfaces



Entertainment platform

Features and connectivity mirroring the home-entertainment experience

Autonomous drive/ operating system

Advanced central operating system with self-driving capability

Apps and services

Full library of applications from 3rd parties

Alternative business models

Autonomous vehicle sharing, new service offerings, etc

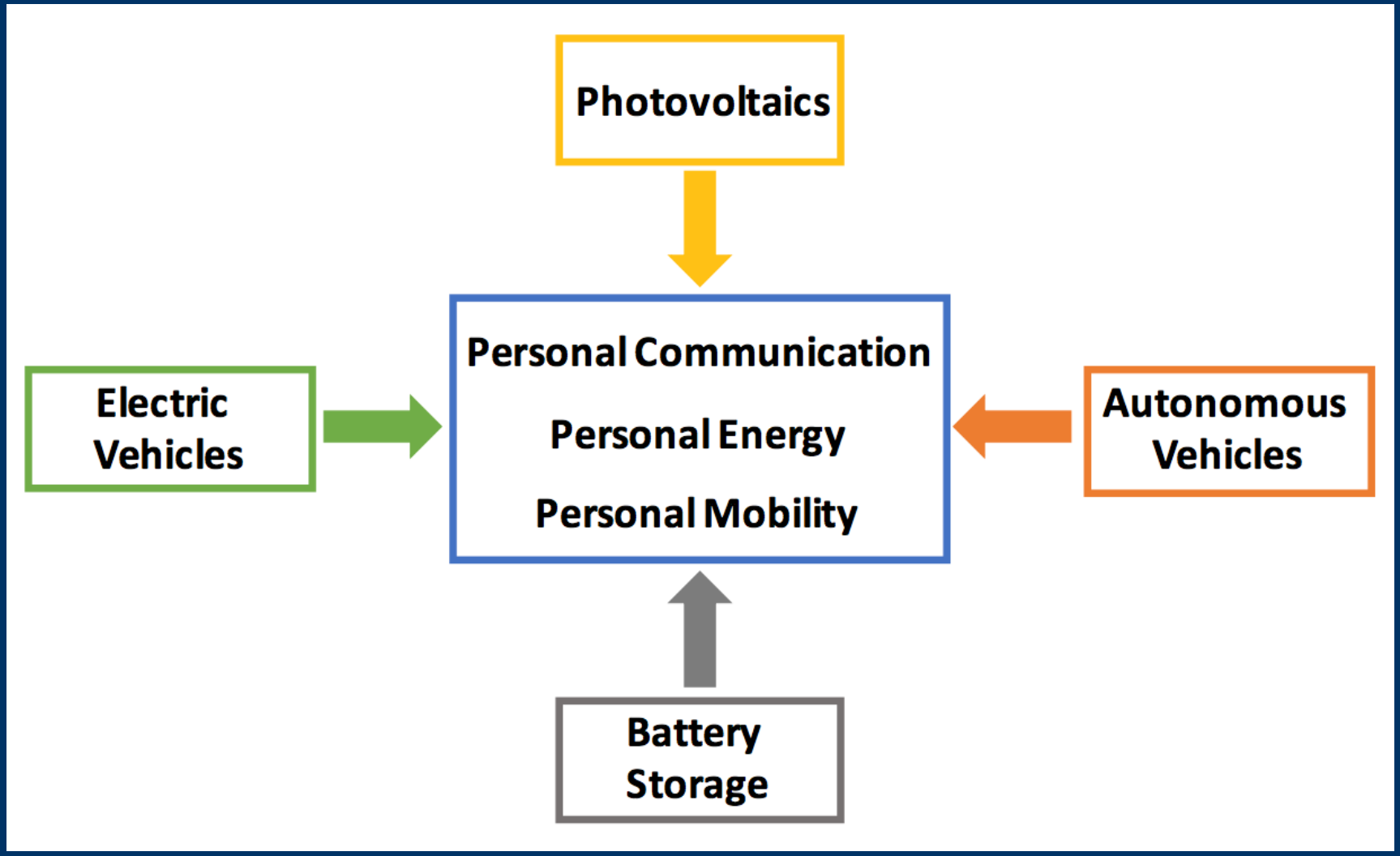
Data analytics

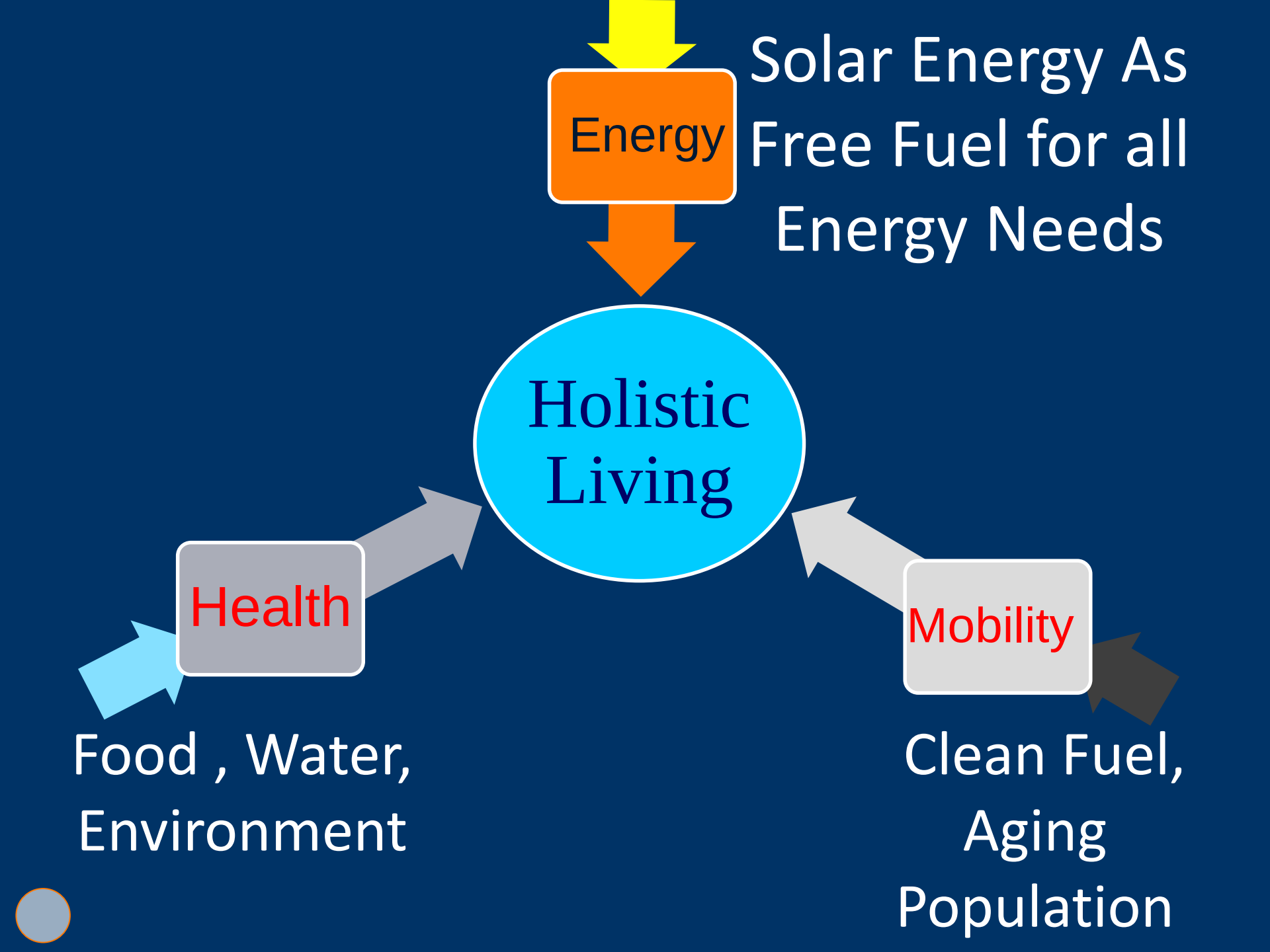
Fully connected cloud processing and data feeds for manufacturers

McKinsey&Company | Source: 35 expert interviews (across Asia, Europe, and United States)

HOLISTIC LIVING

Drivers of Intertwined Global Revolution




Energy
Solar Energy As Free Fuel for all Energy Needs
Holistic Living
Health
Food , Water, Environment
Mobility
Clean Fuel, Aging Population

Only Solar, Wind & Ocean Waves as Energy Source Have minimal Adverse Health Effects

- **1.7 Million Children Die Every Year From Unhealthy Environments, WHO Reports**
  - https://cleantechnica.com/2017/03/07/1-7-million-children-die-every-year-unhealthy-environments-reports/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+IM-cleantechnica+%28CleanTechnica%29
- **Childhood Leukemia And Oil & Gas Development Strongly Associated, Research Finds**
  - https://cleantechnica.com/2017/02/20/childhood-leukemia-oil-gas-development-strongly-associated-research-finds/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+IM-cleantechnica+%28CleanTechnica%29
- **~18% Of Preterm Births (Globally) Are Associated With Exposure To Outdoor Air Pollution**
  - https://cleantechnica.com/2017/02/20/18-preterm-births-globally-associated-exposure-outdoor-air-pollution/?utm_source=fee
- Childhood Leukemia and testicular cancer are associated with High Voltage Power
  - http://www.nature.com/bjc/journal/v103/n7/abs/6605838a.html
  - https://link.springer.com/article/10.1007/s00420-004-0550-1
  - dburner&utm_medium=feed&utm_campaign=Feed%3A+IM-cleantechnica+%28CleanTechnica%29

RESEARCH: HUMAN CENTRED ENGINERED SYSTEMS

Campus Infrastructure for Cyber Research

Campus Infrastructure for Cyber Research

Networking

Campus scale SDN testbed (20 buildings)

National SDN with 100G Science DMZ

Internet traffic analysis resistance testbed

Information Centric Networking (ICN) testbed

Computing

NSF GENI (national, international)

NSF CloudLab (distributed datacenter)

CloudLab

Cybersecurity Operation Center & Internship

Palmetto HPC

System Risk Management for Individuals and Society

- Maintain a consistent view of security incidents and monetary transactions that are not subject to manipulation by insiders[1].
- Maintain authorized user access and system-wide usage statistics, without storing information (collision-included probabilistic counting (CIPC)) that can compromise user privacy[2,3].
- Ability to design system so as to make loss of availability
  - (Denial of Service) difficult to cause[4] and easy to tolerate[5].
- **Resulting System** will
  - allow users *universal access* as needed,
  - provide important *logging of incidents*, while still
  - maintaining essential *user privacy*.

[1] *"CICI: Data Provenance: Collaborative Research: Provenance Assurance Using Currency Primitives", NSF, Richard brooks, PI (2016-2018).*

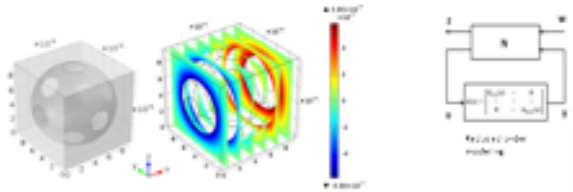
[2] *"Advanced Storage – High Performance File System Research," Los Alamos National Laboratory, Richard, brooks, PI (2013-2015).*

[3] *"Internet Democracy Support for West Africa," Department of State, Richard brooks, PI (2012-2016).*

[4] *Course: ECE893 Special Topics on distributed denial of service (ddos), ece dept., Clemson university (2017).*

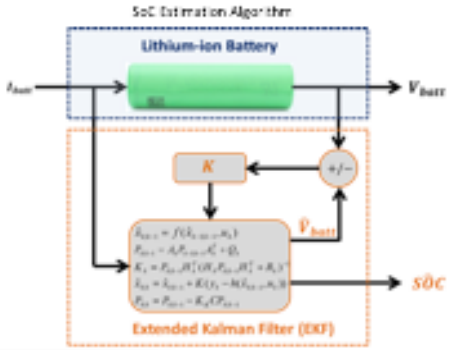
[5] *"CPS-Synergy-Security if Distributed Cyber-Physical Systems with Connected Vehicle Applications" NSF, RICHARD BROOKS, Co-PI, (2015-2018).*

Advanced Battery Management System



•Structured model order reduction
•Matlab/Simulink implementation

3. Physically meaningful control-oriented models

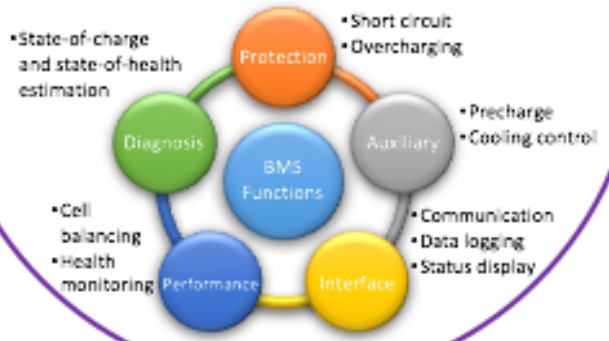


•Micro/macro scale modeling
•Parameter Identification and model validation

2. Physics-based battery modeling

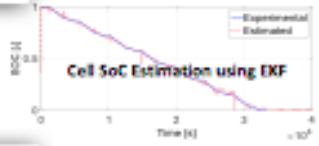
Battery Management System (BMS)

Our approach is to rely on electrochemistry and physics to develop embedded BMS systems by following the 5-step methodology



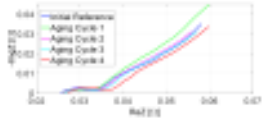
4. Estimation and control development

•SoC and SoH estimation
•Aging propagation prediction
•Cell balancing / thermal control



•Characterization tests
•Thermal tests
•Accelerated aging tests
•EIS

1. Experimental Testing



5. Embedded control

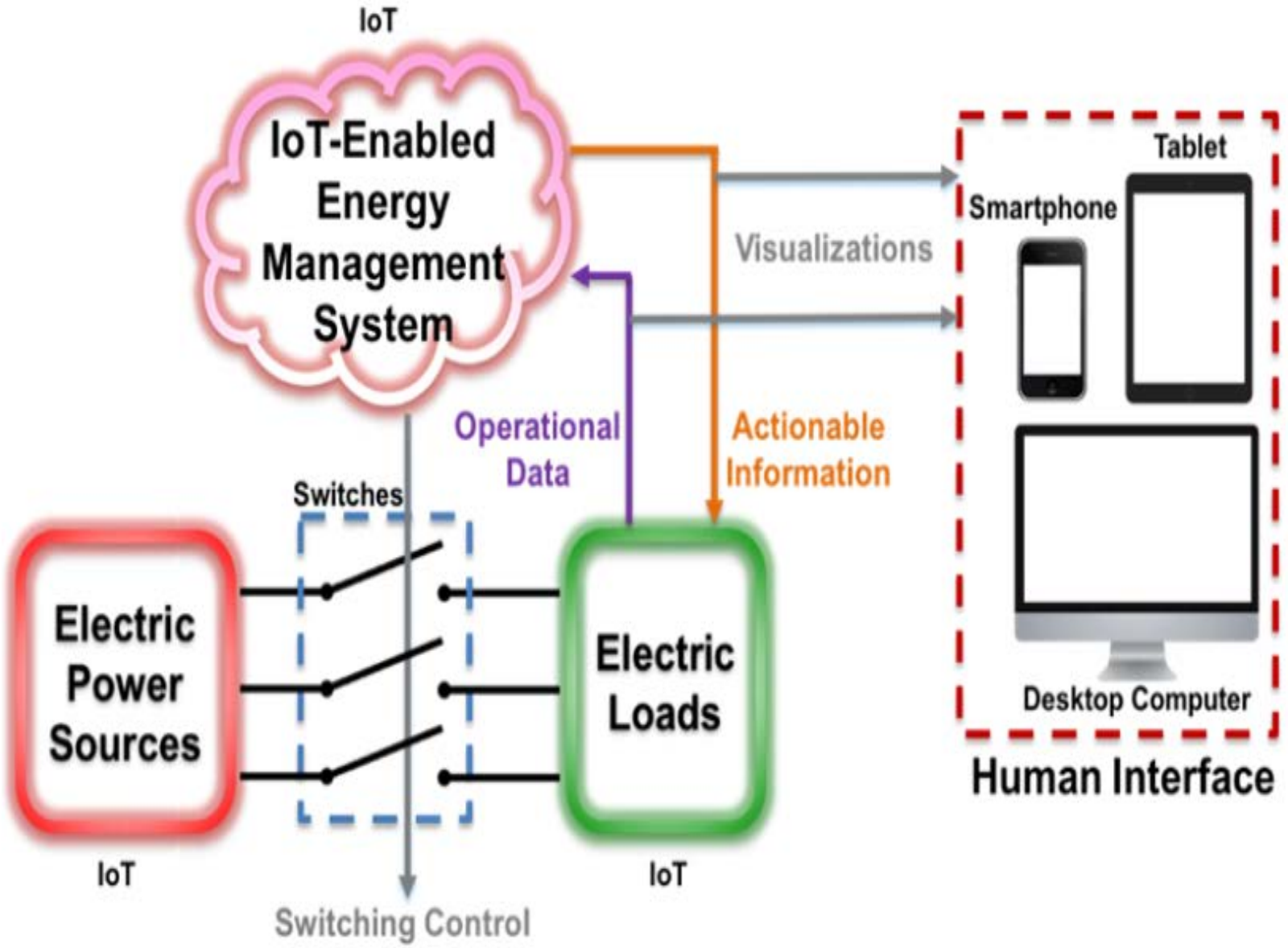
•Real-time algorithm validation
•Hardware-in-the-loop (HIL) simulations

ControlDesk

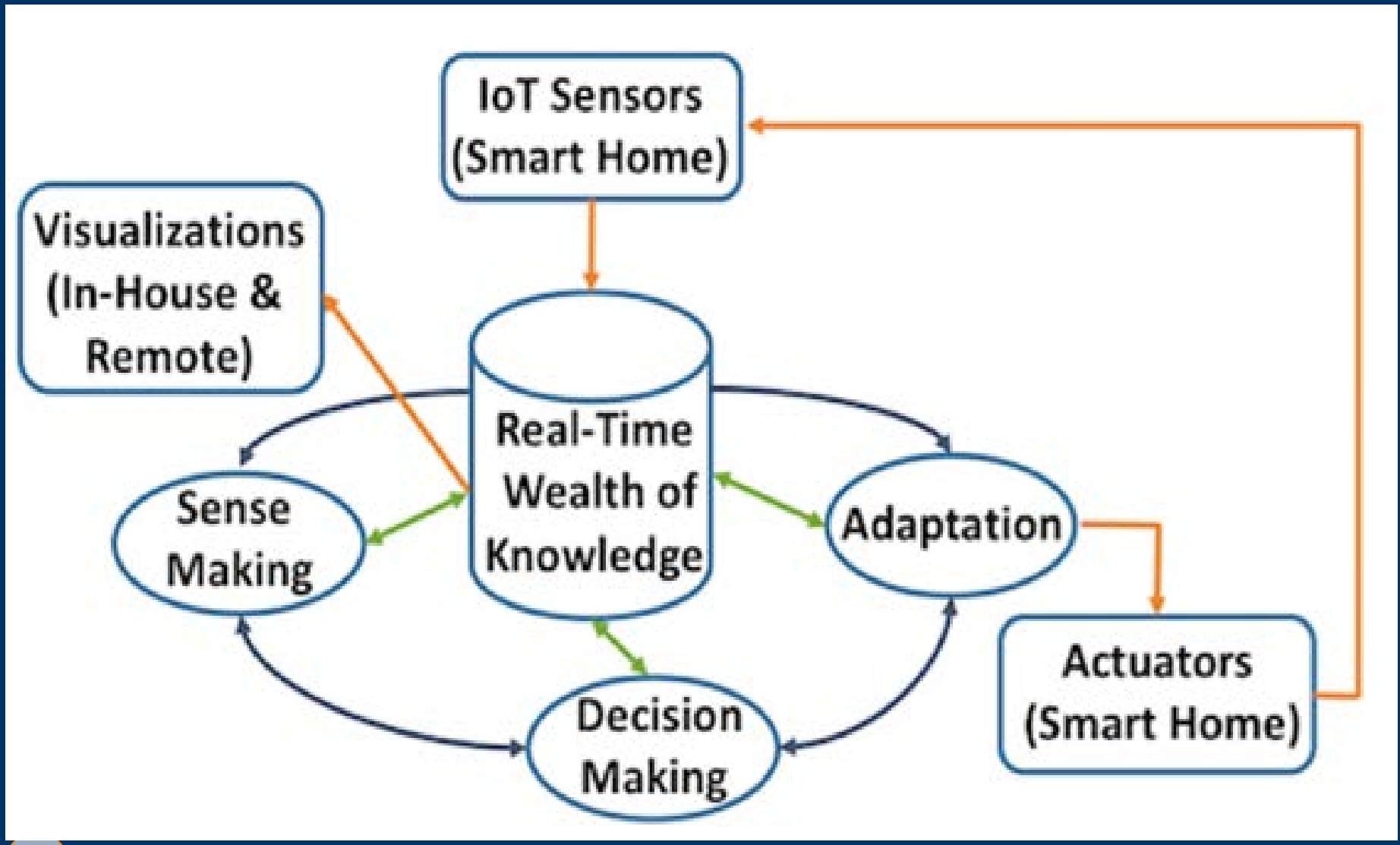
MicroAutoBox II

HIL Simulator

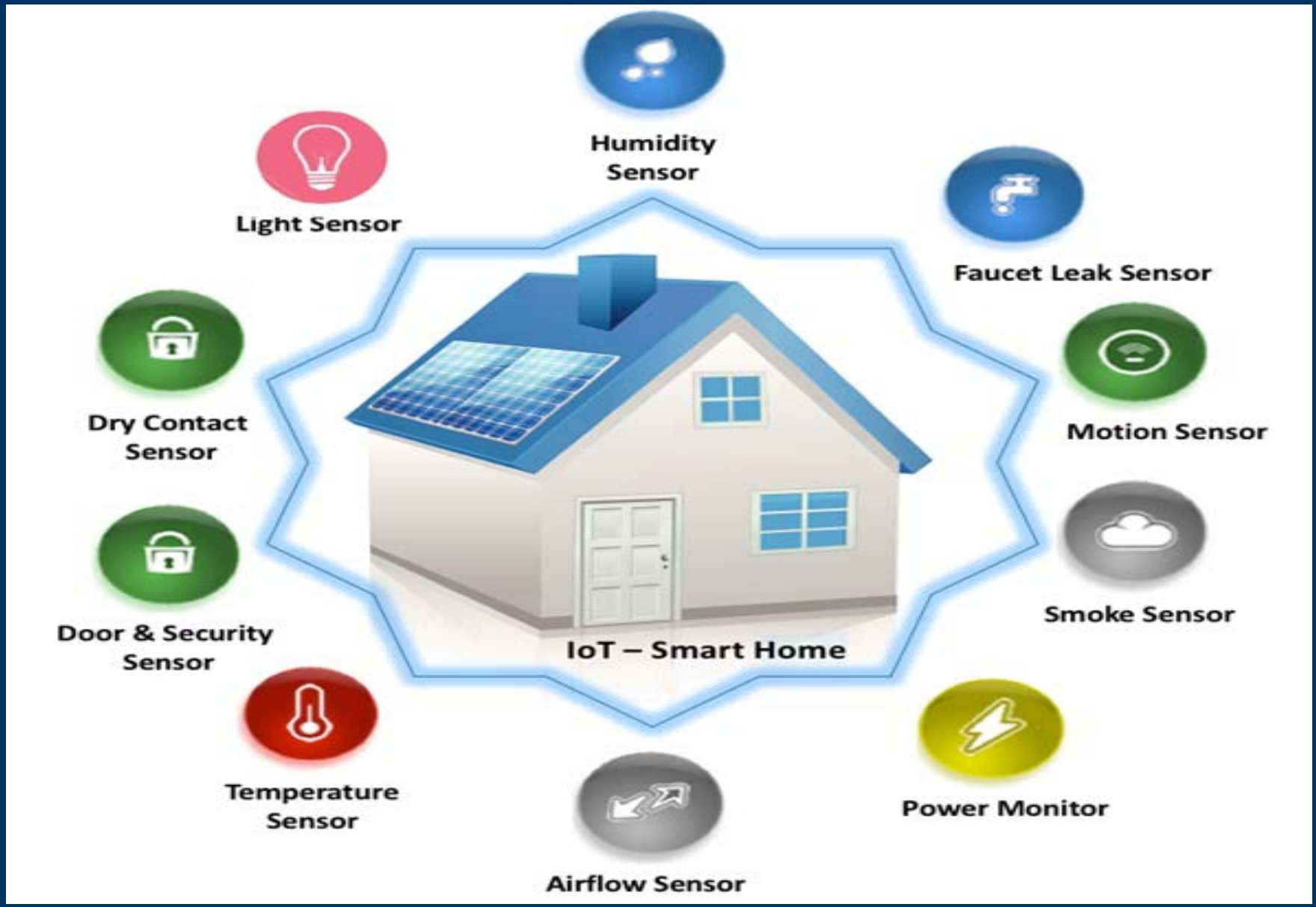
IOT Enabled Energy Management System



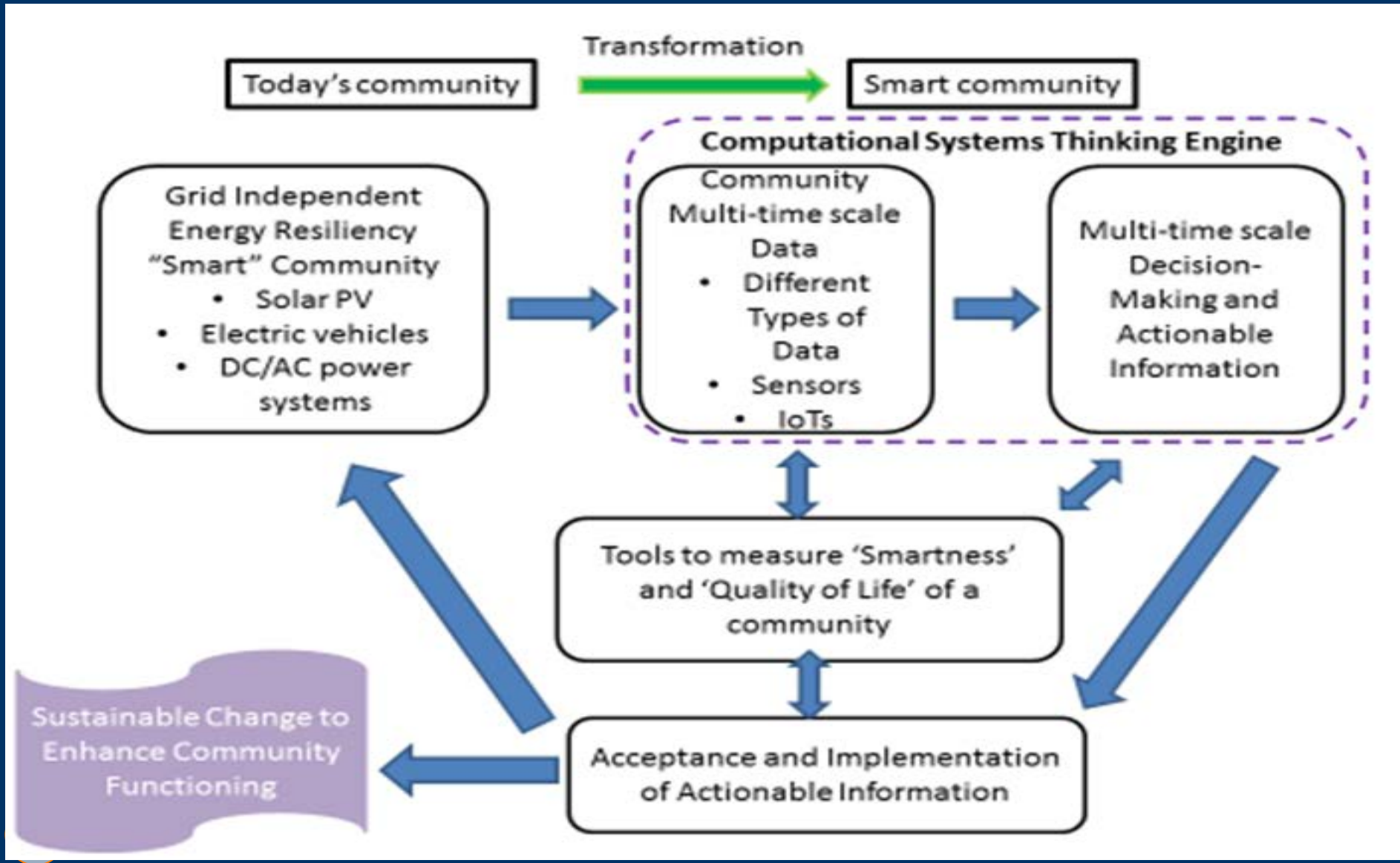
Smart Home Environment



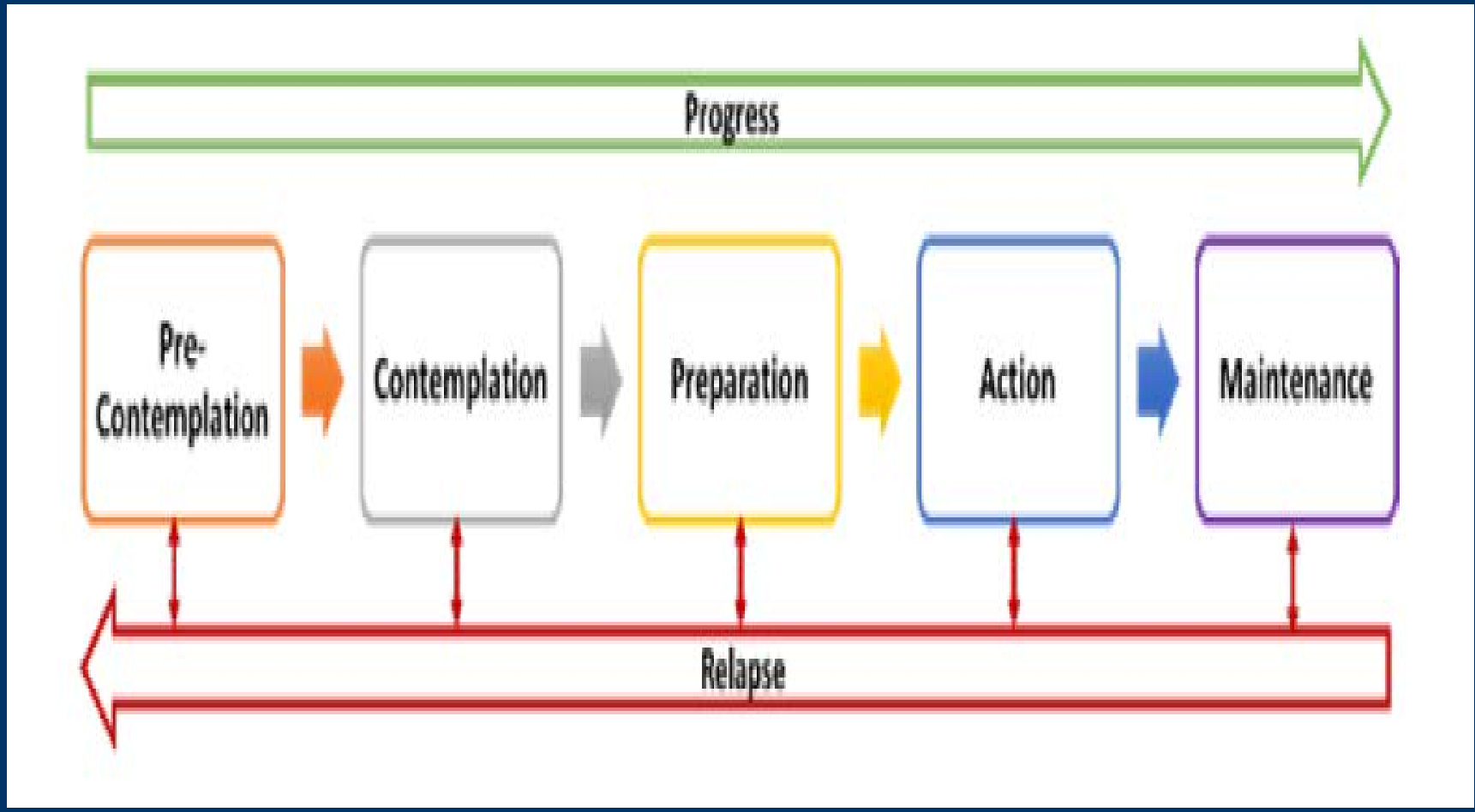
IOT Based Proposed Prototype Home



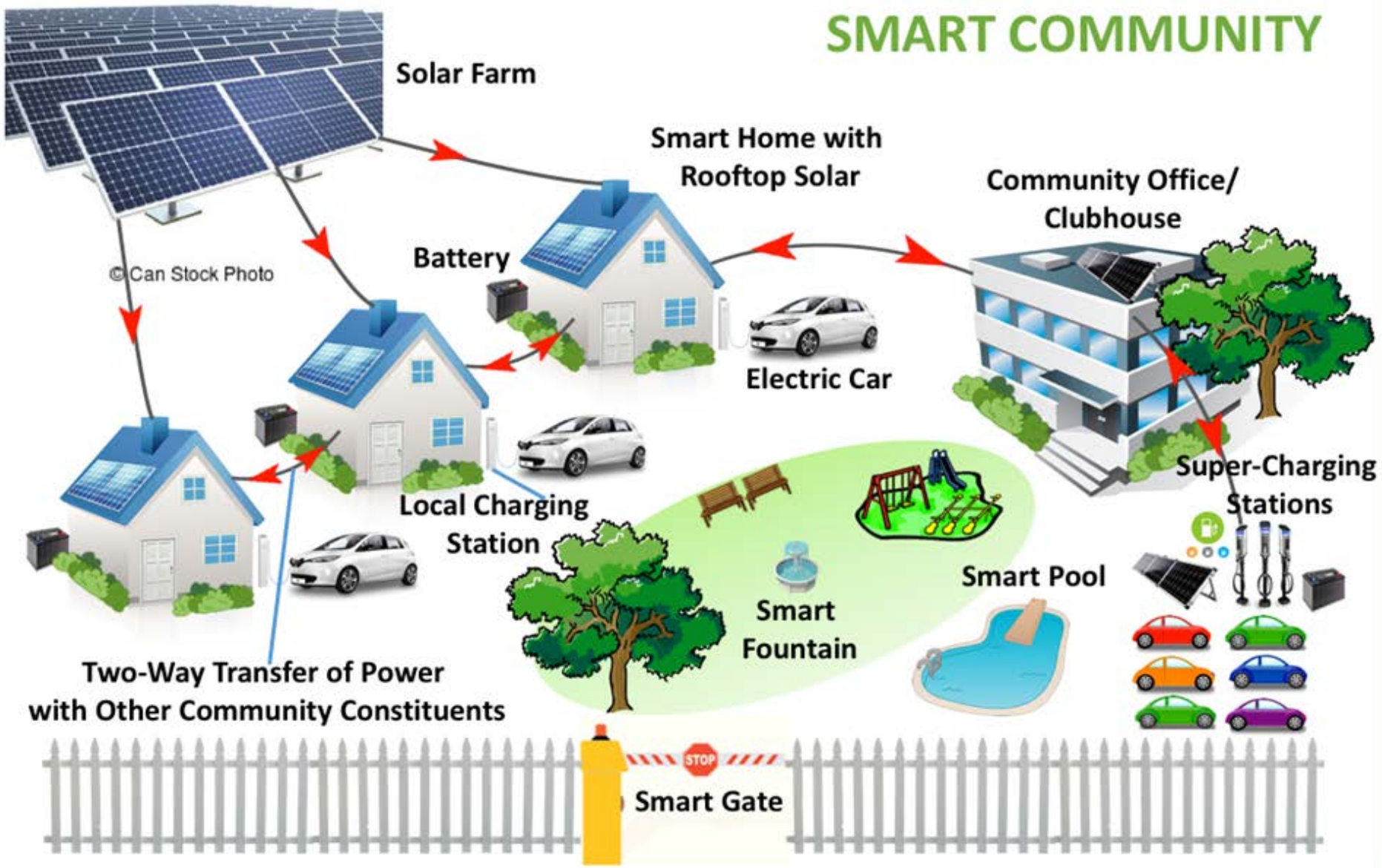
Transformation from Current Communities to Communities with Holistic Living



Transtheoretical Model of Behavior Change.



Future Holistic Living Communities



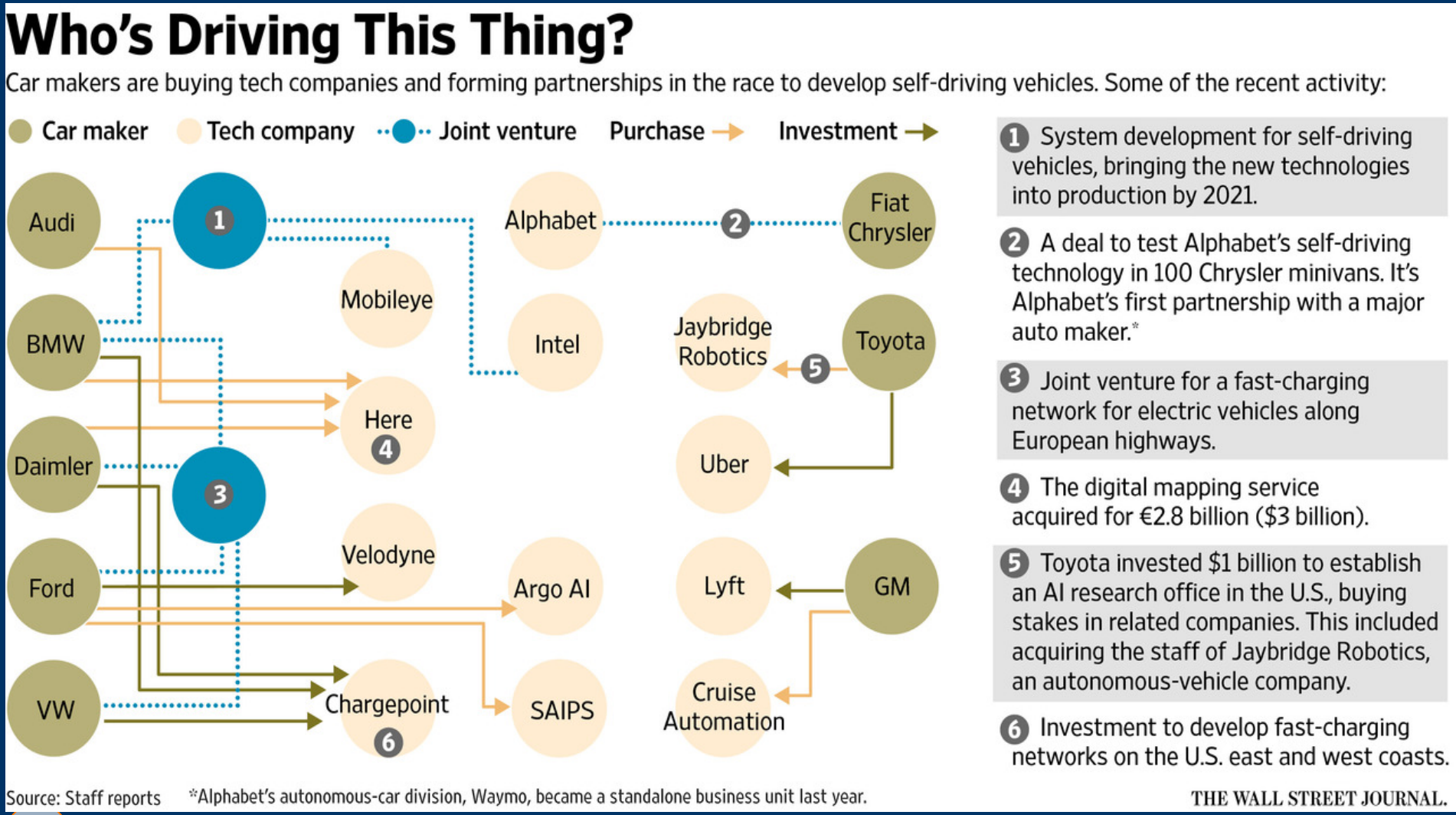
EDUCATION

Education

- Interactions of Engineering students with Social and Health Science Students will provide a real world learning experience to our Future Leaders
- In dialog with Dr. David Bodde to develop a new approach where innovation at all level of learning experience is the key goal

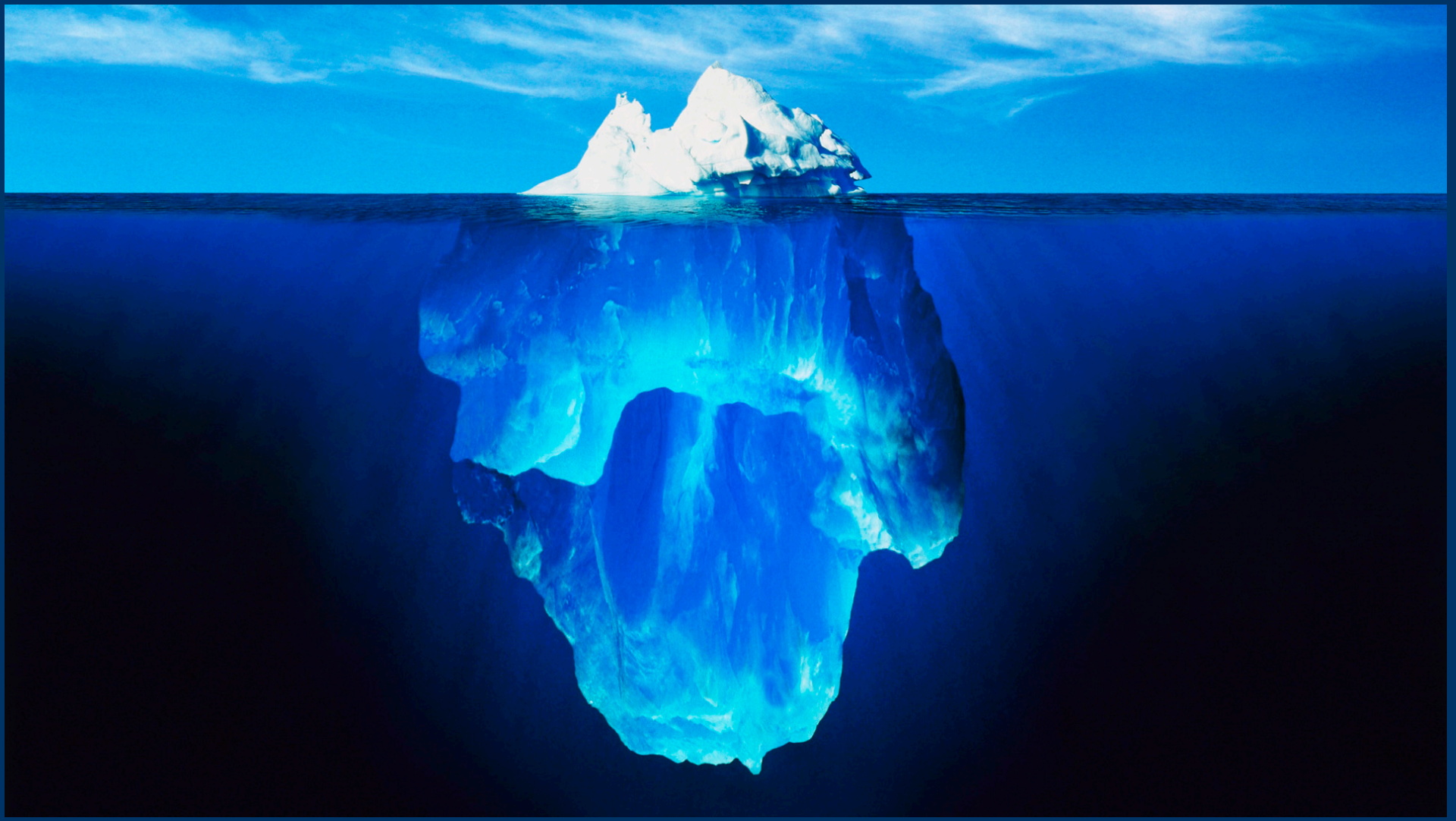
ECONOMIC DEVELOPMENT

Economic Development Opportunities in South Carolina



We are Sitting at the Tip of the Iceberg

http://cdn2.epictimes.com/charlesfaddis/wp-content/uploads/sites/8/2015/08/tip-of-the-iceberg-90839.jpg



Thank You.
Question?