IEA Technology Collaboration Program on High-Temperature Superconductivity (IEA HTS TCP)

HTS Roadmap for the Electric Power Sector 2015-2030

Brian Marchionini

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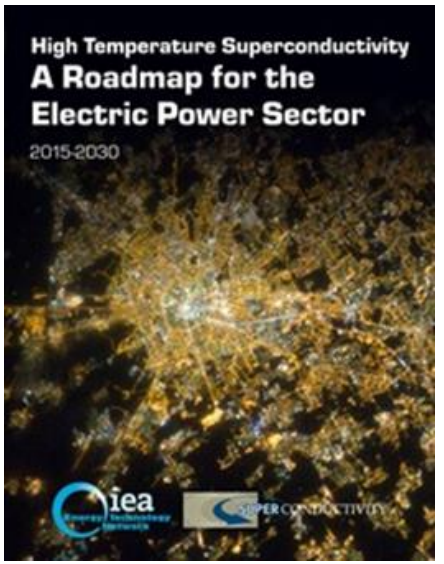
Milano, Italy

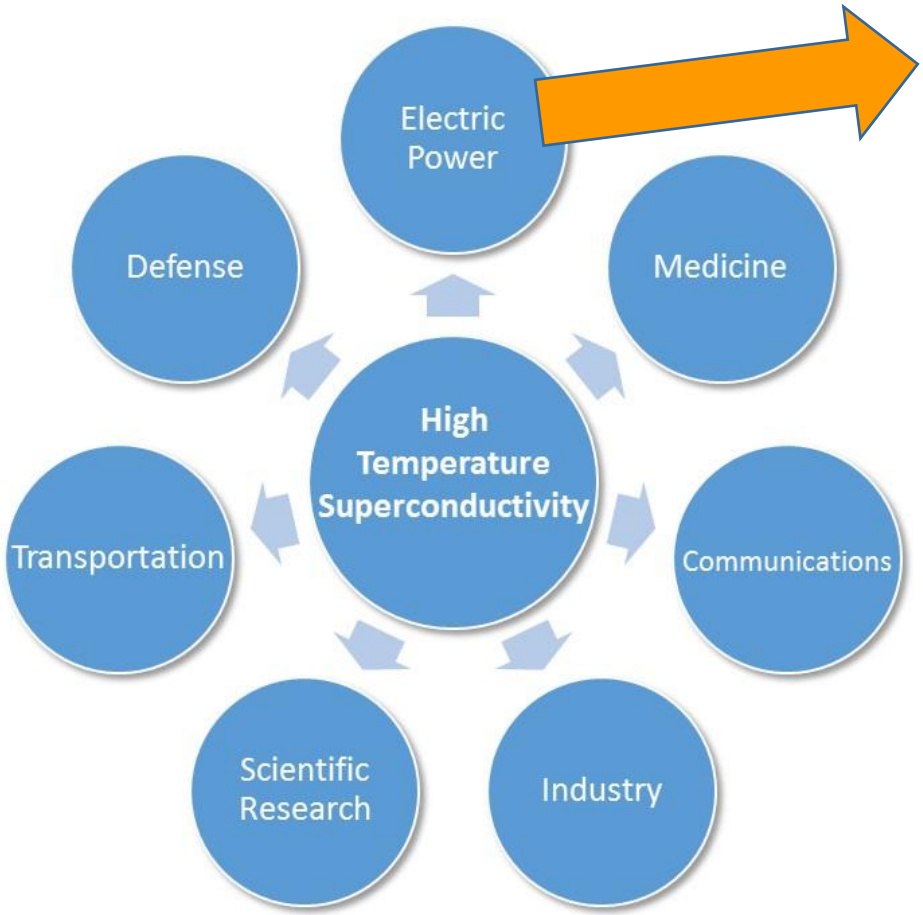
Roadmap Purpose

- Paints a picture of where the HTS industry is at present and what steps it should take to promote widespread adoption of HTS based devices.
- Outlines challenges and needs.
- Provides members of executive committee with info to help inform management in government and industry for future HTS R&D.
- Does not identify specific organizations to overcome issues.



The analysis conducted was based on the best data available at the time; it's intended to be updated in about another year.

Superconductivity has Broad Applications



Focus of Roadmap

- HTS Wire
- Cables
- Fault current limiters
- Generators
- SMES
- Transformers

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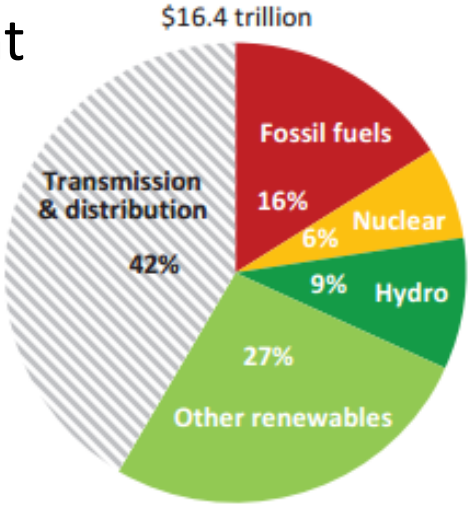
Aging Infrastructure

- For the global power sector, $16.4 trillion of investment will be made; transmission and distribution is expected to account for $7 trillion 2014-2035 (in 2012 US$).[i]
- The Edison Electric Institute estimated that the total infrastructure investment in the US will be between $1.5 and $2.0 trillion; transmission and distribution is expected to account for about $900 billion by 2030.[ii]
- HTS based devices have the potential to play a critical role in helping to transform the global transmission and distribution grid.



[i] "Cumulative global power sector investment by type and selected region in the New Policies Scenario, 2014-2035" from IEA, "World Energy Investment Outlook – Special Report", OECD/IEA, 2014. https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf

[ii] Edison Electric Institute. "Transforming America's Power Industry: The Investment Challenge 2010-2030." November 2008. http://www.eei.org/ourissues/finance/Documents/Transforming_Americas_Power_Industry_Exec_Summary.pdf.

Unique Solutions

- Conventional technologies provide *some* of the same grid solutions as HTS based devices.
  - non-superconducting FCLs for distribution voltage have been designed and tested
  - supercapacitors offer an alternative to superconducting magnetic energy storage for voltage sags
  - conventional generators are being used in multi-MW off shore wind platforms
- However, superconducting based devices do not simply provide improvements over conventional electric grid technologies; they provide unique solutions to challenges that cannot be achieved otherwise.
  - Fault current limiters that can operate at distribution and transmission voltages in a small footprint
  - Ultra high-capacity power cables
  - Lighter weight and more compact generators for off-shore wind turbines

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Challenges

Needs

Challenges	Needs
Process control. There is a general lack of manufacturing knowledge in producing HTS wires over kilometer lengths.	QA/QC and process control tools that can meet the requirements of high-yield manufacturing in high volume.
Long term reliability. Data are not available that proves undiminished product-performance HTS components life time over 30 years.	Accelerated lifetime testing is essential to confirm reliability and guide product improvements
Outreach. Utilities and regulatory community are generally unaware of HTS applications & benefits.	Targeted communications and outreach on system benefits; regulatory structures could be modified to better incentivize HTS.
Economics. The cost associated with manufacturing HTS wire is several times more expensive than copper.	Because of the unique attributes of HTS devices, a system cost analysis should be conducted.

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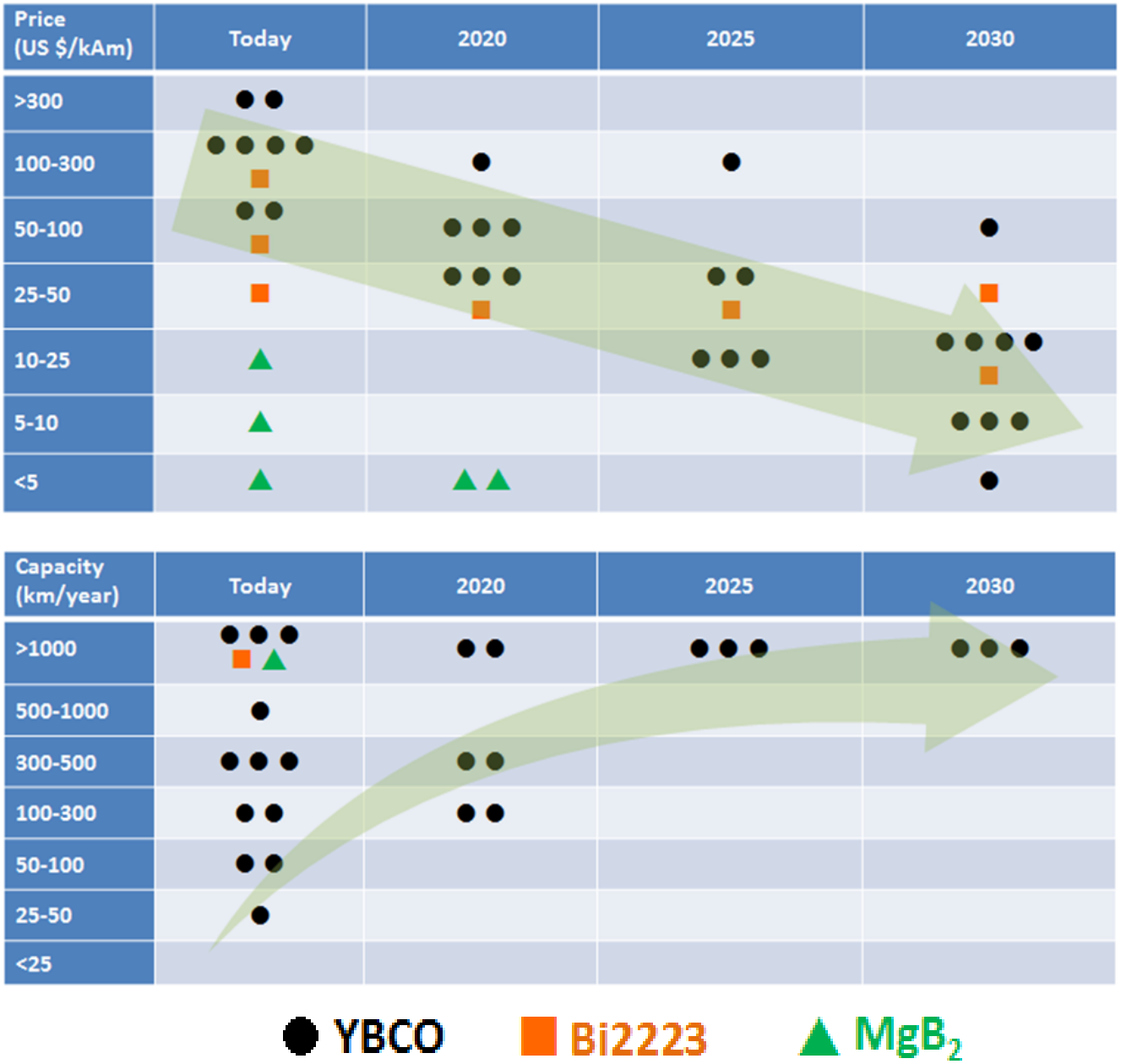
Price and Capacity for HTS Wire

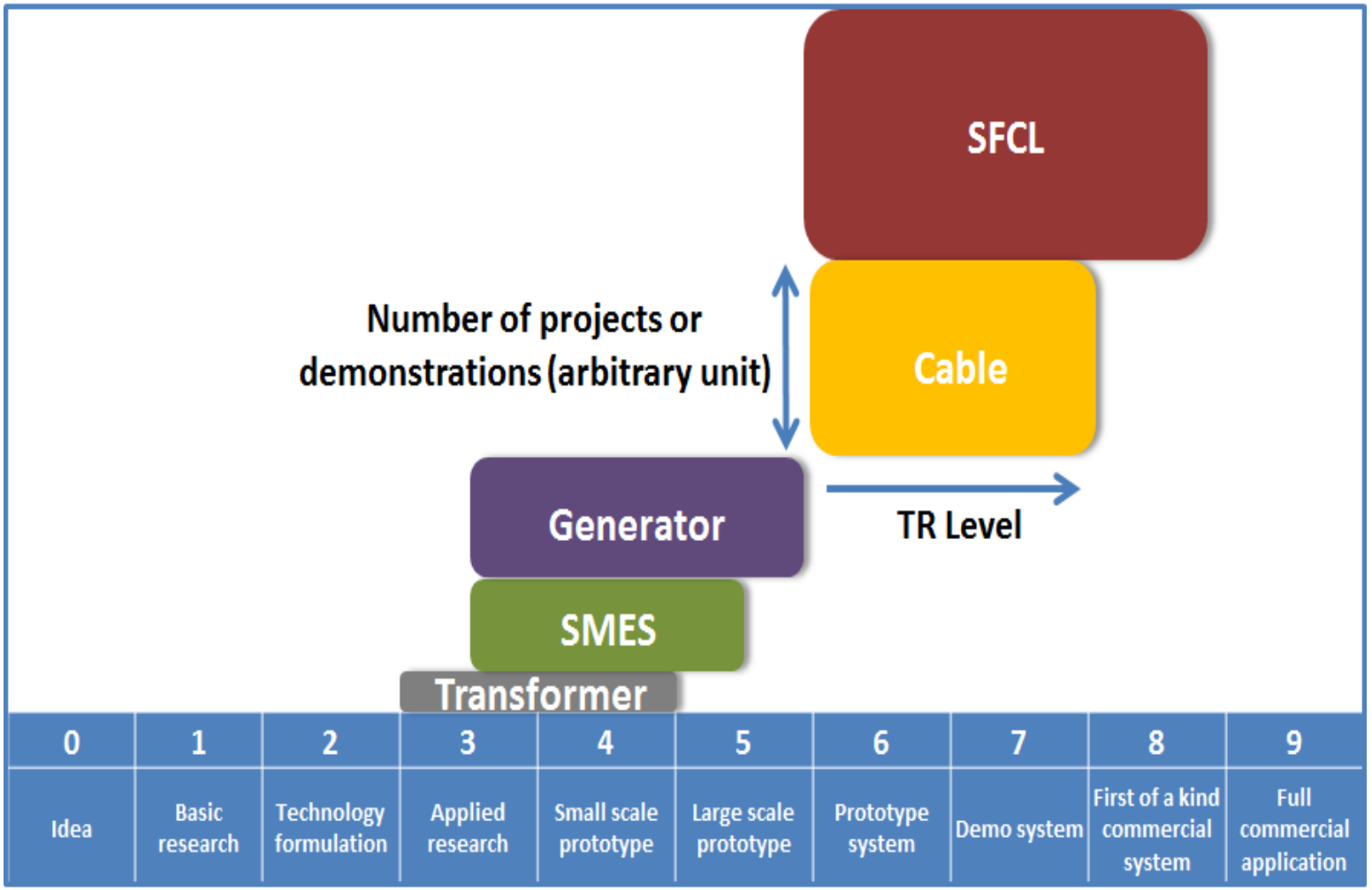


Stages of Market Maturity - Cables

Stages of Market Maturity	Today	2020	2025	2030
Widespread market maturity			●●● ■■■	●●● ■■■
Mass production		●● ■■■	●●● ■■■	■
Initial market penetration	●● ■	●● ■■■	● ■■	● ■
Demonstration in the field	●●● ■■■	●●		
Research and development	●			

● Distribution <60 kV, ■ Transmission >60 kV

TRL (Technology Readiness Level)



For More Information

- Download the Roadmap executive summary: www.ieahts.org
- Brian Marchionini, IEA HTS Operating Agent bmarchionini@energetics.com
- Yutaka Yamada, IEA HTS Operating Agent yamadayu@shibaura-it.ac.jp
- Luciano Martini, IEA HTS ExCo Chairman Luciano.Martini@rse-web.it
- Hiroyuki Ohsaki, IEA HTS ExCo Co-Chairman OHSAKI@k.u-tokyo.ac.jp

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