IEA PVPS

Global cooperation towards sustainable deployment of photovoltaic power systems

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PVPS Task 12 Operating Agents

PVPS

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Technology Collaboration Programme

PVPS

- "To enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems".
- 32 members: 27 countries, EU, SolarPower Europe, Copper Alliance
- Activities are carried out collaboratively on a country basis along a number of technical and non-technical subjects
- Currently, 8 Tasks are active

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The PVPS Objectives

- PV Technology development
- Competitive PV markets
- An environmentally and economically sustainable PV industry
- Policy recommendations and strategies
- Impartial and reliable information

Present IEA PVPS Tasks

- Task 1 – Strategic PV Analysis and Outreach
- Task 9 - Deploying PV Services for regional development
- **Task 12 - PV Sustainability**
- Task 13 - PV performance, quality and reliability
- Task 14 - High-penetration of PV systems in electricity grids
- Task 15 - Enabling Framework for the Development of BIPV
- Task 16 - Solar Resource for High Penetration and Large Scale Applications
- Task 17 – PV for Transport

Task 12
PV Sustainability

- Recycling and End-of-life Management
- Life Cycle Assessment
- Other Sustainability Topics

Active Contributors

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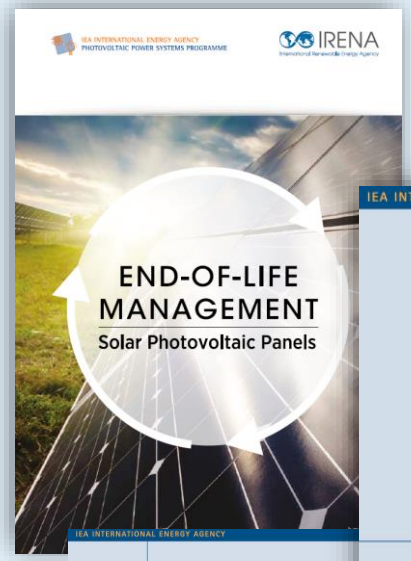
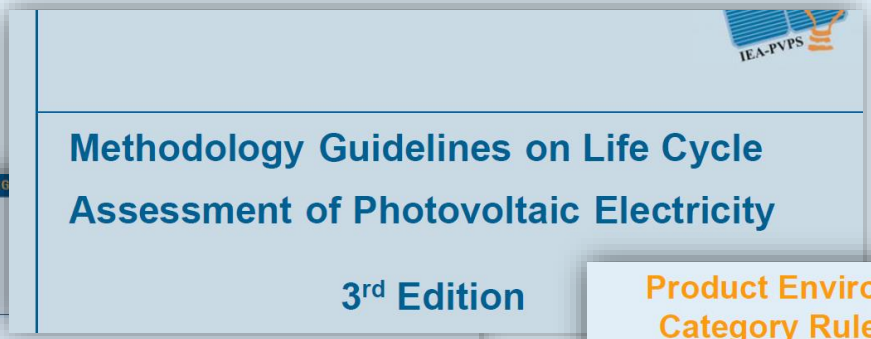
- Switzerland - Rolf Frischknecht, treeze
- The Netherlands – Frank Lenzmann, ECN
- USA - Garvin Heath/Parikhit Sinha, NREL/First Solar

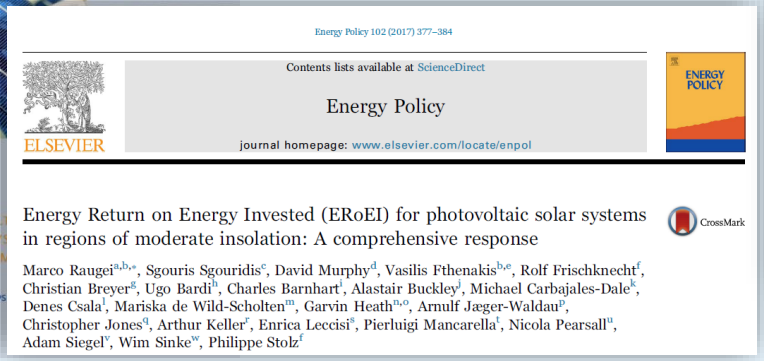
12 Countries, 1 Industry Association,

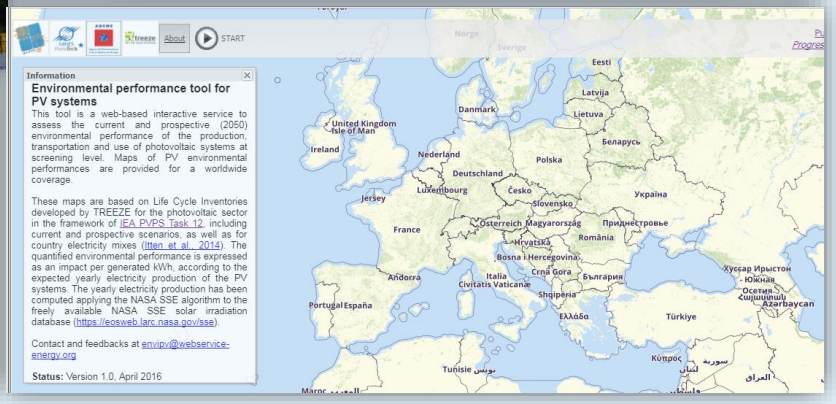
PVPS

WORK PERIOD 2013-2017









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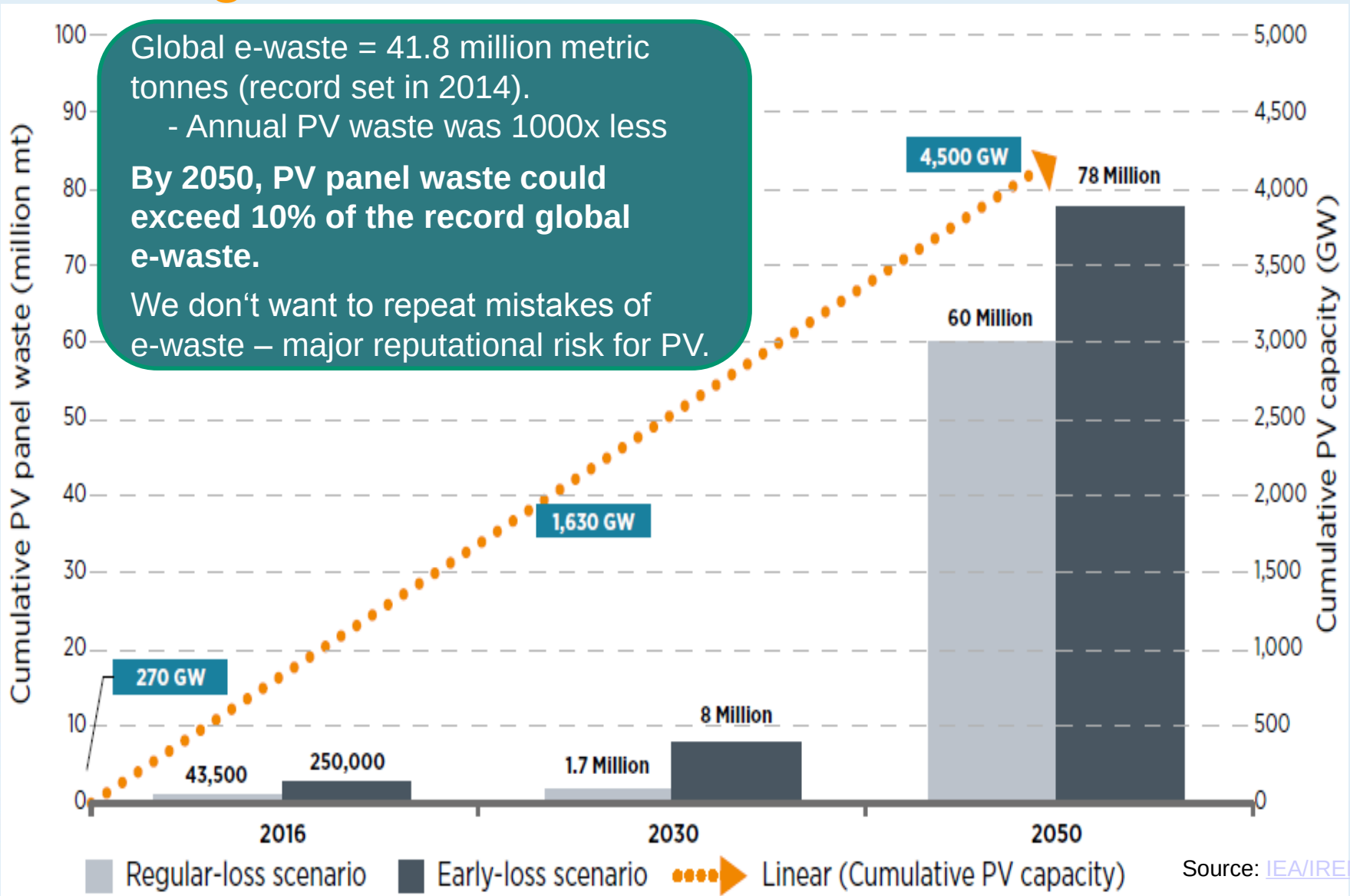
Low Volumes Now, PV Waste Will be Significant Challenge in Future

Global e-waste = 41.8 million metric tonnes (record set in 2014).
- Annual PV waste was 1000x less

By 2050, PV panel waste could exceed 10% of the record global e-waste.

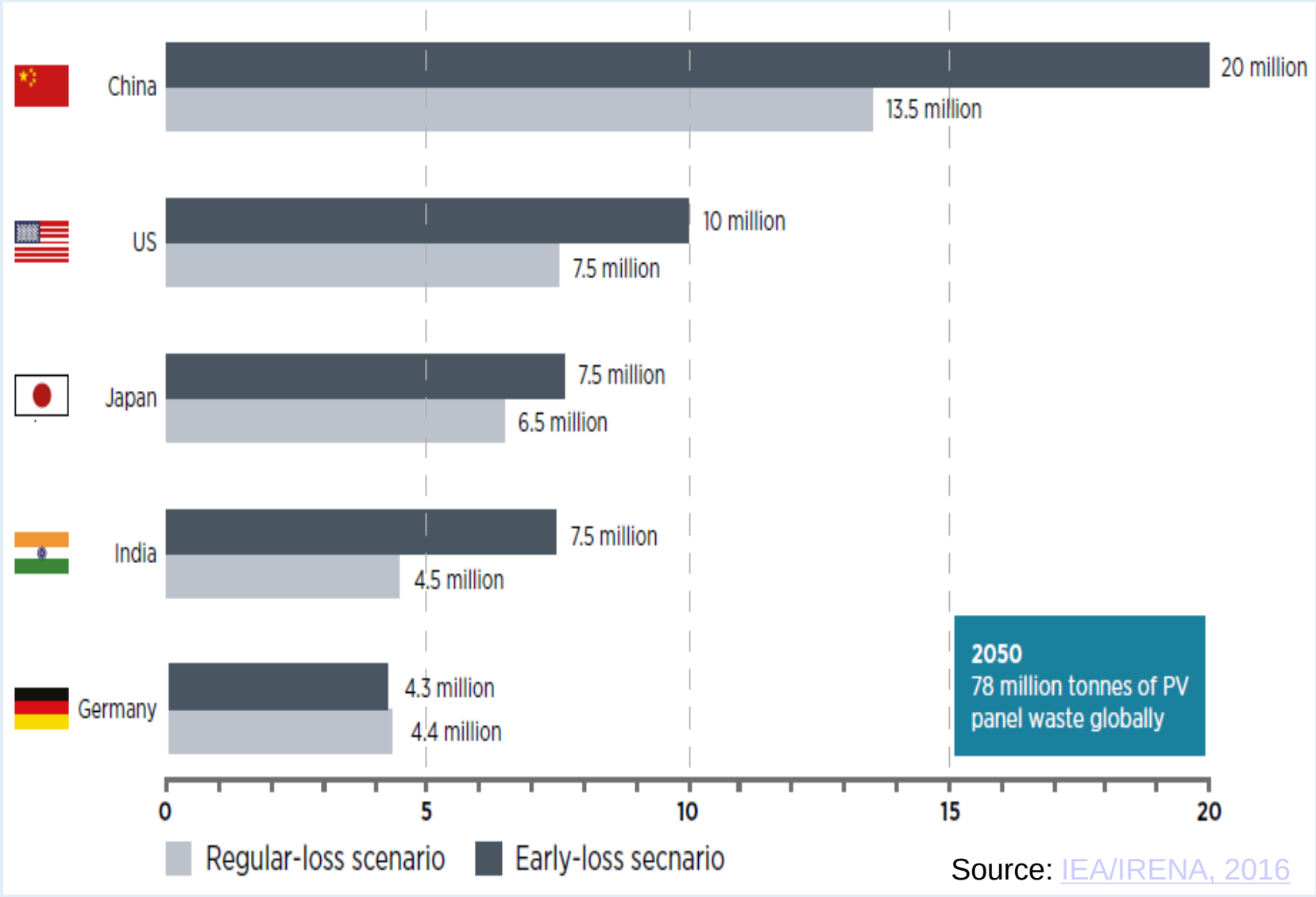
We don‘t want to repeat mistakes of e-waste – major reputational risk for PV.



Source: IEA/IRENA, 2016

Countries with Largest Expected Waste Volumes by 2050

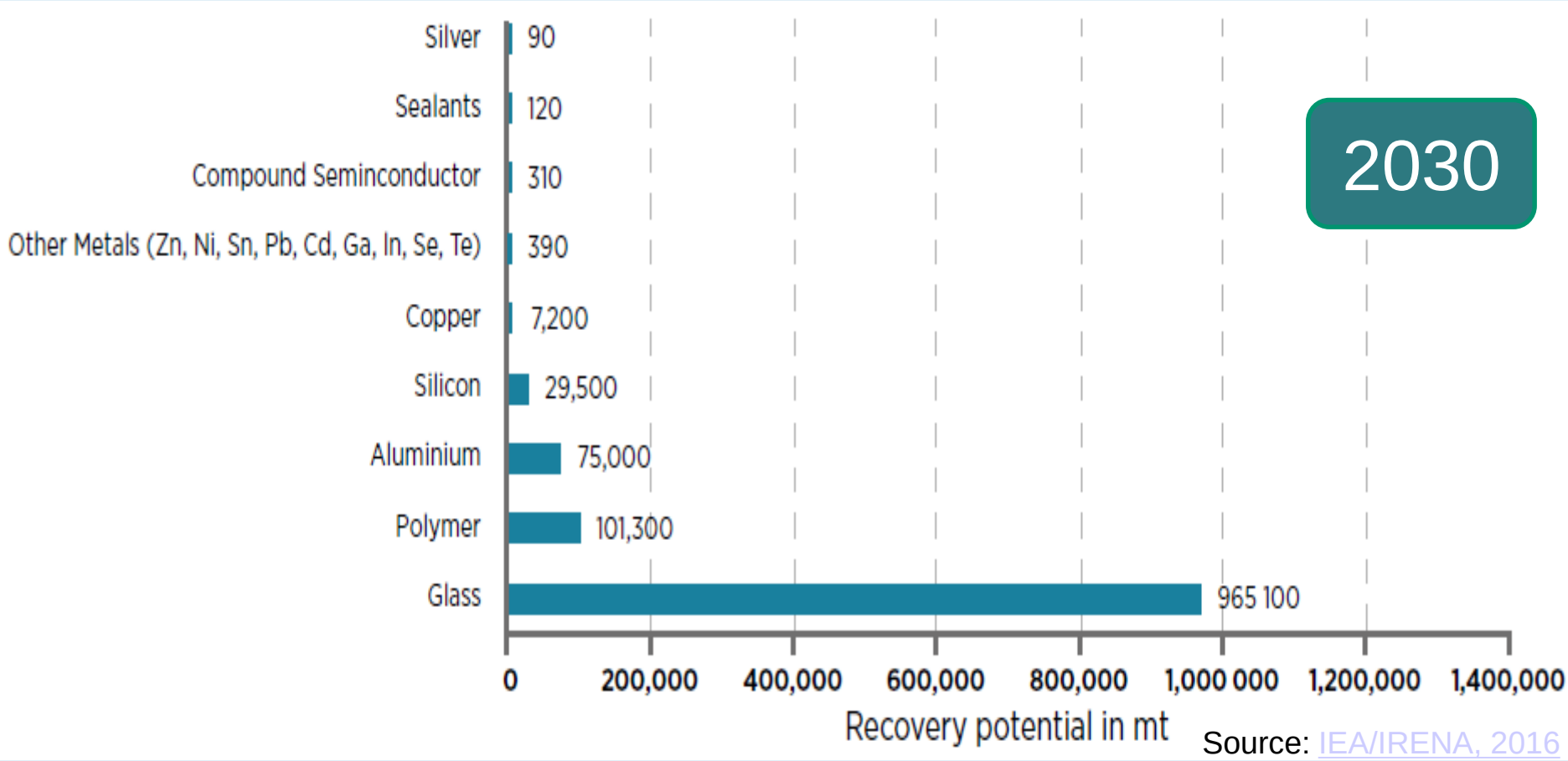
Australia: 950,000 tons expected



Source: IEA/IRENA, 2016

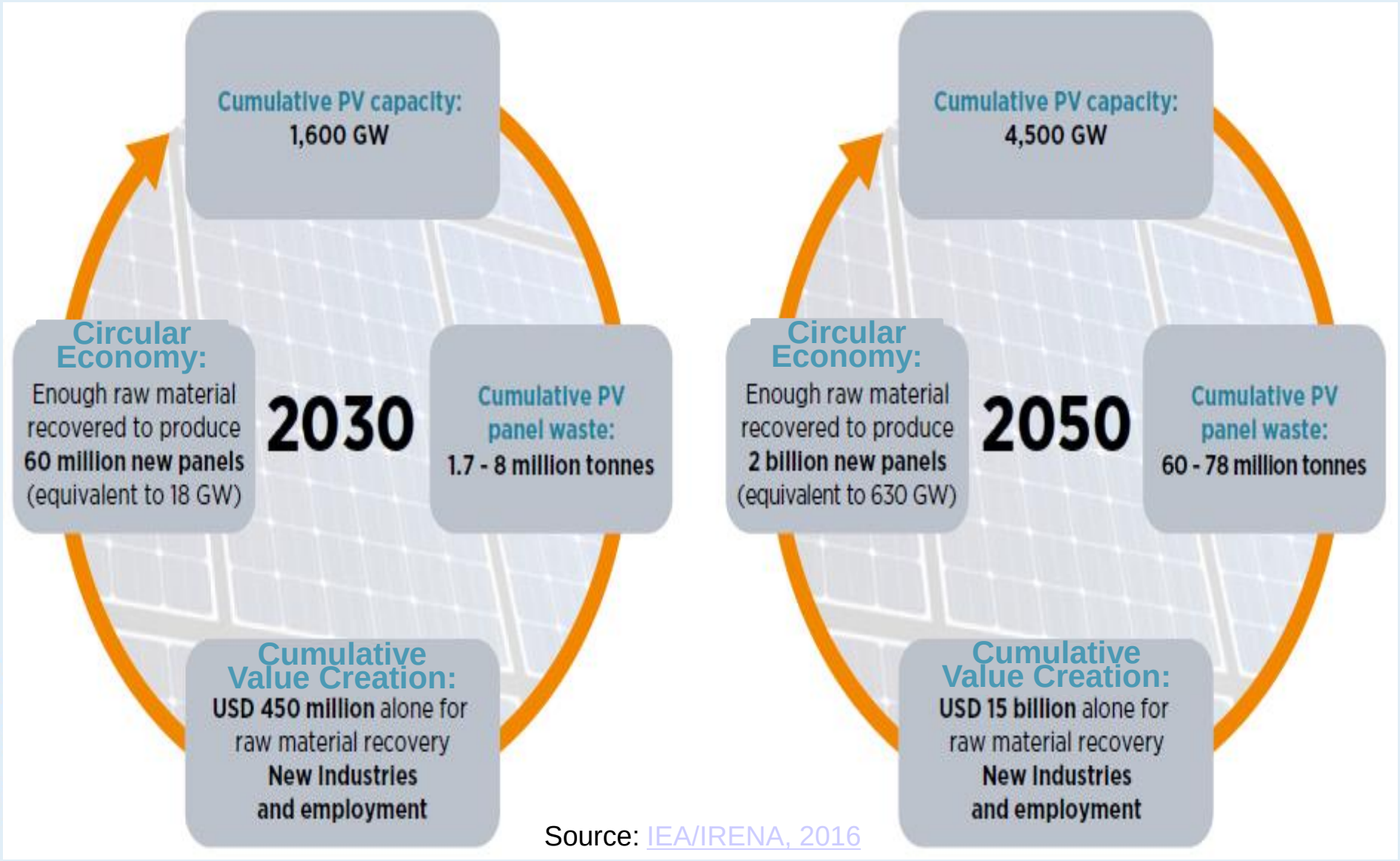
Why Recycle Modules? ... Circular Economy

Cumulative technical potential for end-of-life material recovery
(under the regular-loss scenario and considering anticipated changes to module design, like dematerialization)



Source: IEA/IRENA, 2016

Potential Value Creation – A New Waste Management Industry?



Source: IEA/IRENA, 2016

R&D Challenges

Waste Management and Recycling

Challenges are to prepare the technologies, systems and policies to manage decommissioning and disposal of end-of-life modules that can

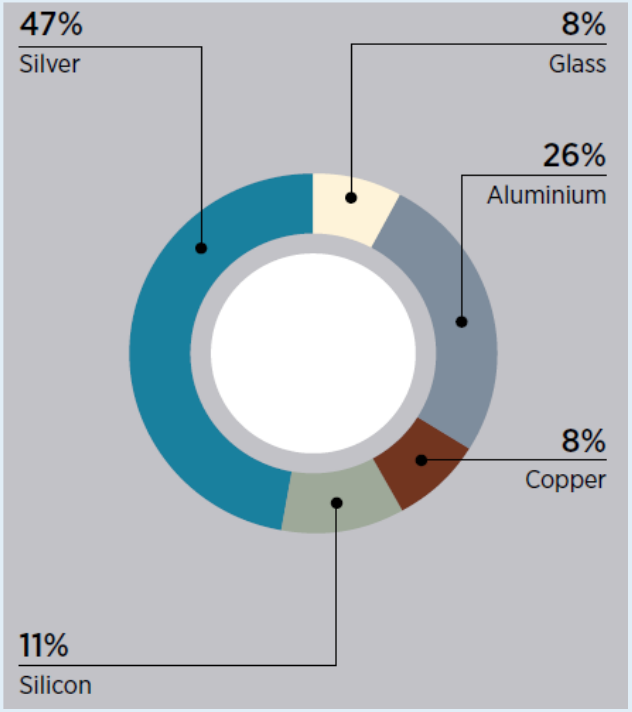
- Minimize costs and
- Minimize environmental impacts, while
- Maximizing materials recovery.

Design for Recycling

Conversely, one way to facilitate economical recycling and maximize material recovery is to design new modules that

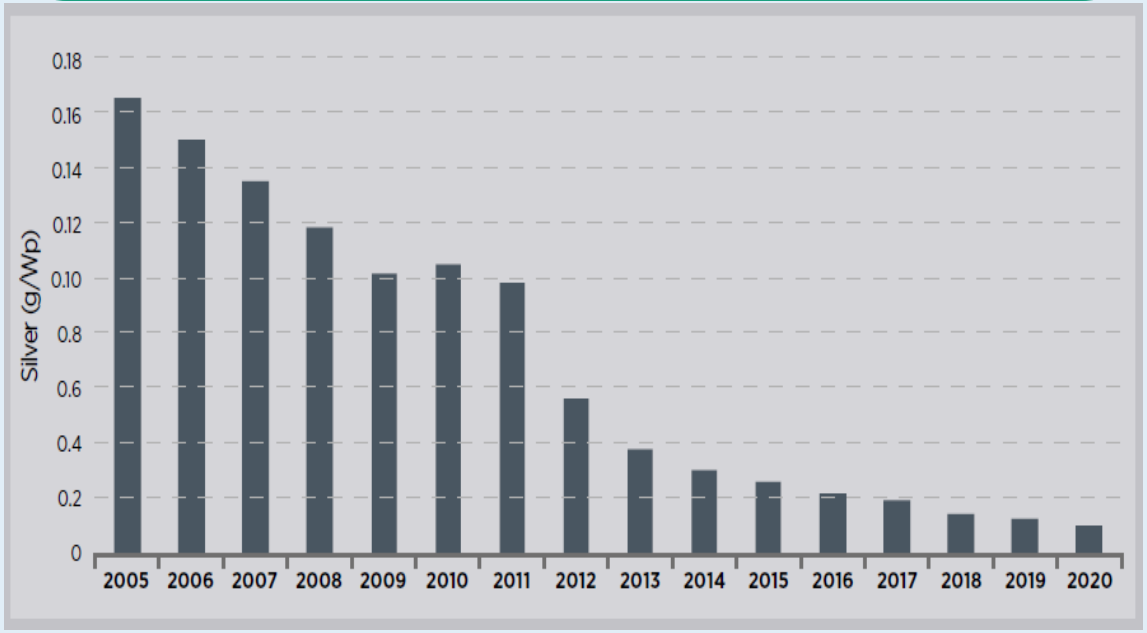
- Increase speed and ease of dismantling,
- Improve rate and purity of recovered materials, and
- Reduce waste.

An Interesting Twist: Dematerialization (a 3R Strategy „Reduce“) is a Challenge to the Recycling Value Proposition



Relative material value of a c-Si Panel
Based on Raithel (2014)

From a value standpoint, silver is by far the most expensive component per unit of mass of a c-Si panel – consuming today about 15% (incl. losses) of the global silver production.
Reduction of the use of silver is a clear manufacturing target, yet significantly affects value of recycled modules.



Historic and expected silver consumption per Wp
Based on: Perez-Santalla, M. (2013), Silver Use: Changes & Outlook, www.bullionvault.com/gold-news/silver-use-103020132

Source: IEA/IRENA, 2016

Food for Thought Today: R&D Questions

- Current recycling costs are high relative to landfilling or other options
  - R&D and industrial experience is needed to reduce cost, increase material recovery rates, increase purity and decrease contamination
- Science questions
  - What are the mechanisms and effect of contamination of Silicon wafers during use and through recycling processes? This influences what can be done with recovered wafers.
  - How much fluorine gas is produced from thermal treatment of modules and how does fluorine gas treatment effect design and cost of recycling processes? What are the tradeoffs for use of non-fluorinated backsheets?
  - Are there upgrading steps that could turn waste streams into value co-products? E.g., lead to lead oxide?
  - Could the energy use, purity and recovery fraction from electrolysis be improved with pre-treatment steps?
- Analysis questions
  - What will be the market size for PV waste in the US in future years from multiple sources
    - Manufacturing scrap
    - Early retirement – disasters, repowering
    - True end of life (after 20-30 year lifetime)
  - What is the total value proposition of recycling as compared to reuse, repair, remanufacturing, or disposal?
  - How do costs and effectiveness compare between different recycling policy design options including consideration of collection systems through treatment and disposal?
  - What are limitations and challenges to circular economy of PV modules given current codes, standards, regulations?