The Energy Doctor LLC DBA
High Performance PV

"Tweaking The PV Business Model To Deliver PV as Energy Infrastructure"

A More Reliable & Profitable PV System Delivery Process Approach

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Tweaking The PV Business Model To Deliver PV as Energy Infrastructure
A Question of Balance:

- **Why is PV *System Delivery as Reliable Energy Infrastructure* important to you?**
- **Why it's critical to have a PV Repowering Planning and Specification Processes in place prior to EPC bidding?**
- **Why it's critical to determine and agree on defining stakeholder Success and Failure, including an "All In" lifecycle cost and benefits analysis?**
- **The historic challenges in building PV Energy Infrastructure, what holds us back?**
- **Two Industry Solutions to Consider**

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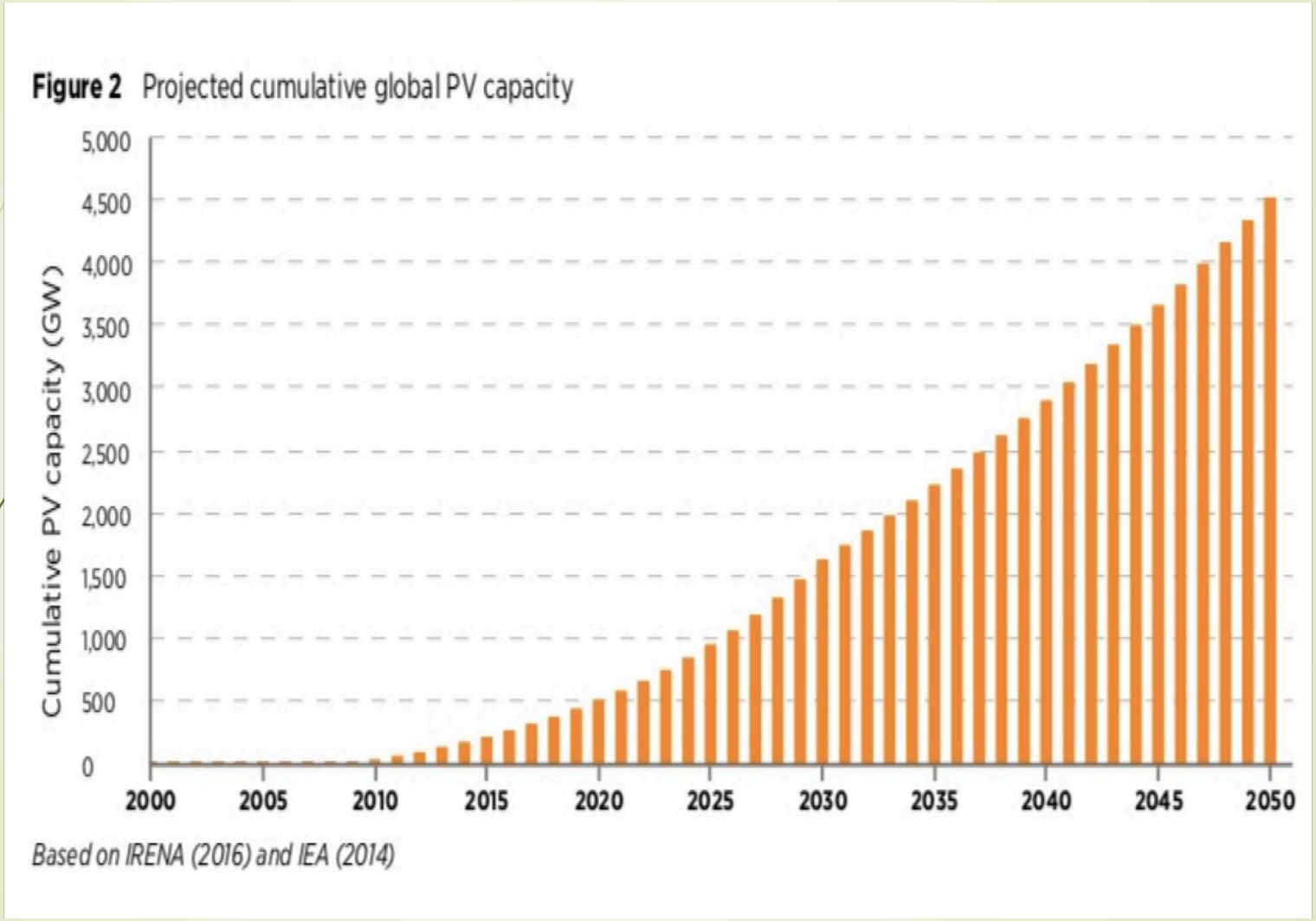
PV System Capacity from 2000 to 2050

(End – of – Life - Management, Solar Photovoltaic Panels, IRENA and IEA-PVPS)



(End – of – Life - Management, Solar Photovoltaic Panels, IRENA and IEA-PVPS)

Dramatic Improvement of PV Reliability & Profitability Requires Substantively Different Thinking, Choices & Change

- Issues to be Resolve in Delivering PV as Infrastructure
  - All Lifecyle Stakeholders wants, needs, expectations and profitability must be addressed in a PV Lifecycle System Deliver Process including O&M
  - The primary System Specification must be completed prior to EPC bidding to reduce Lifecyle costs
  - The EPC bidding Process must refine the "System Specification & Design prior to signing contracts.

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What will be operable in 2050?

End – of – Life - Management, Solar Photovoltaic Panels, IRENA and IEA-PVPS

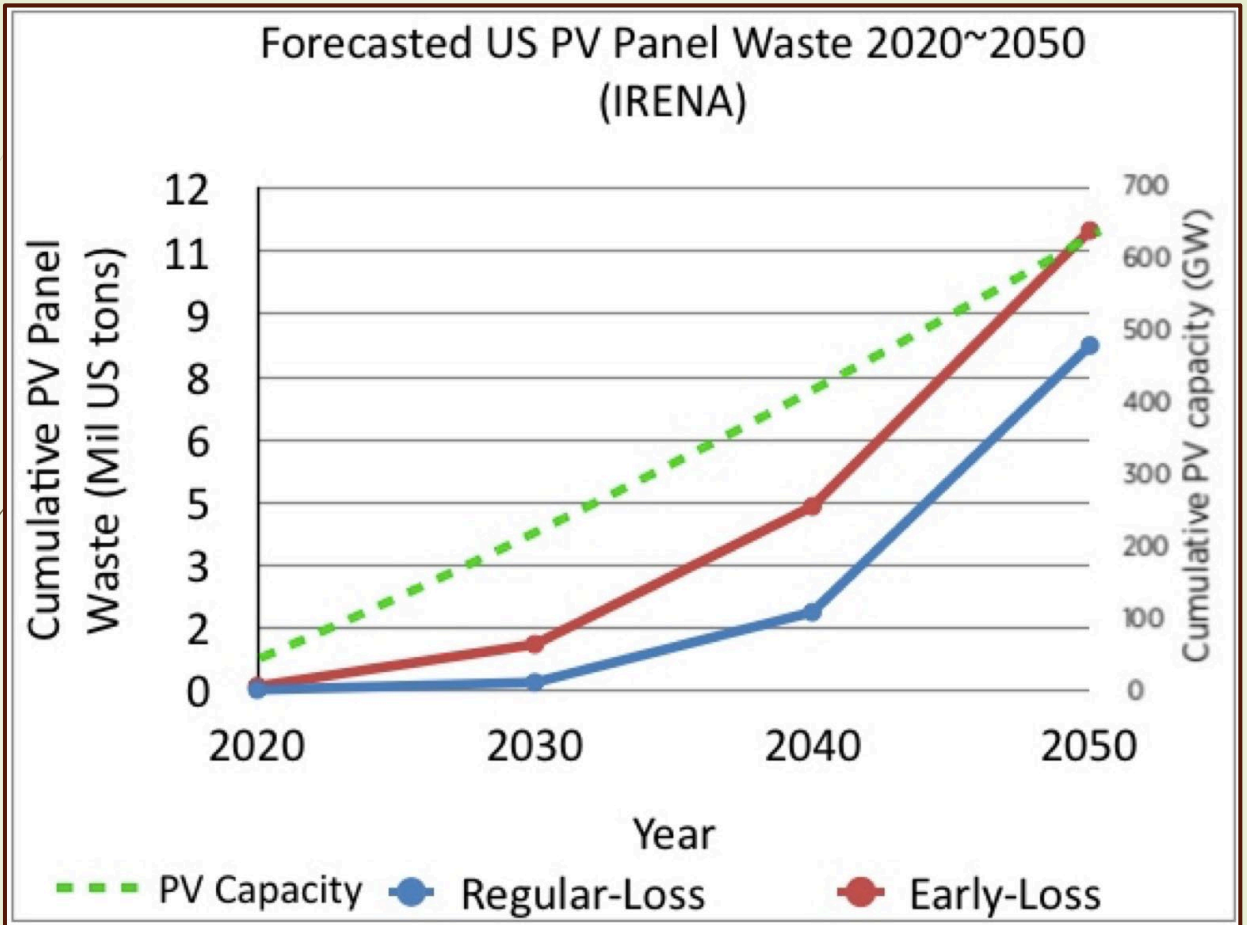
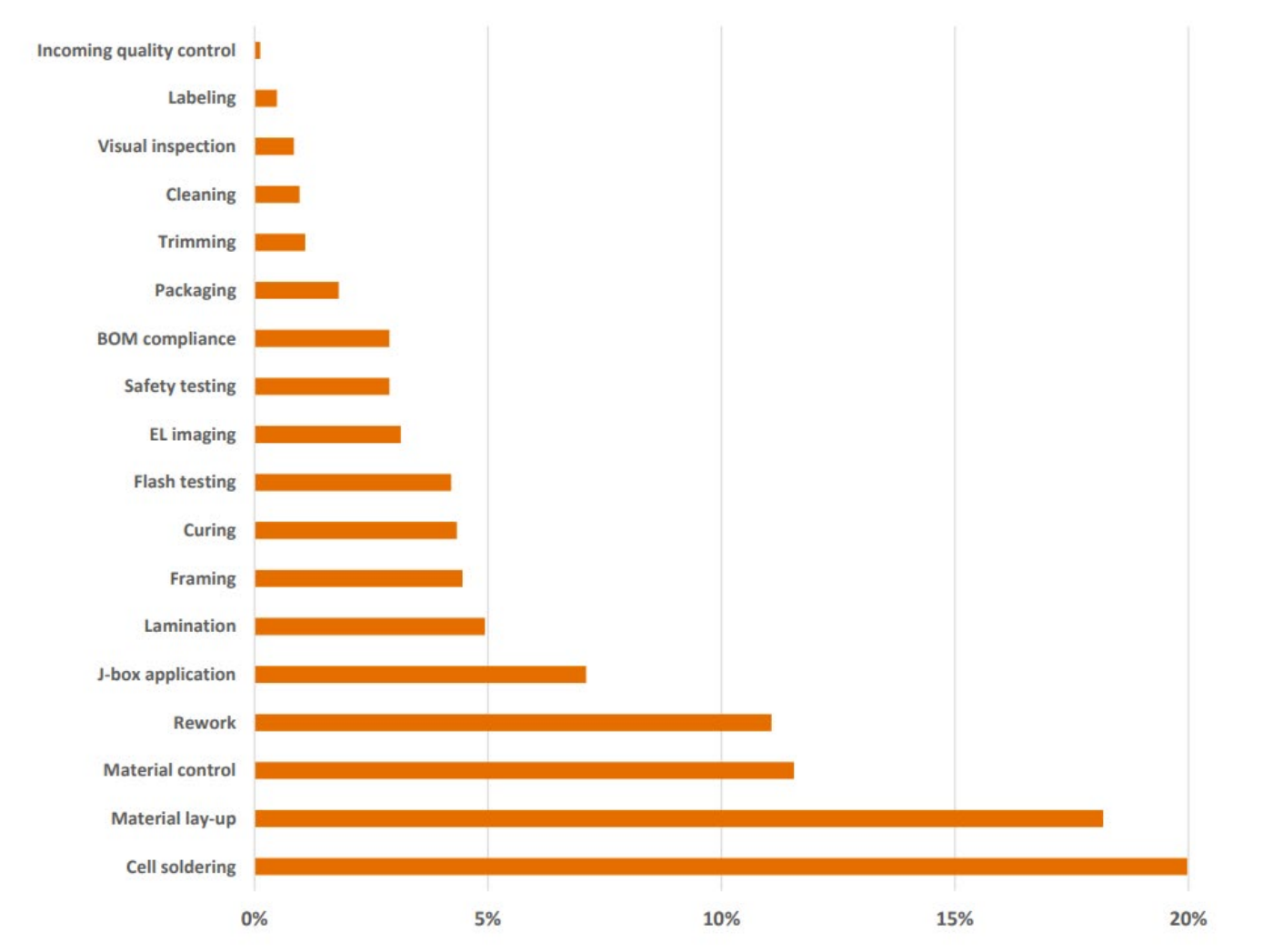


Figure 6. Forecasted US PV Panel Waste 2020~2050

Source: IRENA Report

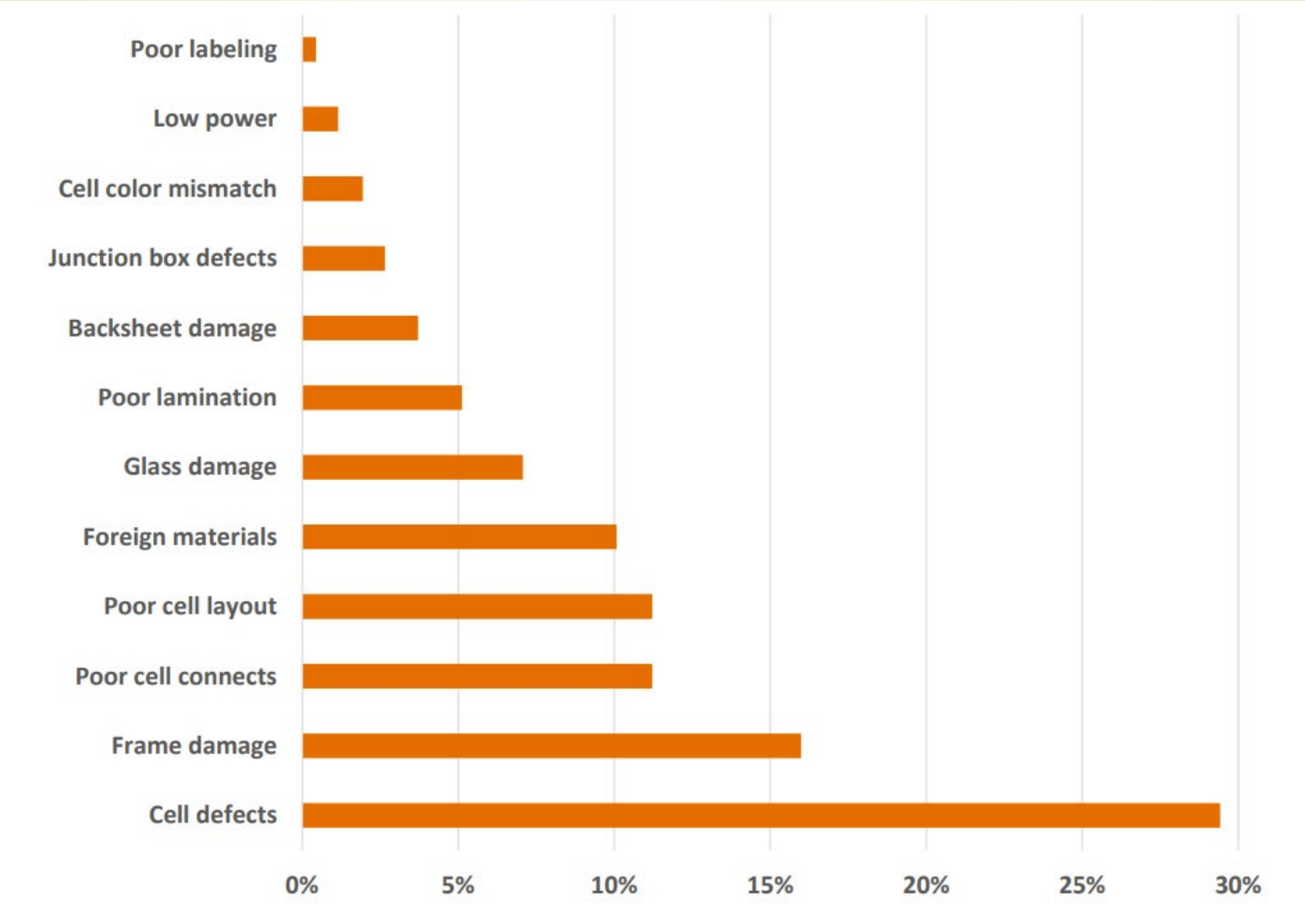
(End – of – Life - Management, Solar Photovoltaic Panels, IRENA and IEA-PVPS)

Sources of Module Defects in Manufacturing



Sources of PV module defects in the manufacturing process (2016-2020)
Credit: PI Photovoltaik-Institut Berlin AG (PI Berlin)

The Distribution of Defects in faulty modules

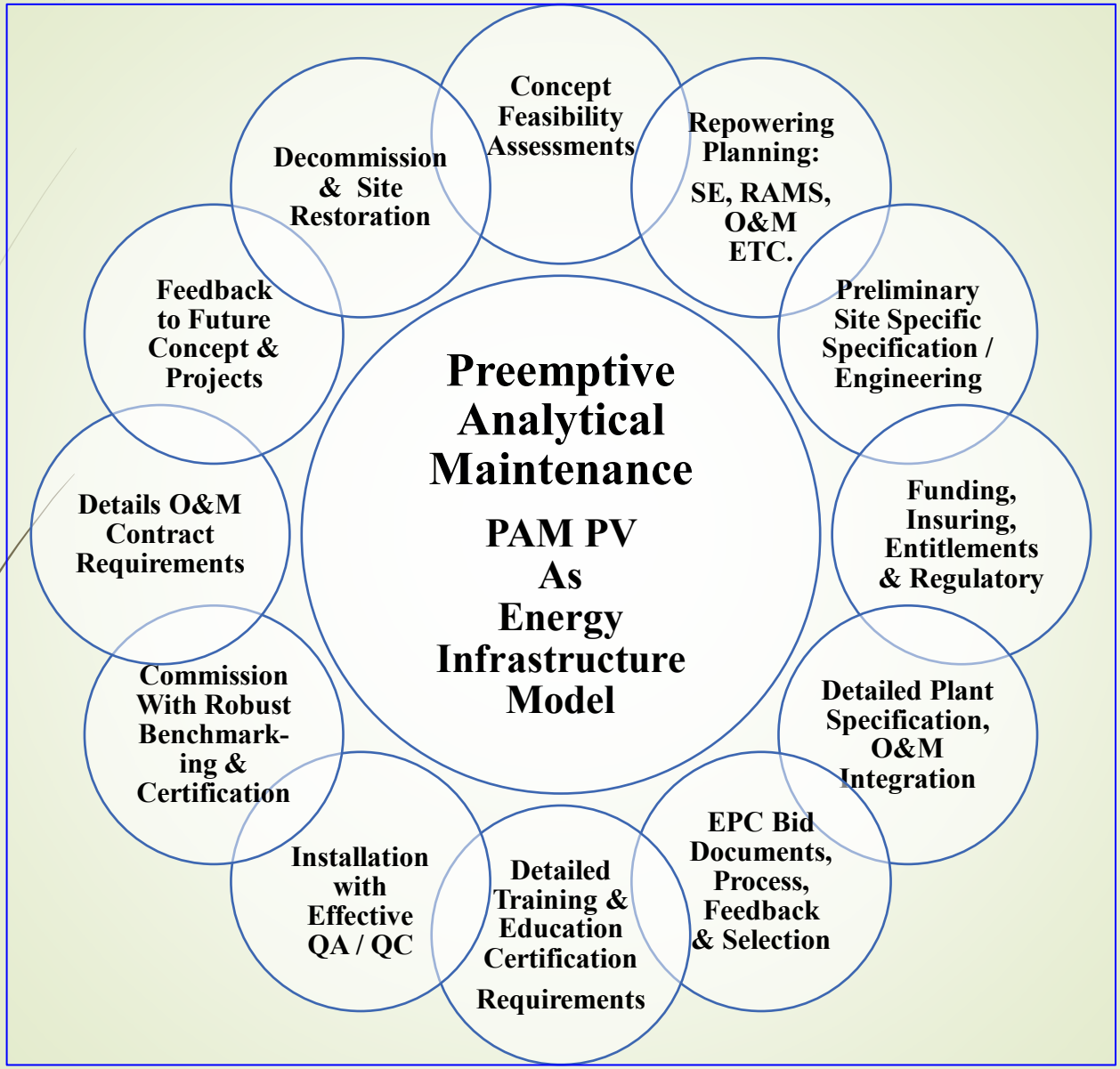


Distribution of defects in faulty PV modules (2016-2020)
Credit: PI Photovoltaik-Institut Berlin AG (PI Berlin)

Todays **PV Project** repowering model *Versus* a **PV System Planning Repowering™** Process Model

- Todays PV project repowering has no defined standards, requirements, industry wide planning processes, procedures or practices
  - It is whatever major maintenance must be done to keep the plant viable
  - Everyone's version of repowering is different with little to no attention to down stream stakeholders.
- A PV **R**epowering™ System Delivery Process with a capital "R" includes:
  - Clearly defines language, standards, requirements processes, procedures, commonly used Metrics, shared data and useable documentation
  - Addresses tong term needs for lifecycle planning, increased energy production, revenue and delivery, plus the costs of site restoration.
  - It is a Systems Engineering (SE) and a Reliability, Availability and Maintainability (including Testability) and Safety **(RAMS)** Process

The (PAM) Model Infrastructure Model



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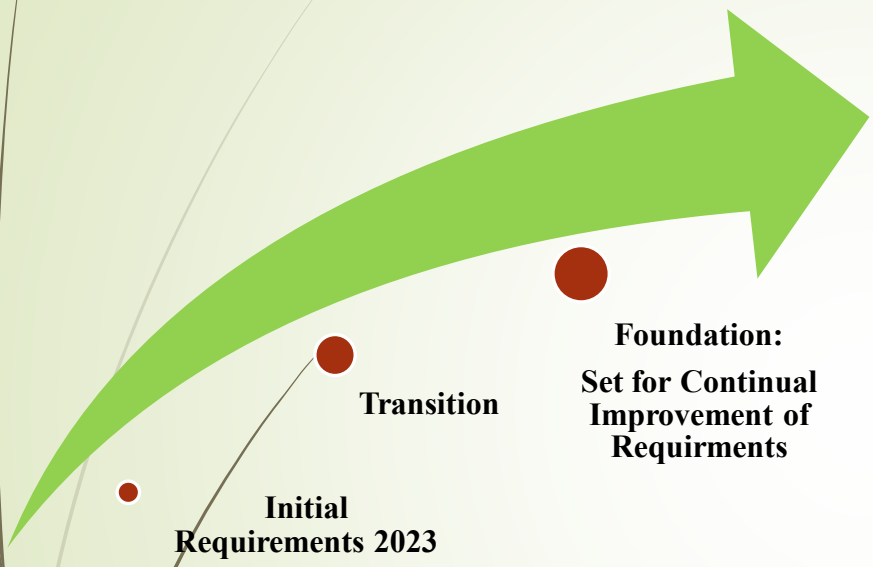
Two Functional Solutions Including Incentives for Success

- **Solution 1**
  - Determine and agree on defining stakeholder requirements for Success and Failure, including an "All In" lifecycle cost and benefits analysis at concept
  - Include stakeholder participation
  - Agree to address stakeholder concerns at concept and specification prior to EPC Bidding
- **Solution 2**
  - Lobby Congress for a 10 year PV "Plant Infrastructure & Resiliency" (PIR) Tax Credit with Requirements at 5 %
  - Include requirements that increase for the first five years and reduce the PIR Credit over the last five years

Flow of PV Plant Infrastructure & Resiliency (PIR) US 5%Tax Credit with PAM Requirements

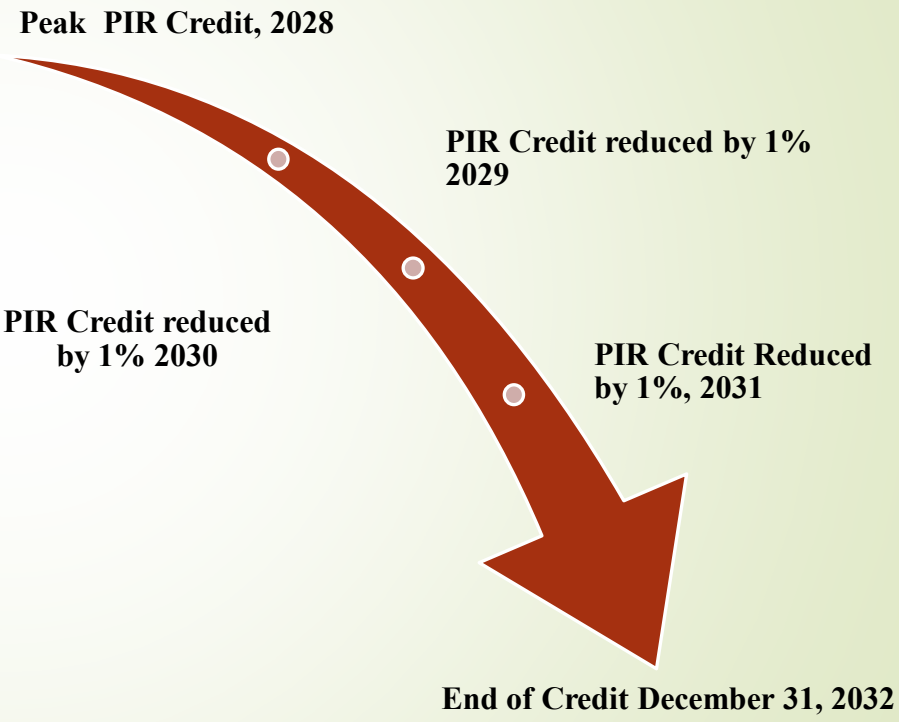


Primary Requirements to be continually updated 2023 - 2032 and beyond:

- PV **R**epowering Process:
- Specification
- SE - RAMS
- Component Reliability, Reparability & Recyclability
- Clearly Defined Data Requirements and Sharing
- Education and Training
- Plant Evaluation Criteria

Flow of PV Plant Infrastructure & Resiliency (PIR) Tax Credit and Requirements at 5 %

- **Tax Credit Reduction:**
  - Beginning In 2029, the PIR will be reduced by 1% annually until it is eliminated following December 31, 2032
  - All Requirements will be updated annual beginning in 202.



Conclusion: A Change for the Better:

With the More Resilient PAM System Delivery Model:

- The Existing Project Delivery module is a short term - high risk Financial Model
- We can build and operate longer lived, more productive and profitable PV Infrastructure.
- Reliability and Repowering Planning are a critical foundation to building better more robust, durable and profitable plants.
- Success requires addressing the performance and reliability issues at specification, including both RAMS and SE-SMART Engineering Practices that define the system prior to EPC bidding and contracting.

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High Performance PV Measurements of Success and Failure

Thank you for your participation

Please reach out if you would like to discuss the issues and Learn more!

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High Performance PV Measurements of Success and Failure

Success:

- If you don't ask for it, you will not get it! It's all about the Details!!!
- Never Assume Anything!
- There is a Great Need for Improved Training and Education Industry Wide
- Requires addressing real technical and financial challenges to improve the industry

Failure:

- Not being able to dismiss industry Myths and Assumptions
- Not Meeting All Stakeholder Requirements, Want, Needs and Expectations.