



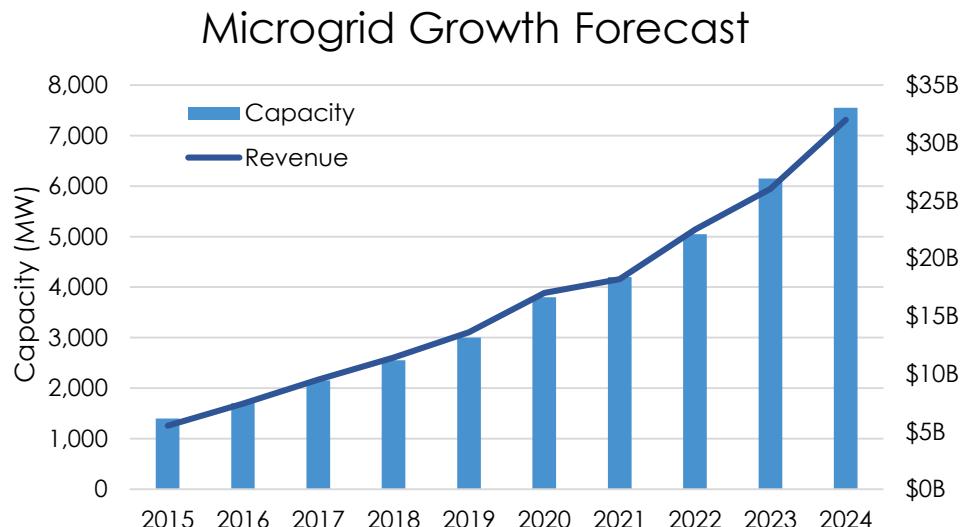
# ALECTRO LLC

Solar Power for the Railway Industry

2<sup>nd</sup> UIC Digital Awards

# The Future of Energy Markets

The energy landscape is changing rapidly. While electricity providers used to rely on centralized fossil fuels to serve their customers, a transition is occurring towards **distributed renewable energy** supported by Smart Grid technology. Implicit in the transition to a Smart Grid is increasing reliance on digital technologies including the **Internet of Things, smart metering, and artificial intelligence**. Essential to smarter electricity production is the development of **microgrids**. Microgrids are not a single technology, but rather a system of systems that offer benefits to regions all over the world. Simply put, microgrids represent the future of energy markets. They allow electricity markets to operate more quickly, efficiently, and reliably. Through its innovative solar modules and algorithms, Alectro places railways at the **heart of the coming revolution** in microgrid technology, leading the transition to **a renewable economy**.



“Microgrids may be the mechanism through which this **revolution** in clean distributed generation will be carried out – a portal for leaving the traditional power grid.”

– Renewable Energy World

# Microgrids: What You Should Know



A microgrid is a system of distributed energy sources (e.g., solar, storage) capable of operating independently from, or in tandem with, the grid. The centralized grid upon which railways rely for energy is **unsustainable**. Microgrid technology offers key benefits to railways and will **revolutionize energy markets**:

- **Disruptive Potential:** Microgrids and distributed renewable energy represent a “**mortal threat** to the existing utility system.” – NRG Energy
- **Global Application:** “In the developing world, [microgrids] may leapfrog the need for conventional utilities -- the same way mobile phones leapfrogged the need for landlines -- and bring power almost half of the **1.3 billion people** on Earth who don’t have it.” – Renewable Energy World
- **Cost Savings:** “In 2020, the use of microgrids can provide anywhere from **US\$64b to US\$171b** in electricity cost savings to commercial companies in the 20 countries we analyzed.” – EY Research
- **Resilient Energy:** “There is no question that microgrids breaking the grid down into smaller sections can prevent **millions of people** being knocked out of power by a major circuit going down.” – Honeywell
- **Cyber Security:** “Microgrids provide the ability to self-island from a distribution network that is under cyber- or physical-attack as well as use distributed, **self-healing architectures** to maintain energy delivery.” – Accenture
- **Digitization:** “In its true form, IoT goes beyond merely the ‘connected home’ and covers the **entire power (smart) grid.**” – RAD Group

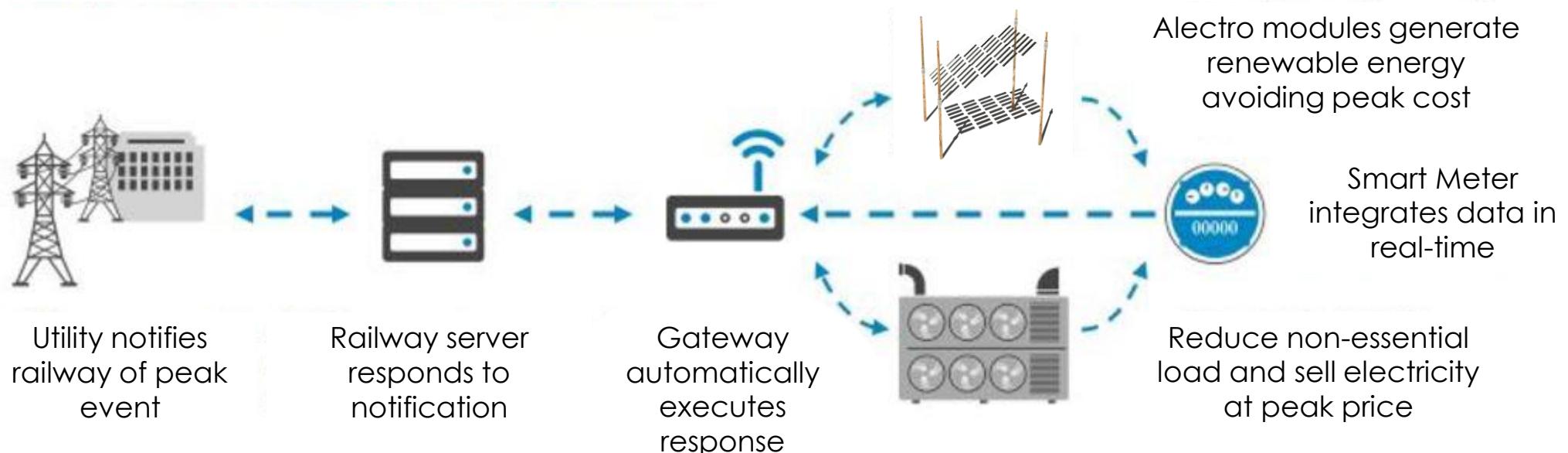
# Microgrid Digitization Potential



Microgrids are the “**killer app**” capable of making the Smart Grid a “**must have technology**,” allowing mass integration of innovative technologies with railroads’ energy systems, including:

- Internet of Things (IoT)
- Artificial Intelligence (AI) Demand Forecasting
- AI Electricity Price Forecasting
- Automated Demand Response (ADR)
- Renewable Energy Generation (REG)
- Command and Control Networks
- Smart Metering Infrastructure (SMI)
- Electric Vehicle (EV) Charging Stations

## Example of Automated Demand Response and Internet of Things Integration

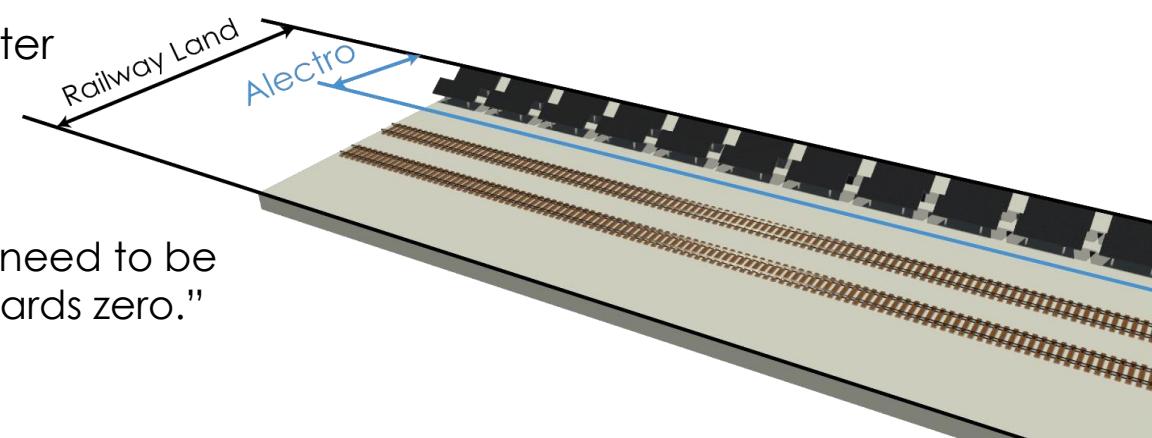


# Bringing Microgrids to Railways

Alectro's innovative solar modules place railways at the center of the coming **microgrid revolution**. While our primary mission is accelerating the transition to clean energy, we do so by offering **immense value-add** to rail companies. Railway land is **severely underutilized**. Space alongside and above railways is empty, failing to capitalize on **real economic potential**. Alectro modules can transform the railroad into a microgrid capable of producing and distributing clean, **renewable solar power**. Trackside solar provides rail companies a number of **critical benefits**:

- **Power Resiliency:** Storms, natural disasters, and cyber attacks can cause **catastrophic power outages** through grid blackouts and disconnections. Alectro's on-site generation provides vital energy security.
- **Energy Savings:** The cost of solar PV electricity fell at an annual rate of **78%** between 2009 and 2014. Industry experts expect them to fall even further, reducing costs for rail companies.
- **Electricity Revenue:** Microgrids allow the **sale of unused electricity** to the grid. 1km of Alectro trackside solar has more generation capacity than an acre of traditional solar farms.
- **Clean Energy:** The transportation industry is a heavy emitter of greenhouse gases responsible for climate change. Alectro modules allow rail companies to **lead the fight** against one of the largest problems facing humanity.

"By mid-century, greenhouse gas emissions from transport will need to be **at least 60% lower** than in 1990 and be firmly on the path towards zero."  
– European Commission



# Railways: The Optimal Solar Site



Microgrids are already being integrated with rooftop and utility-scale solar farms. In 2016, solar power was the **fastest-growing** energy source, accounting for 39% of new electricity generating capacity. With so much solar investment, why shift the focus to railroads? It's simple: Using railways with Alectro's unique module design offers a number of **key competitive advantages**:

- **Land Efficiency:** Trackside solar maximizes economic potential of **pre-purposed railroad land** to reduce financial and environmental cost.
- **Scalability:** Alectro's modular design simplifies the process of building out additional capacity, and our tilt algorithms **maximize generation** at every point along a track.
- **Local Generation:** Generating on-site minimizes transmission and distribution costs while **reducing energy loss** by up to 7%.
- **Economies of Scale:** The ability to build large-scale solar farms along tracks ensures **minimum operating expenses** relative to revenues.

	Rooftop Solar	Utility Solar	Alectro
Land Efficiency	✓	✗	✓
Scalability	✗	✓	✓
Local Generation	✓	✗	✓
Economies of Scale	✗	✓	✓

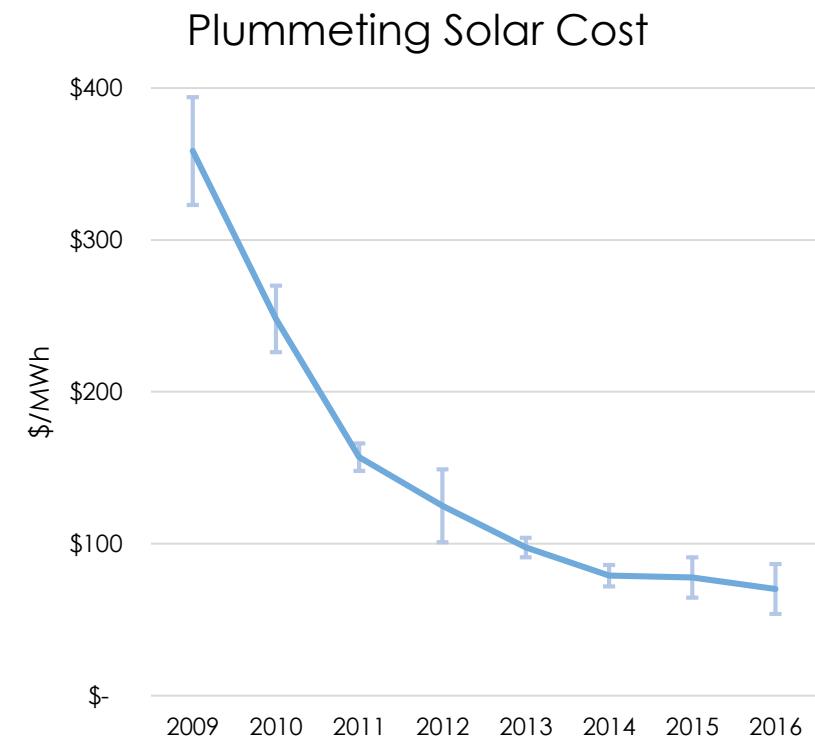
Alectro essentially combines the benefits of rooftop and utility-scale solar to develop the **optimal solar solution**.

# Solar: The Optimal Railway Energy



Countries across Europe are investing billions in electrified rail to reduce greenhouse gas emissions. But as long as the electricity is supplied by burning fossil fuels, rail transport will **contribute to climate change**. Alectro is not alone in thinking solar is the solution to these problems. According to researchers at the Imperial College London, trackside solar is the **key to sustainable rail power** for a number of reasons:

- **Global Application:** Developing and refining the trackside solar concept would have “applications on electrified rail networks **all over the world.**”
- **Renewable Synergies:** Building out the technology to make railways sustainably self-sufficient can “open up **thousands of new sites**” for renewable energy development not reliant on the grid.
- **Grid Limitations:** In various areas of Europe “the electricity grid has **reached its limit**” for supplying power to rail companies.
- **Energy Matching:** The maximum amount of energy solar is able to generate “**more or less match[es]**” the maximum amount demanded for rail transport.
- **Geographic Fit:** Certain land areas receive more sunlight than others and are thus more suitable for solar; many railways “run through areas with **great potential for solar power.**”



# Led By a Strong Team

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Alectro has a dedicated team of founders...

**CEO: Farouq Ghandour** – Physics, Econ @ Yale University

**CTO: Andrew Suiter** – Civil Eng, Architecture @ Iowa State University

**CFO: Omar Zaki** – Physics, Econ, Math @ Yale University

**COO: Jon Langel** – Finance, Econ, Risk Mgmt @ University of Iowa

... and a highly skilled team of advisors.

**Guy Warner, PhD** – CEO @ Pareto Energy. Expertise: Microgrids, off-loading, customer acquisition

**Georges Sassine** – Principal @ GE Energy. Expertise: Capital raising, startup operations, energy markets

**Sean Suiter** – Founder @ Suiter Swartz IP. Expertise: Legal, technology, intellectual property

**Peter Boyd** – Executive Fellow @ Yale Center for Business & Envt. Expertise: Entrepreneurship, clean tech

The disruptive potential of Alectro's technology has been recognized by the Yale School of Management, OneH Technologies Corp., and New York's Next Gen Summit.



Alectro Team Experience

Morgan Stanley



**Deloitte.**





# Dossier Information

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We thank you for considering our proposal to bring  
renewable energy to the railway industry.

ALECTRO LLC