Energy Internet Corporation (EIC) is an energy technology company, that helps assure and accelerate the achievement of Sustainability and Zero Carbon goals. EIC helps Utilities pay for their modernization to highly-distributed-renewable-power-generation grids, and the phased decommissioning of fossil fuel generating plants. EIC's solution, Intelligent Grids[1] (IG), help deliver high availability and lower-cost power to consumers, with distributed as well as concentrated renewable power generation.

Energy internet Intelligent Grid or Ei IG, is a cloud orchestration, optimization and prediction system. The IG cloud provides Energy Distributors (ED), Power Producers (PP) and Consumers a Standard Protocol (IG-SP) to intelligently access the long duration storage systems – EIC's Hyper Scale Energy Storage (HSES) and Data Center Energy System (DCES). IG cloud uses standardized technical protocols (T-Port) to collect sensory power data, such as phase current & voltage, and frequency. It uses this data to predict, optimize and manage the flow of power to, into and from the Grid, through the T Port's standard-protocol actuation controls. Ei IG also has a standard commercial protocol, called C Port for a formal rule capture of key commercial understandings[2] between parties, such as pricing, availability, and peaking. It uses this data to optimize and manage the power flow.

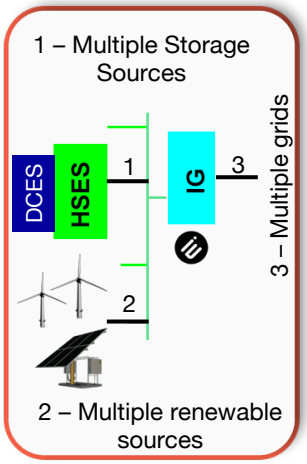
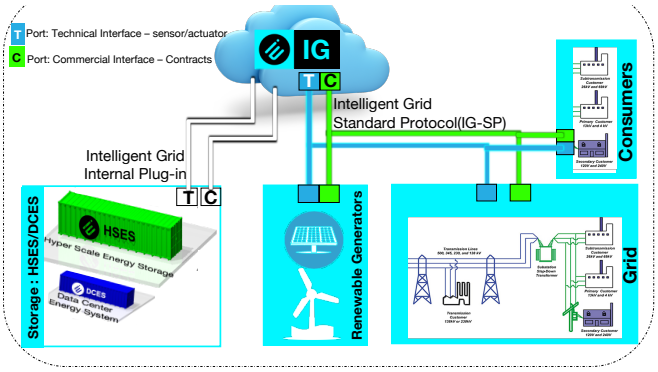


Figure 1: Intelligent Grid - Power Flow

Figure 2 shows the IG sourcing power from multiple renewable sources and storage sources. Storage providers may have independent and direct energy sources to charge their systems.

As Fig 3 shows, the Grid can serve its demand (3), by sourcing low-cost, highly intermittent renewable sources (see 2a & 2b). Any deficit is made up by the storage systems (1a), even under extended (40+ days) periods of zero renewable power generation. Similarly, where allowed,

Figure 2: Intelligent Grid - Control Orchestration & Standard Protocol



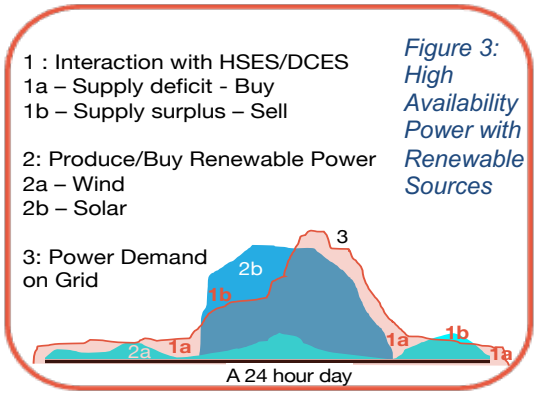


Figure 3: High Availability Power with Renewable Sources

[1] IG is an intelligent power distribution system for traditional power grids, islanded grids or a grid-interactive installations – like a rooftop solar in homes-, where power can flow in both directions. Intelligent Grids lowers the costs of traditional power grids, by substituting higher cost peaking plants.

[2] This includes PPA (power purchase agreement), SLA (Service Level Agreements) and general and often unstated market expectations – such as 3.5 9s of power availability to a grid consumer today.

surplus power on the grids can be stored (1b).

Ei IG helps Grids:

- Significantly accelerate plans to Zero Carbon energy
- Better finance modernization of grids for distributed renewable generation and pay for decommissioning fossil fuel assets
- Serve emerging power-intensive infrastructure, like EV and Data Centers, with their requirements of heavy power peaks
- Lower costs to consumers
- Improve energy security with larger reserves of energy storage and more distributed generation
- Avoid power dumping by renewable power plants, and utilize hydro & nuclear power plants optimally
- Improve Power Availability and Quality of Supply (QoS) on both supply and demand side grids, while better serving peak power needs without demand response or abatement.

Ei IG leverages a Grid's expertise and legacy in power distribution and management. It accelerates substitution of fossil plants, by delivering higher project economic returns, and attracting more innovative project financing.

Possible financial benefits (see Fig 4):

- Reduce the average cost of energy delivered from about $60/MWH to $45/MWH[3], with the flexibility to deliver power to customer demand, under extended deprivation (40+ days) of renewable generation
- Average Return on Investment (ROI) of 14%[4] (6.9 years payback), for an investment of about $0.2 Mill/MW each, for IG and Grid modernization
- Carbon credits increase the ROI by 8.1%[5].

Figure 4: Illustration – IG Economics [(3), (4)]

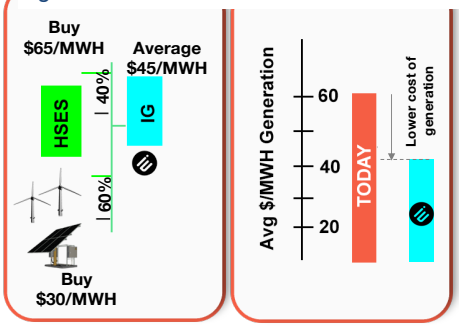
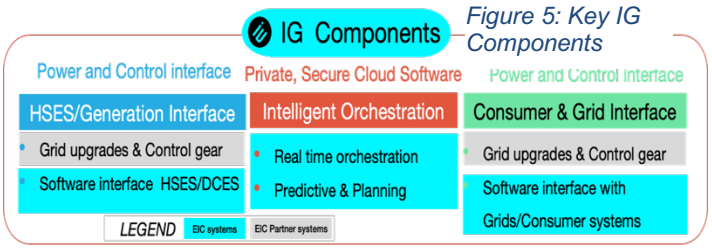


Fig 5 shows key IG system components.

- **Hardware and Systems** (Shown in Fig 5 in gray): Grid-modernization components, in terms of grid upgrades and control gear at the storage interface, and the distribution and consumer interfaces. These are commercially available, third party gear, provided to EIC specifications.
- The **software components/services** include
  - Secure T & C interfaces (Fig 1) with ED, PP & Consumers; and IG distributed-hybrid-clouds
  - Real-time orchestration of power flow to/from Grids and HSES/DCES
  - Optimization of power flow based on IG's prediction and planning systems
  - Cloud Tools to develop & test integrations (with existing control environments) and new applications.

Figure 5: Key IG Components



[3] $30/MWH is an average cost to the utility for the procurement of renewable power from a mix of lower-cost concentrated grid-scale renewable plants and relatively higher costs of rooftop solar installations.

[4] Based on EIC's software and services costs of about $0.2/W and grid upgrade costs on supply side and consumer side of $0.2/W, and annual EIC S/W and incremental upgrade-system OpEx costs of $0.01/W/yr, totaling $0.03/W/year. Assuming 44% average load factor (today's average in the USA):
- Sourcing Costs: 40% power from HSES @$65/MWH, 60% from directly procured renewable generation @ $30/MWH; 10% sale of surplus renewable power generation to HSES @ $20/MWH
- Delivered power per MW per year: 8760hr/yr X 44% = 3854.4 MWH/yr
- Average net purchase cost: {(40% X $65/MWH) + (60% X $30/MWH) + [10% X ($30-$20)per MWH]=$45 per MWH
- Average reduction in costs : $60/MWH - $45/MWH = $15/MWH → $15/MWH X 3854.4 MWH/yr → $57,816/MW/yr
- ROI on incremental investment by way of reduction in costs: ($57,816/yr)/($200,000/MW + $200,000/MW) = 14.5% pa or 6.9 years payback

[5] CO_2 sequestration: @523 tons of CO_2 per 1,246.847 MWH of NG power→0.42 tons/MWH. Revenues per MWH of $50/ton of C → @margins of $20/ton, $8.4/MWH→$32,377/MW/yr – 8.1% ROI.