LINUX FOUNDATION
COLLABORATIVE PROJECTS

@OPENGRID.SOLUTIONS

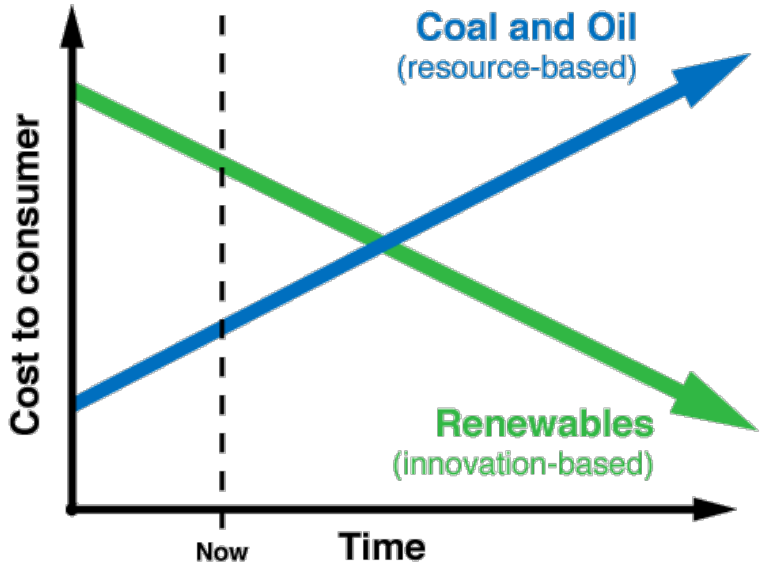
Formation Discussion Draft

February 14, 2017

WHY DO WE DO WHAT WE DO?

The Great Transition Accelerates

- Renewable energy moves to zero-marginal costs after capital investment, the future becomes the electrification of everything.
- Renewable energy will displace reliance on fossil fuels.

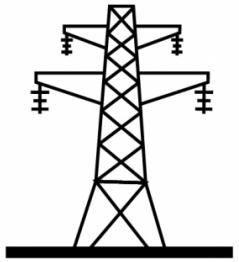


- The new paradigm overturns all aspects of the traditional electric industry – moving from from extractive to transactional.
- Central to this historic change is the proliferation and declining costs for small-scale technologies with increased capability for energy supply and management.
- These distributed resources are maximized by layering information and communication technologies (ICT) on top of billions of sensors (IoT) that can direct and manage a *transactional* and *efficient* energy management system.

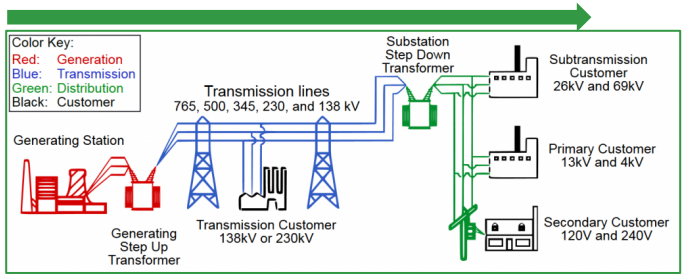
CHANGING PARADIGMS – TRADITIONAL

- EXTRACTIVE ENERGY PARADIGM = Supply is dominated by large-scale central generating plants and one-way distribution services to deliver power to meet consumer demand. Privileges large monopolies, and centralized utilities. Think "mainframe". Natural resources are either extracted from the earth or natural systems are radically modified with multiple unintended consequences. True costs are rapidly increasing both in terms of extractive costs, environmental costs, and geopolitical costs, but are typically omitted from market prices (ignored entirely or dismissed as "externalities"). New business models are difficult to establish.

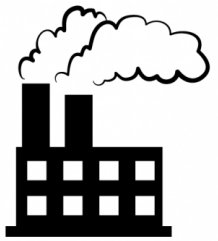
Behemoth



Unidirectional



Dirty

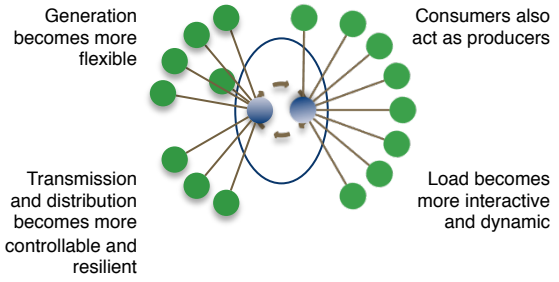


CHANGING PARADIGMS – EMERGENT

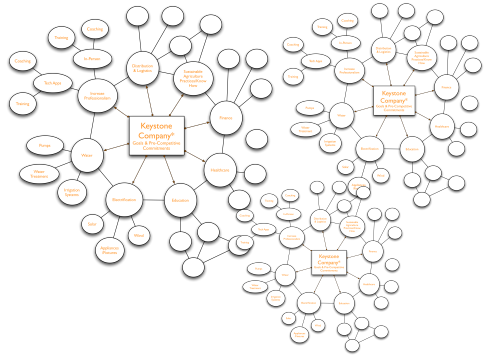
- TRANSACTIONAL ENERGY PARADIGM = Energy users and energy resources are local, co-located at the grid edge, with the grid providing residual energy needs and a platform for transactions between consumers and prosumers. User-centric vs system-centric. The paradigm is composed of networks of networks, much like the Internet. Energy becomes free to prosumers and can be traded. The open source platform guarantees equal access to market actors and opens complementary efficiencies which drive innovation. Value occurs through hardware, products, and services layered on top of the network.

Ecosystem

Transactional



Networks of Networks.



IMPLICATIONS

- Electric and energy industry transformation requires a whole-system multi-layered architecture that includes the physical electric network, and new communication and control systems, new business models, new markets, and new regulatory frameworks.

From Prediction to Intention: Technology and Innovation in Service to Societal Values

An Intentional Energy Future

- The electricity industry is undergoing massive transformation – renewable and small-scale distributed resources, powerful new technologies, environmental policy mandates, growing public awareness of impacts
- Industry participants are fully aware of “disruptive” changes and challenges, but lack a vision of where the changes are going, a vision of the future electric system
- Experts tend to think of major change as passive observers, in terms of prediction:
  - *Where are the trends going and how fast?*
- Our opportunity – indeed, our duty as engaged citizens and professionals – is to shift from prediction to intention:
  - ***What energy future do we want?***

What Energy Future Do We Want?

What values and societal objectives drive the future electricity system? A sample:

- Sufficient supply to meet energy needs – Local systems customized for the energy needs of families, communities, the 21st century economy
- Accessible and affordable for all residents, including businesses, government facilities, farmers, etc.
- Ecologically sustainable – Energy life cycle does not degrade water, soil, air and oceans, does not destroy habitats, ecosystems, species
- Resilient to extreme disruptions – weather, cyber attacks, economic volatility and political instability
- Reliable and safe under normal conditions
- Energy democracy and justice objectives – Universal access, local control, local jobs and economic opportunities; no sacrifice zones

ARCHITECTURE FOR THE ENERGY FUTURE BEGINS BY COMPARING STRUCTURAL OPTIONS.

Centralized: Large-scale power plants, high-voltage transmission, radial distribution systems to serve customers, limited use of small-scale local resources

- The traditional electric system paradigm
- Large sunk investment in mega-assets
- Industry structure, regulatory frameworks, investment financing – were all designed around this paradigm

Decentralized: Imagine community-level energy systems designed and built to serve local needs

- Enabled by powerful new technologies
- Micro-grids can function autonomously as energy islands
- System control structure organized as laminar decomposition

SMALL-SCALE TECHNOLOGIES ARE OVERTURNING LONG-STANDING ENERGY CONCEPTS.

Customer vs. Resource: Every end-use customer can be a micro resource for the energy system, consuming and producing energy at different times

Community as the customer: The locus of decision making and action is the community, not just the individual

Energy Services vs. Commodities: Energy needs driven by local end-uses can rely less on the grid-supplied kWh commodity

Local grid as platform for resilient communities: Future grid can achieve synergies among energy-using essential services

Scale economies come from widespread adoption: Instead of building huge assets, communities share knowledge, adopt best technologies and systems and adapt them for their needs and conditions

RESILIENCE AND SUSTAINABILITY FOR THE 21ST CENTURY ARE CREATED FROM THE BOTTOM UP.

Context: Increasing volatility of climate, natural ecosystems, natural resources, national and global economy and politics

Context: Demonstrated inability of established institutions to address human needs and provide for long-term sustainability

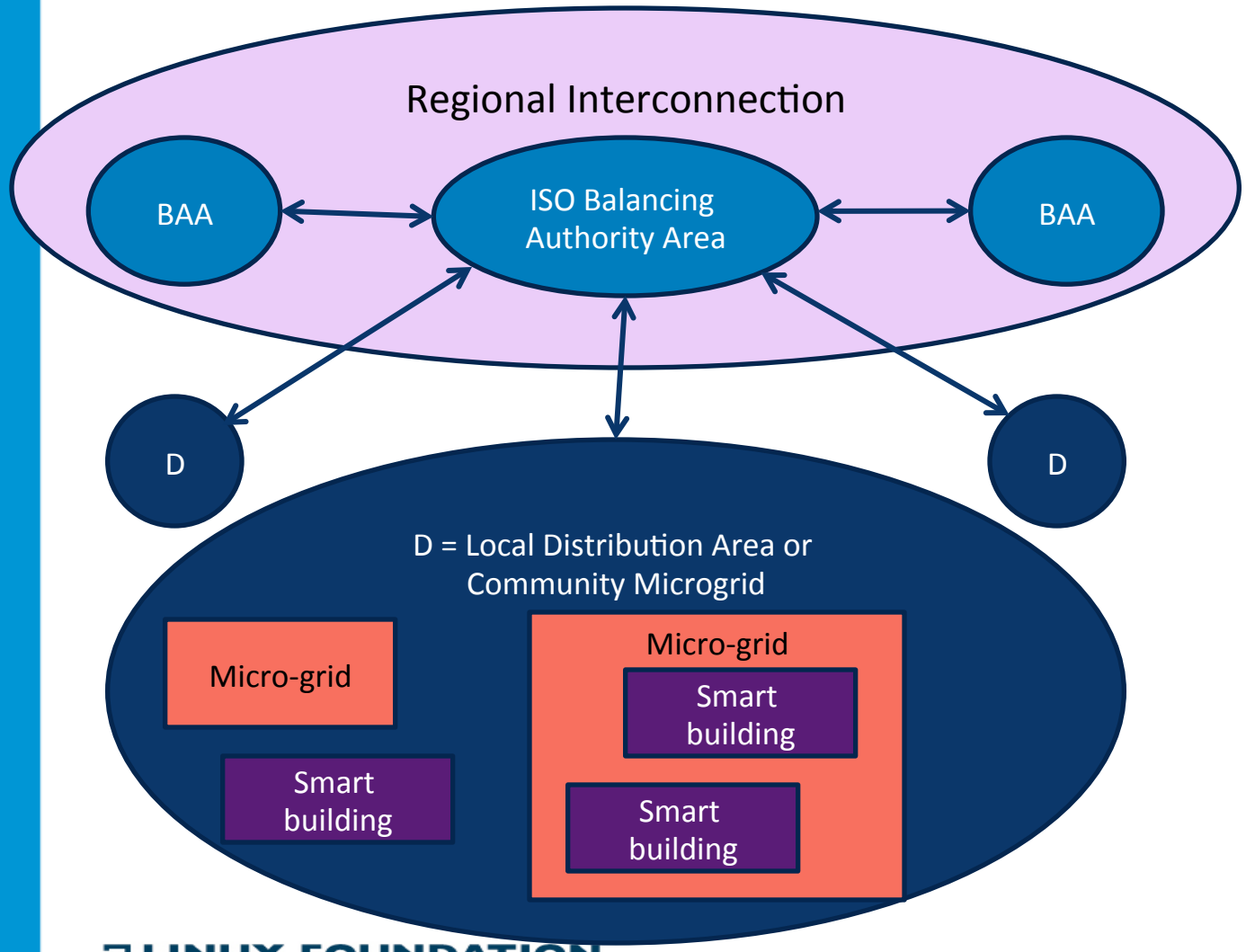
The resilient community response: View the local community as an ecosystem and design for synergy, sustainability, resilience, happiness

- Integrate essential services: electricity, local transport, water supply, telecommunications, wastewater treatment, security
- Support and strengthen local economy, local food, locally-owned business, local financing, medical services, practical skills
- Recover energy, nutrients, materials from waste and use locally
- Create public spaces and events for residents to meet, talk about what matters, beautify and improve their neighborhoods
- Use technology and innovation to enable all of the above

Future Vision for Electricity and the Grid

- An “integrated-decentralized” electric system.
- Structured as a layered hierarchy of self-optimizing sub-systems or microgrids (MG). Transformation of a “mainframe” model of connectivity to a network of networks model.
- Each MG can be customized to meet the needs, goals, and conditions of the local area it serves.
- Each MG can be networked to link to the high-voltage transmission network, to other MGs, and to the wholesale market.

The Future Grid may be a Layered Hierarchy of Optimizing Sub-systems.



- Each tier only needs to see interchange with next tier above & below, not the details of what's inside other tiers
- ISO/TSO focuses on regional bulk system integration while distribution utility coordinates DERs
- Layered control structure reduces complexity, enables scalability, increases resilience & security
- Fractal structure mimics nature's design of complex organisms & ecosystems.

@OPENGRID.SOLUTIONS

@OpenGrid.Solutions is a moon shot initiative meant to ensure and speed the transition to renewable energy and help bring about a fundamentally new energy paradigm:

1. Addresses a huge problem
2. Proposes a radical solution
3. Leverages breakthrough technology

@OPENGRID.SOLUTIONS' MISSION

- @OpenGrid.Solutions seeks to build, repurpose, and diffuse to the marketplace, an open source operating platform that enables distributed energy resources to function as a network composed of interconnected, yet autonomous, microgrids.

PURPOSE

The purpose of @OpenGrid.Solutions is to organize, create, and maintain software libraries that provide a predictable and consistent interface to underlying platform-specific implementations for microgrids.

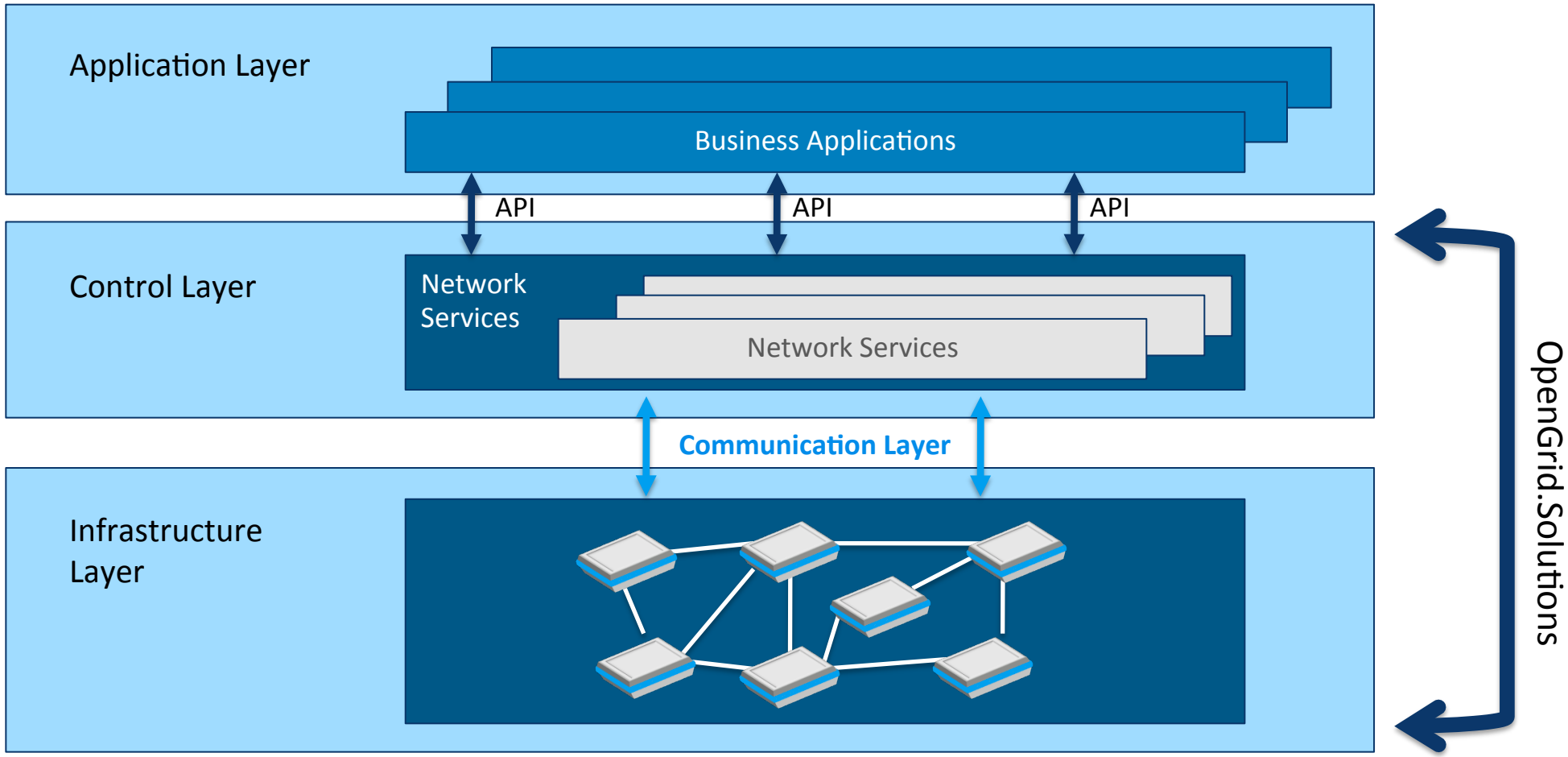
The primary intent is to provide an API to which software developers may code and be assured of predictable if not identical behavior.

Adapted from the mission of the Apache Foundation

@OPENGRID.SOLUTIONS SYSTEMS ARCHITECTURE

- Software defined network: A dynamic architecture that is manageable, cost-effective, and adaptable. Enable the network to become directly programmable and the underlying infrastructure to be abstracted for applications and network services that connect the grid.
- Container packaged: Running in application containers as a unit of application deployment and as a mechanism to achieve high levels of resource isolation in order to improve the overall developer experience, foster code reuse, and simplify operations
- Dynamically managed: Actively scheduled and managed by a central orchestrating process to radically improve grid efficiency while reducing the cost associated with maintenance and operations
- Combine CORD telecommunication services and disaggregated access technologies with open source software to provide an extensible communication services delivery platform. This gives MG network operators the means to configure, control, and extend OGS to meet their operational and business objectives.

ARCHITECTURAL VIEW



@OPENGRID.SOLUTIONS' PARTNERSHIP APPROACH

- Standards, protocols, code base, and developer community will be housed within the Linux Foundation (LF)
- Subject matter and stakeholder engagement strategy will be facilitated by Rocky Mountain Institute (RMI)
  - The LF/RMI partnership ensures neutrality, speed, and coordination across a multitude of initiatives

- @OpenGrid.Solutions will have a Governing Board overseeing all business decision making (e.g. how to spend budget) and a Technical Steering Committee overseeing the technical community and projects

We need your help!

Next Steps

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- To Launch @OpenGrid.Solutions will require:
  - Formalizing the agreement between LF and RMI (in process).
  - Creating an interim “council” to focus and direct efforts (in process).
  - Developing founding member agreement, plus charter and policies.
  - Socializing @OpenGrid.Solutions and engaging stakeholders.
  - Convene a Bootcamp with RMI, LF, Industry Stakeholders, DOE and the National Labs
    - Cross-train developers/engineers
    - Conduct Charrettes to inform specifications
    - Build commitment
- Timeline:
  - Governance documents, key policies and initial membership agreements final: 3/31/17
  - Bootcamp: by 5/10/17
  - Press and analyst pre-briefings start: 5/15/17
  - Public press launch: 6/15/17

КОНЕ́Ц

(JUST KIDDING)