MÜNCHNER KREIS
The Influence of ICT on Energy Efficiency:
Perspectives from Germany and Japan

The Digital Grid Concept:
The First Step towards Realization of the "Internet of Energy"

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THE UNIVERSITY OF TOKYO
Presidential Endowed Chair,
"Electric Power Network Innovation
by Digital Grid"

digital grid
Digital Grid Consortium Inc.,

Vision and Mission

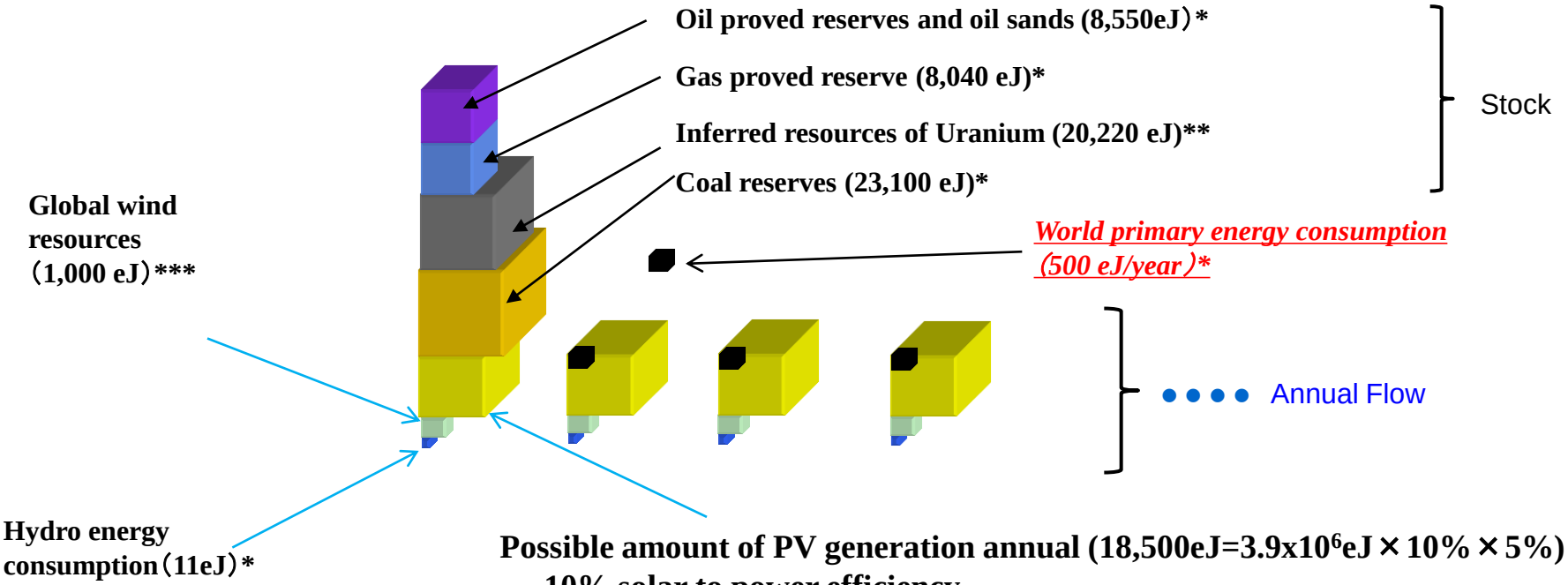
Digital Grid Vision

- A world which makes wide use of abundant natural, renewable energy and is free of conflict over energy resources.
- A world with sufficient energy supply which does not damage the environment and can be used safely, comfortably and sustainably.

Digital Grid Mission

- To spread Digital Grid concept to the world and work together to realize the Vision through Digital Grid technology.

Solar potential is huge and sustainable



Possible amount of PV generation annual (18,500eJ=3.9x10^{6}eJ×10%×5%)
-10% solar to power efficiency
-5% of land area

* : BP world energy 2009
** : OECD nuclear energy data 2008
*** : World energy council survey of energy resources 2007
eJ : exajoule (10^18 J)

Constraints

Some progress has been made in the shift from thermal to renewable energy, but as the speed and scale of the shift increases, we will find two major problems in the current grid system:

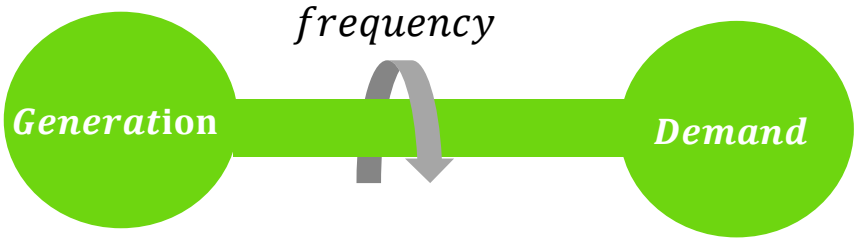
- Technical problem: **The limits of centralized control** and the need to shift to segmented and decentralized control to accommodate distributed, variable renewable energy.

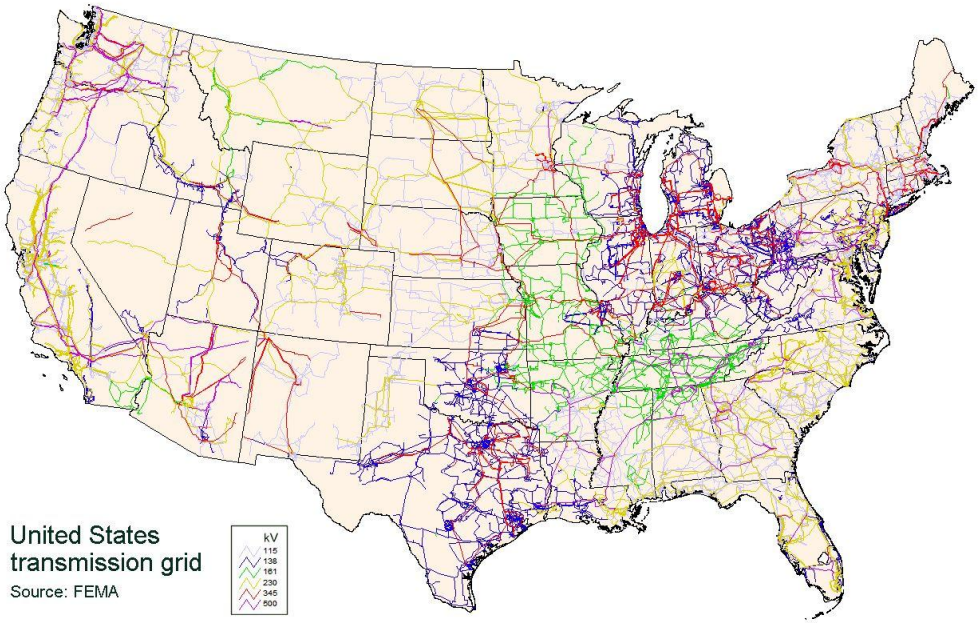
- Problem with the current business model: How to shift from **a planned energy economy** to a market economy with many, competing suppliers

Technical Problem: Current Grid

Current Grid:

- Whole huge grid is synchronously connected
- Generation is controlled to match the demand at any instant moment.





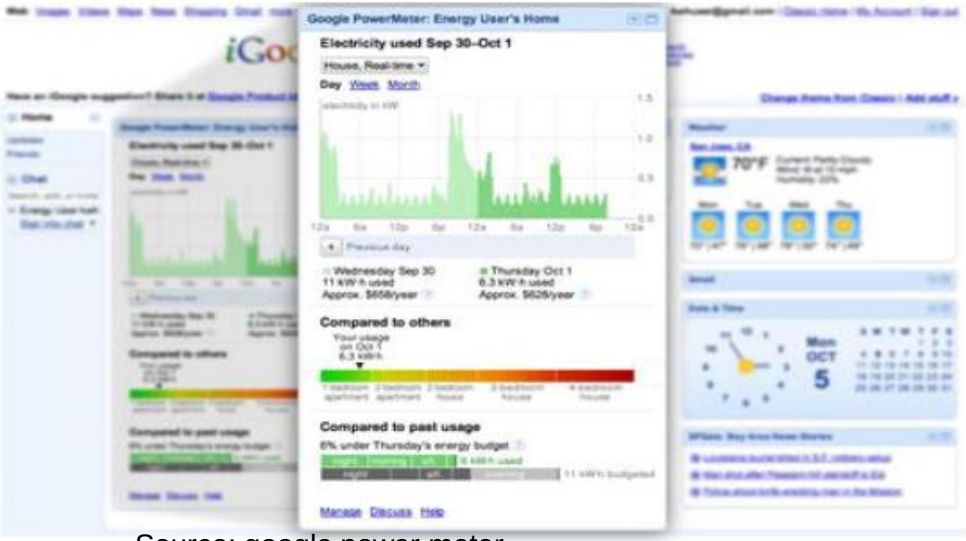
Technical Problem: Smart Grid

digital grid

Smart Grid:

- the electrical grid to use ICT network to watch electric transportation from generation to demand to have better control of the grid.
- Demand is controlled by efficient tools to match the generation.

  ⇨ *too slow*



Source: google power meter

Source: Trilliant

Technical Problem: Cascading Failure

- In the current system, power companies have central control of the grid and they must **balance the supply of energy to meet demand**. This system has been very efficient. But if various sources of renewable energy start to enter the grid, power companies will lose their ability for central control.

- Cascading Failures: One problem with centralized control of a synchronous grid is that when an accident occurs, it can cascade across a wide area. (India)

- To strengthen transmission lines is always discussed, but it won't be the solution for cascading failure. The ideal is to have the ability for **fractal segmented, decentralized, distributed control of energy**, but this technology does not yet exist.

Problem with the current business model:

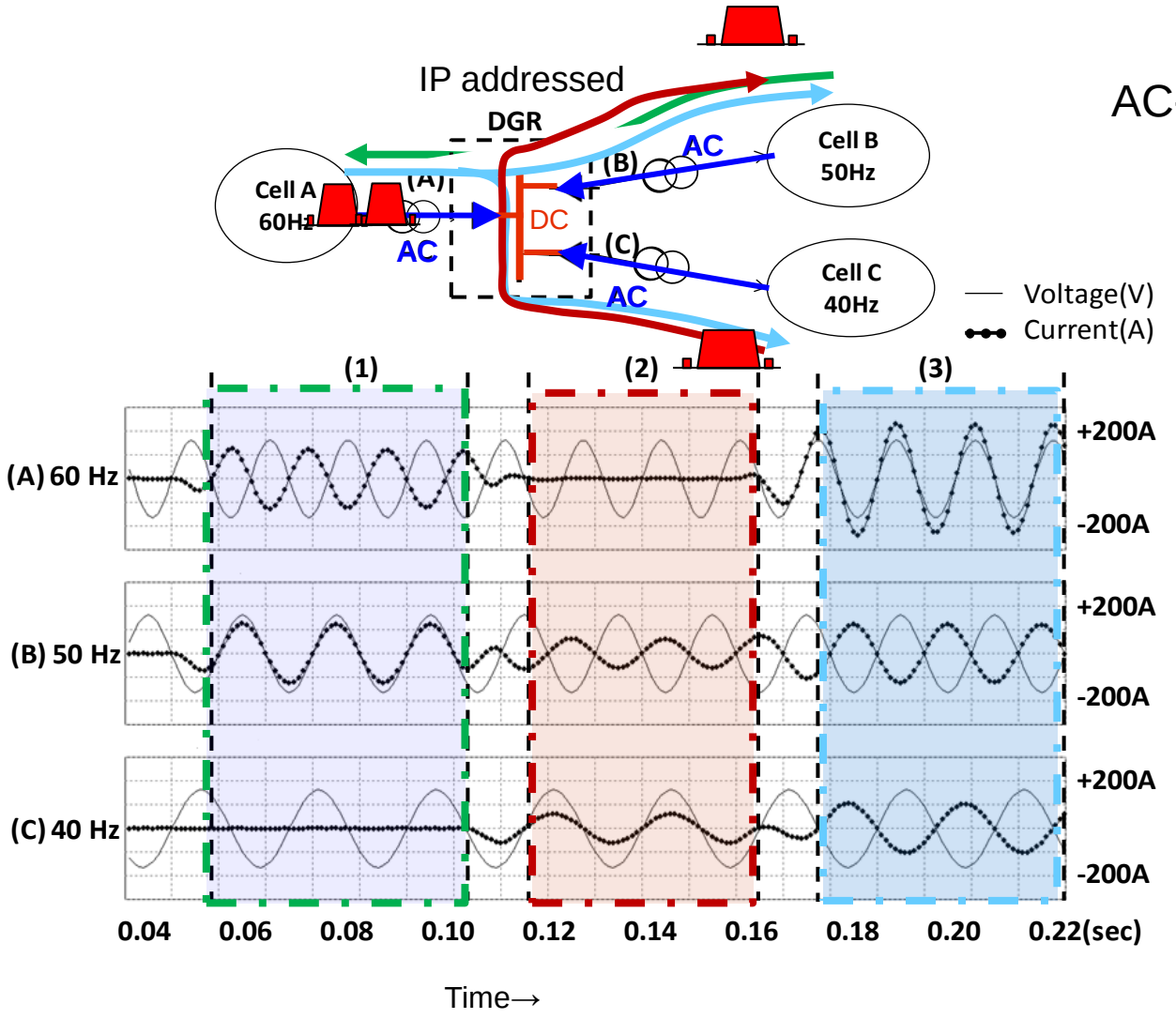
- Currently, the price of electricity is fixed. The consumer **does not know how his power is generated** and he **cannot choose his source of power.**

- To create a free market we need to bring in new suppliers who will compete without price regulation. But this will require a shift from central to decentralized control. And this will also require the ability for the **supplier to "address" his "energy product"** and the **consumer to "identify" his "energy purchases**."

Solutions

- The Digital Grid is proposed as one solution to this problem.
- (1) It allows for segmented and decentralized control through **asynchronous connections.**
- (2) It uses an **Addressable** Power Device which allows consumers to identify and choose energy sources.

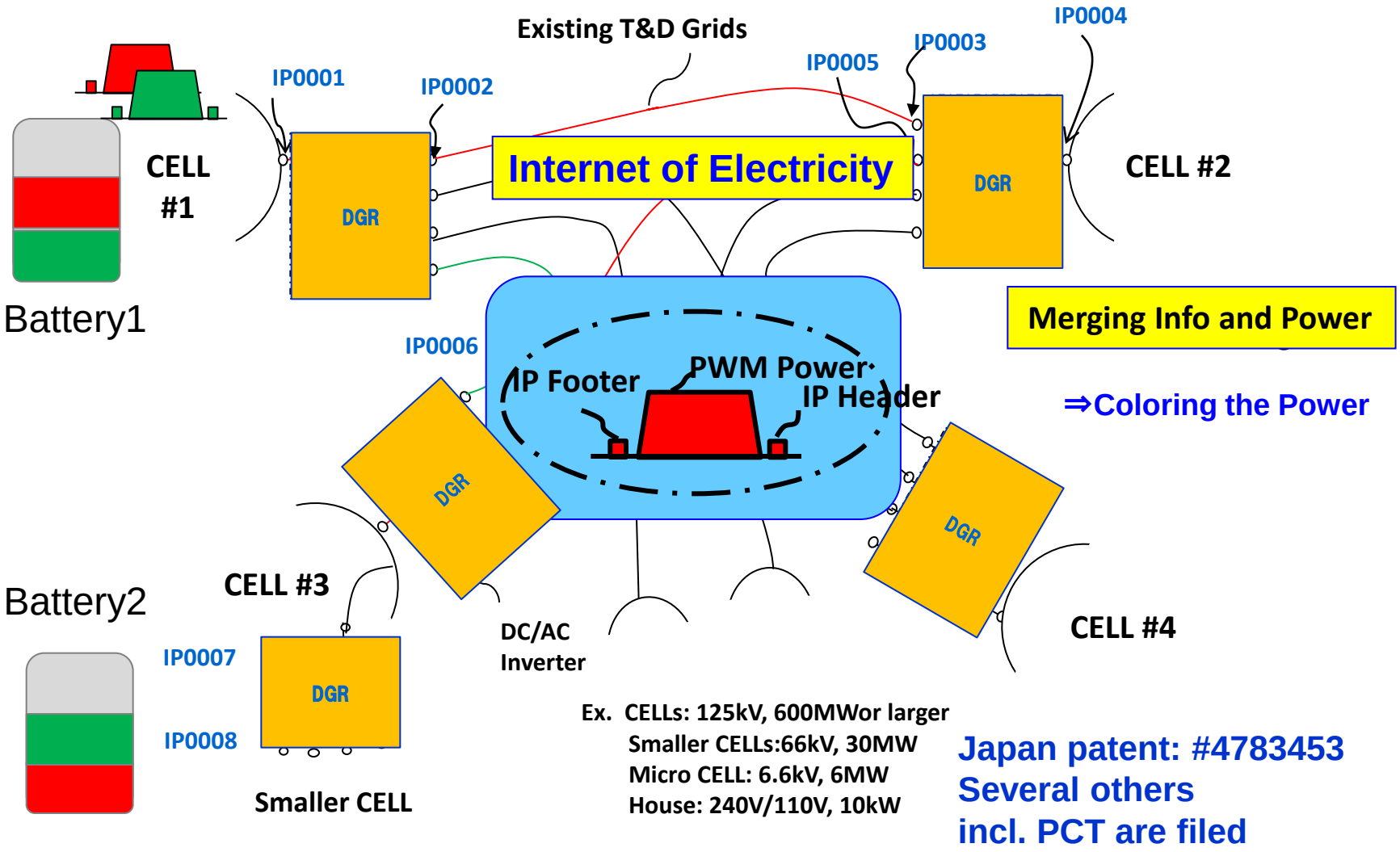
Asynchronous and addressable multi-connection power device: Digital Grid Router (DGR)



AC-DC-AC conversion

- Connect different frequency
- Transfer active power
- Control reactive power
- High frequency conversion
- Smooth transition
- Fast gate block

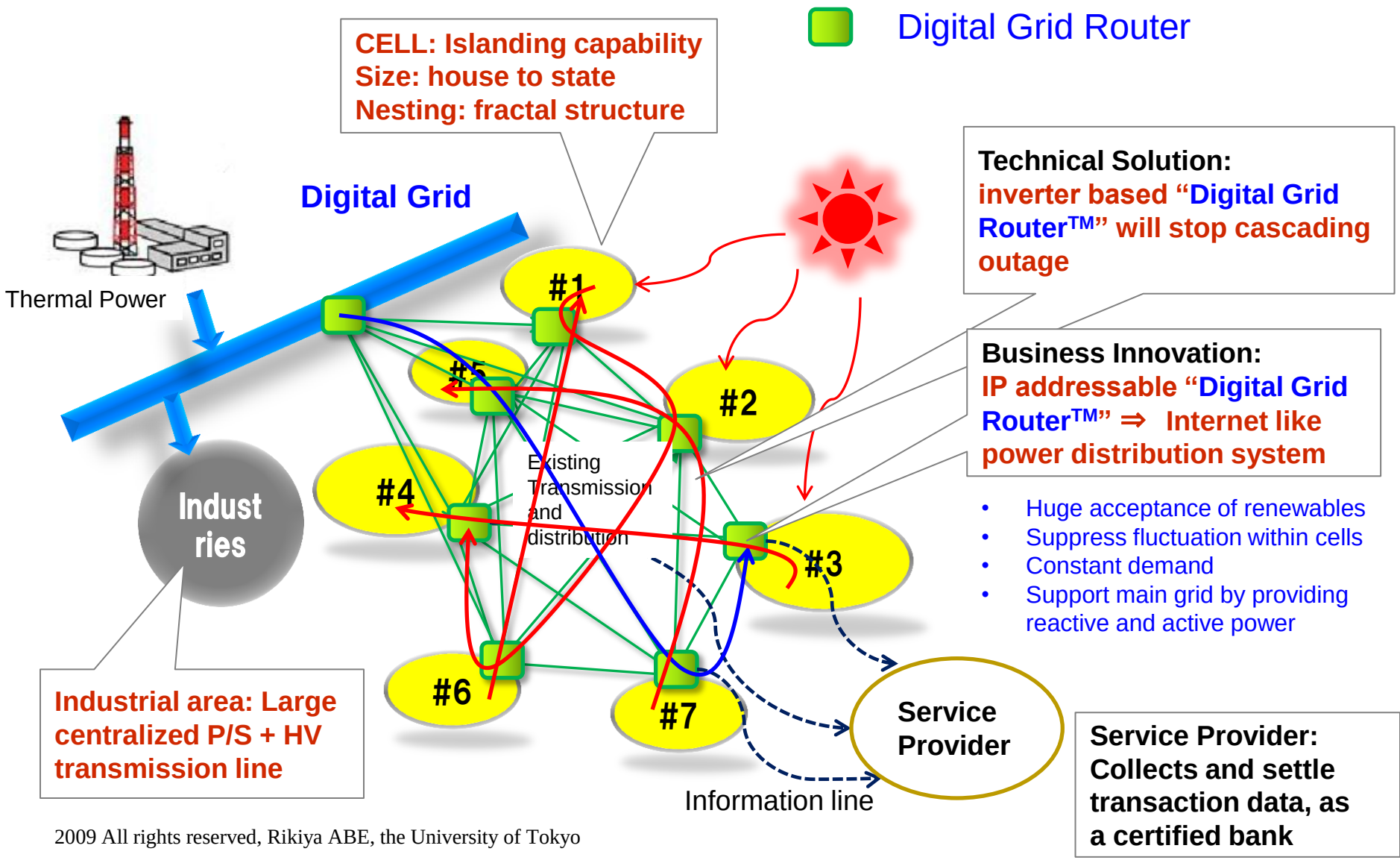
Internet of Electricity



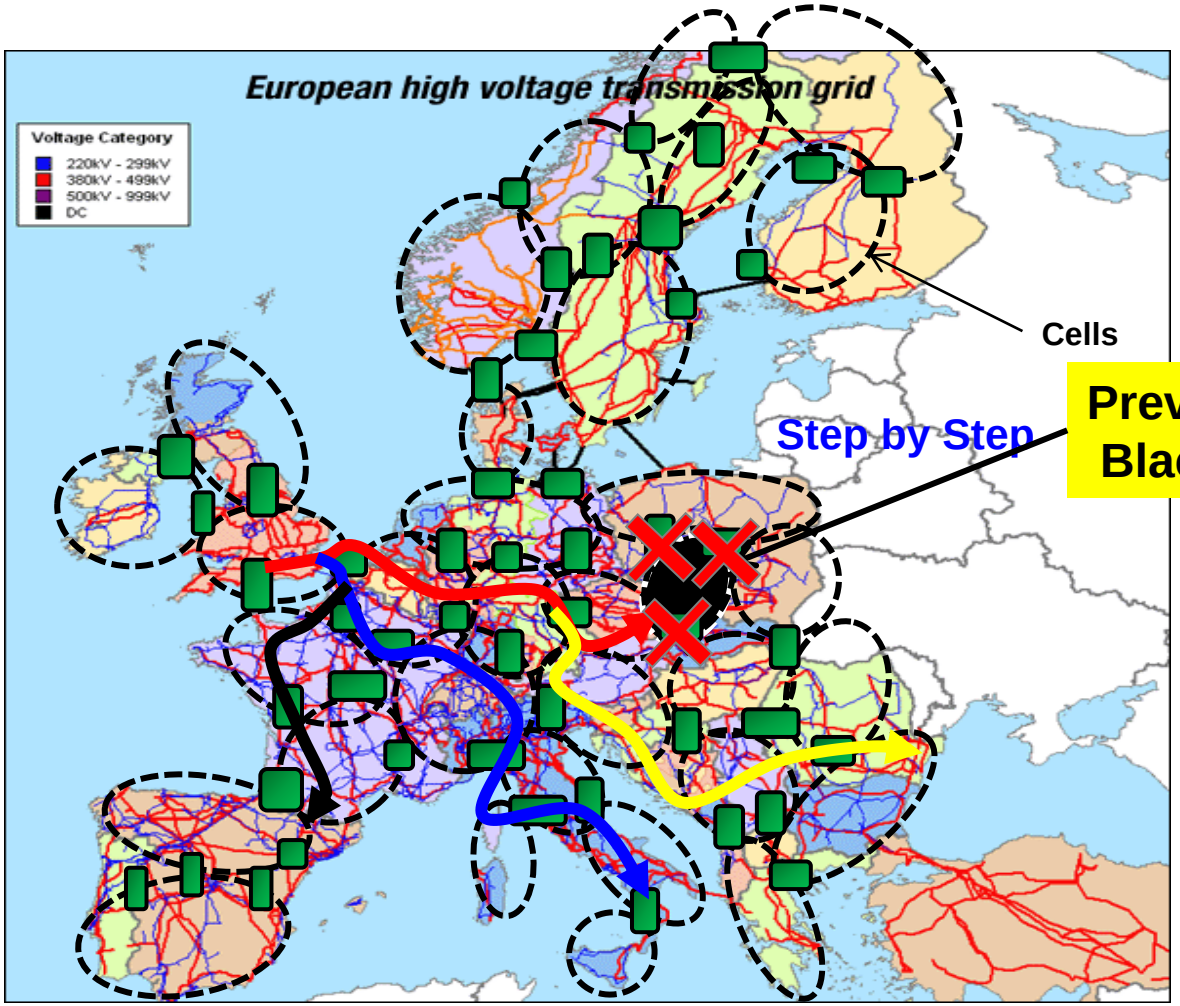
Ex. CELLs: 125kV, 600MWor larger
Smaller CELLs:66kV, 30MW
Micro CELL: 6.6kV, 6MW
House: 240V/110V, 10kW

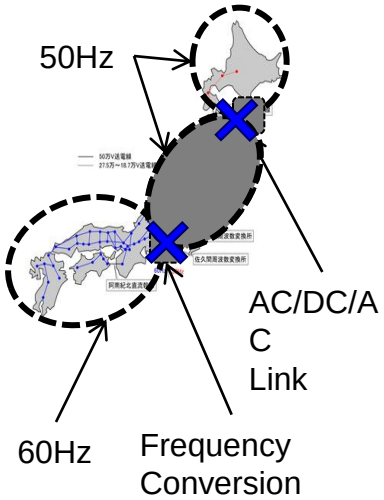
Japan patent: #4783453
Several others
incl. PCT are filed

Digital Grid



Proposed Digital Grid in Europe





Business Potential

digital grid

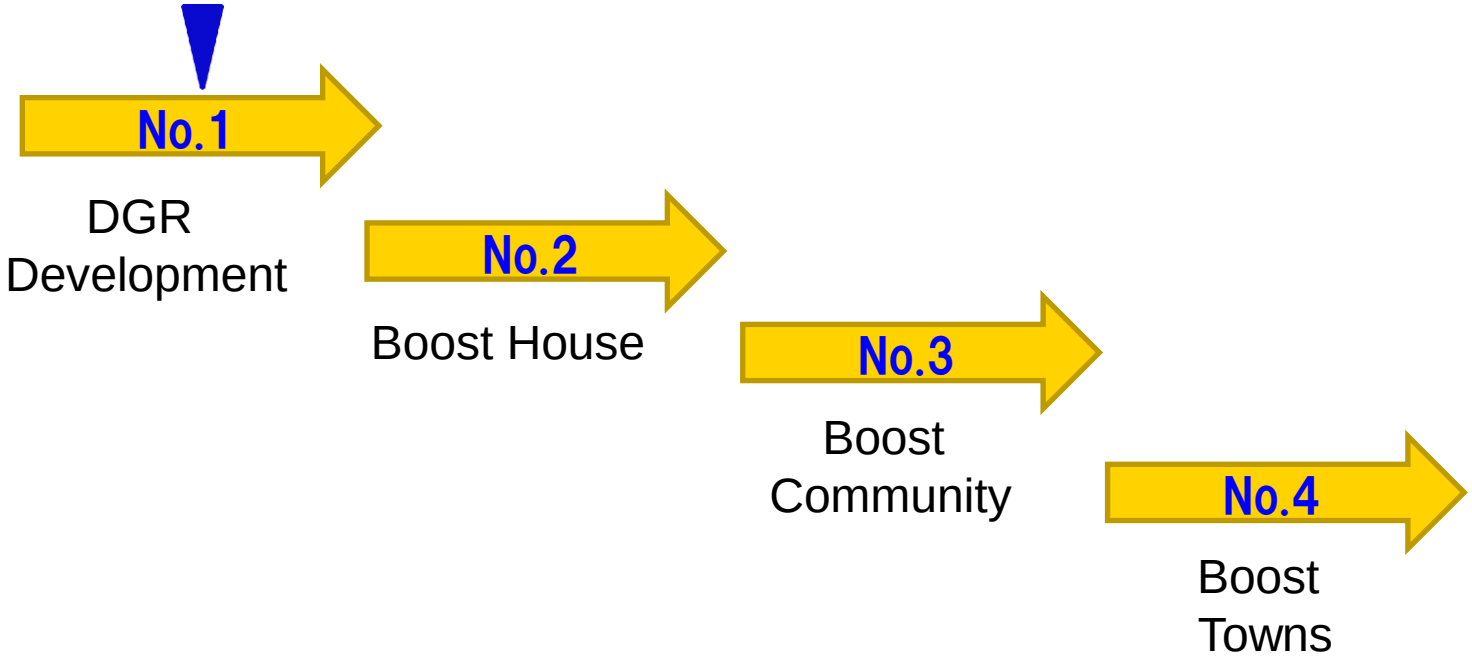
With distributed control of energy, it becomes possible to identify the source of energy and will encourage the development of new, innovative energy services.

Date	Start	Stop	From	Buy	To	Sell	Balance
12, May,' 99	02:15:40	08:17:20	Grid A9806	2890kWh			10299kWh
14,May,' 99	03:07:10	08:55:56			Grid W962	7600kWh	3699kWh
17,May,' 99	18:40:12	23:40:12	Grid B547	3455kWh			7054kWh
20,May,' 99	10:20:32	16:35:44	Int. PV003	456kWh			7510kWh

- Electricity Transaction will be recorded in Digital Grid Router as bank book
- Authorized organization to certify those record
- Many features will be add such as CO_2 credit, RPS value, Green value, etc.

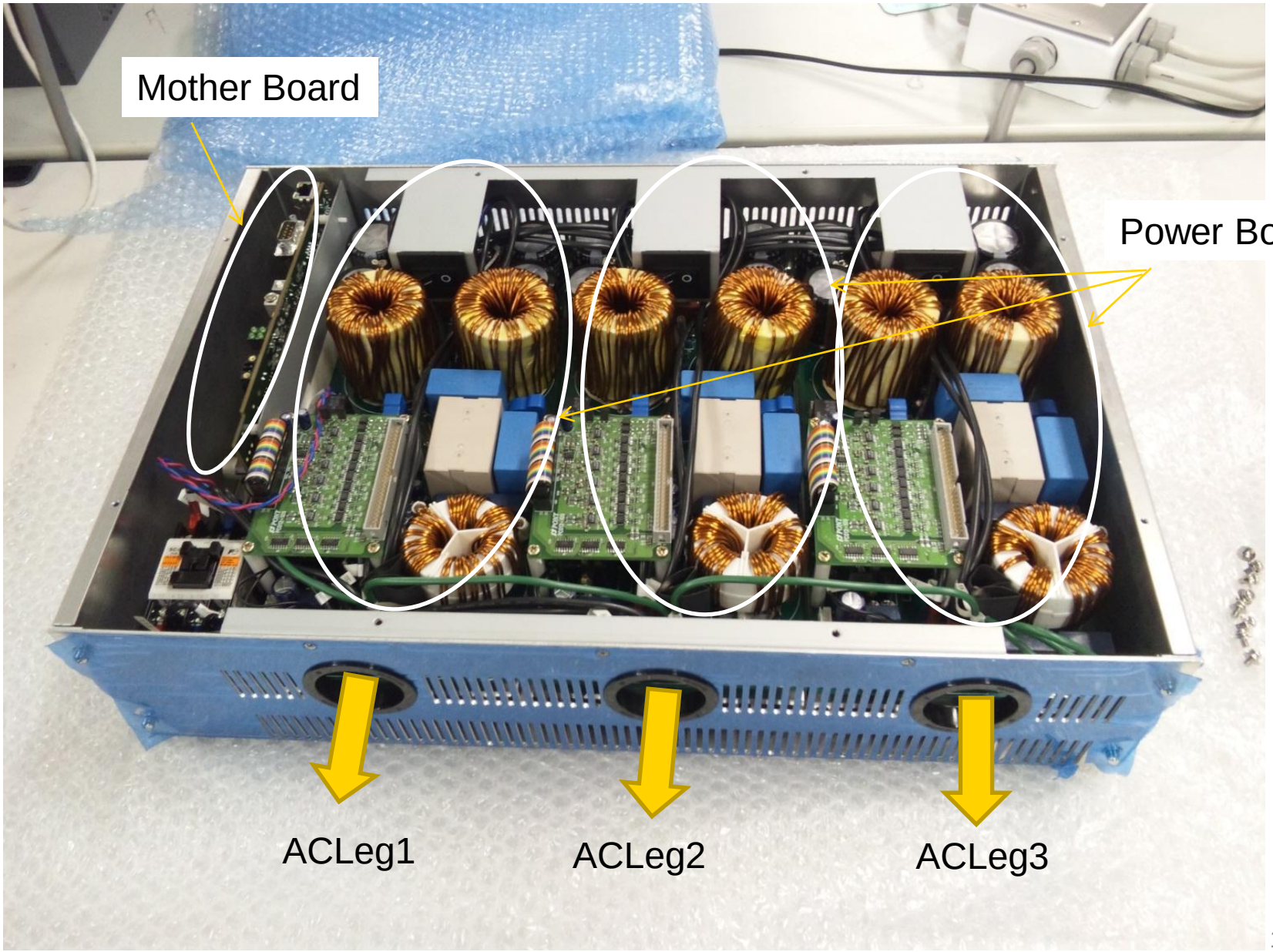
Digital Grid Roadmap

- The development procedure of the Consortium is based on joint development programs

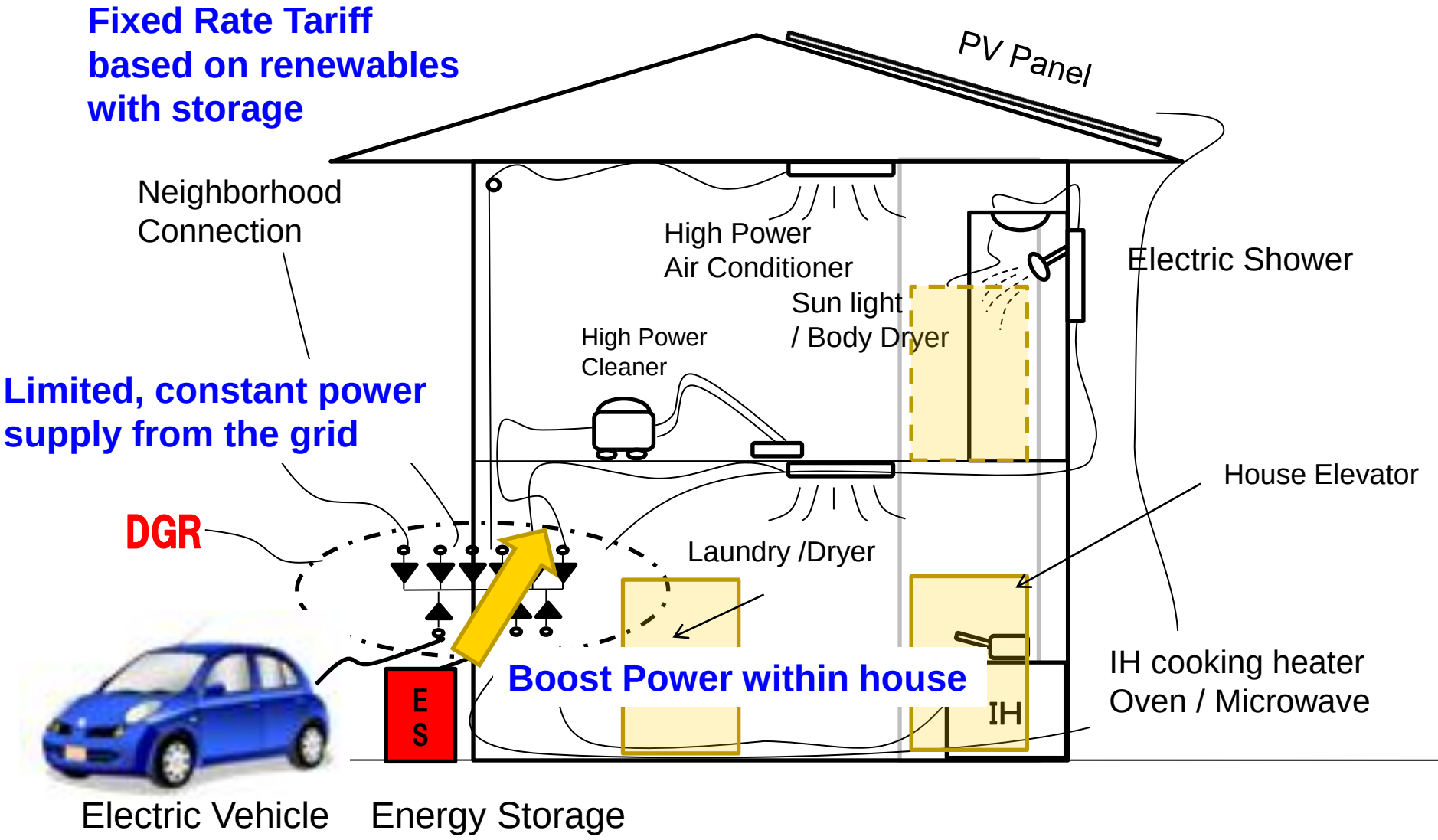


- The first program is now underway and **the first prototype has been developed**, as shown here..

3-Leg Router (Prototype) : 2kWx3



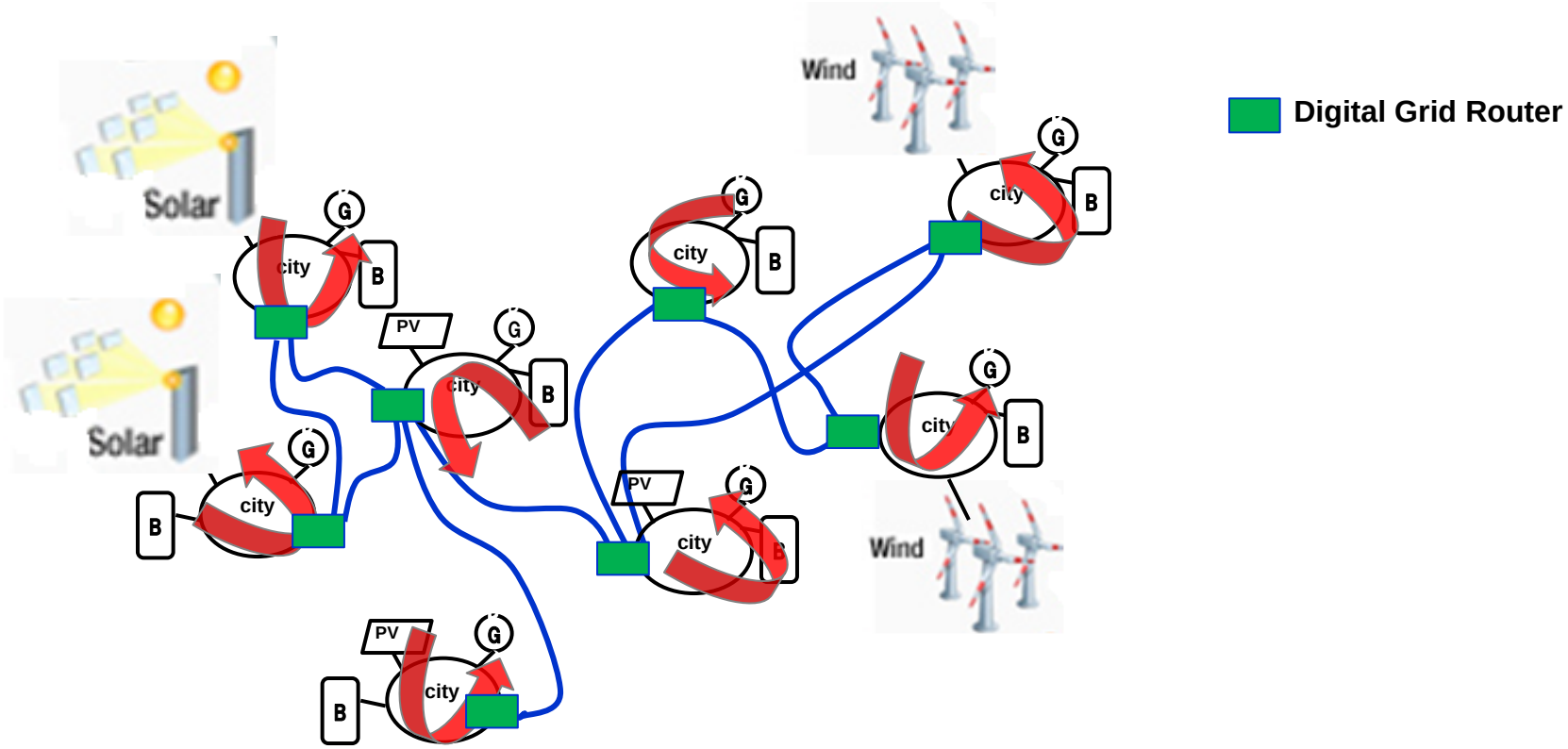
Second Program: Boost House with a DGR



Developing countries may choose different path

digital grid

- Just as developing countries have skipped the use of fixed line phones and have jumped directly to cell phones, it will be possible for the developing world to skip the stage of centralized, one way power generation with large investments in infrastructure and **jump directly to smaller scale energy sources and distributed control**.



Summary

- Fractal segmented and decentralized **renewable energy requires new gird system** to avoid cascading outage and the Digital Grid enables this by reconnecting smaller grids asynchronously.

- Fractal segmented and decentralized **renewable energy requires a new business model** such as a free market mechanism and the Digital Grid enables this by addressable power routers

- The Digital Grid will enable a world which makes **wide use of natural, renewable energy** and is **free of conflict** over energy resources

Thank you for your attention!