FCCJ Professional Luncheon

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

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THE UNIVERSITY OF TOKYO
Advantage Partners
Socio-Strategic Engineering/ Investment Laboratory

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

digital grid
Digital Grid Consortium Inc.,

Agenda

- The Mission of the Digital Grid Consortium:

  Develop a Shared Vision for Energy Distribution which Addresses the Problems of the Present Grid and Realizes a Free Energy Market

- What are the problems of the current energy grid?

  How will they be solved with the Digital Grid?

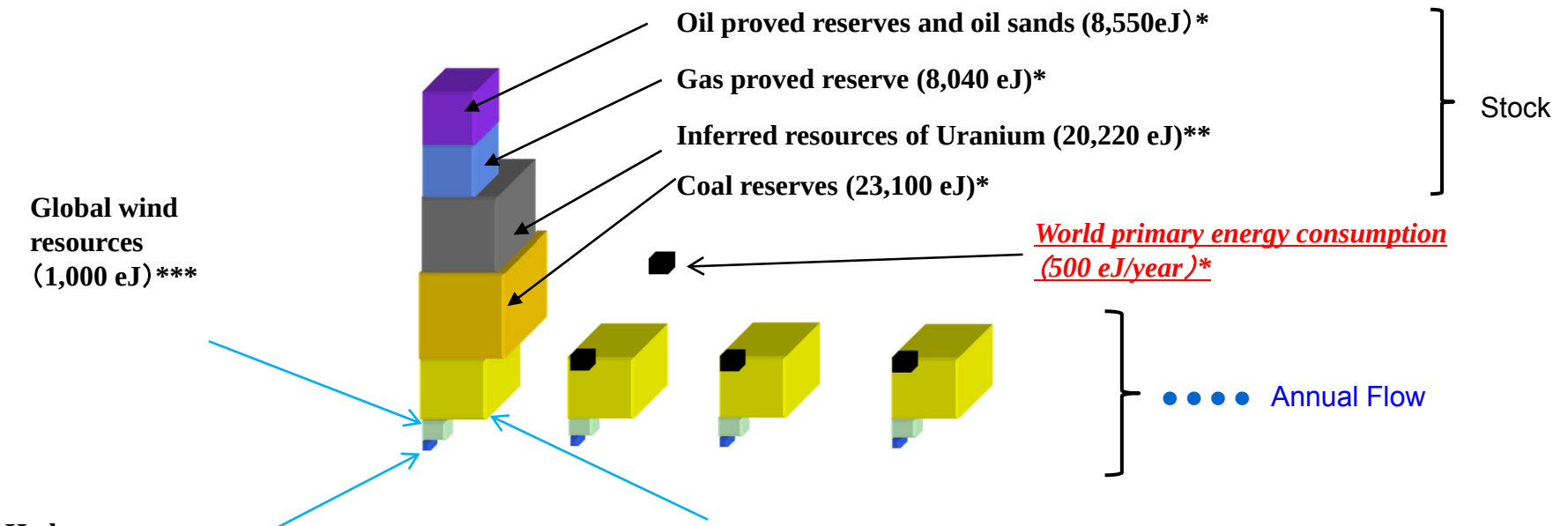
- Digital Grid Consortium: achievements and planned projects.

Future

- **Our Vision: A world which makes wide use of natural, renewable energy and is free of conflict over energy resources**

- **Sustainable energy which does not damage the environment and can be used safely, comfortably and with sufficient supply.**

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 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:

- 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)

- The ideal is to have the ability for **decentralized, distributed control of energy**, but this technology does not yet exist.

Problem with the current business model:

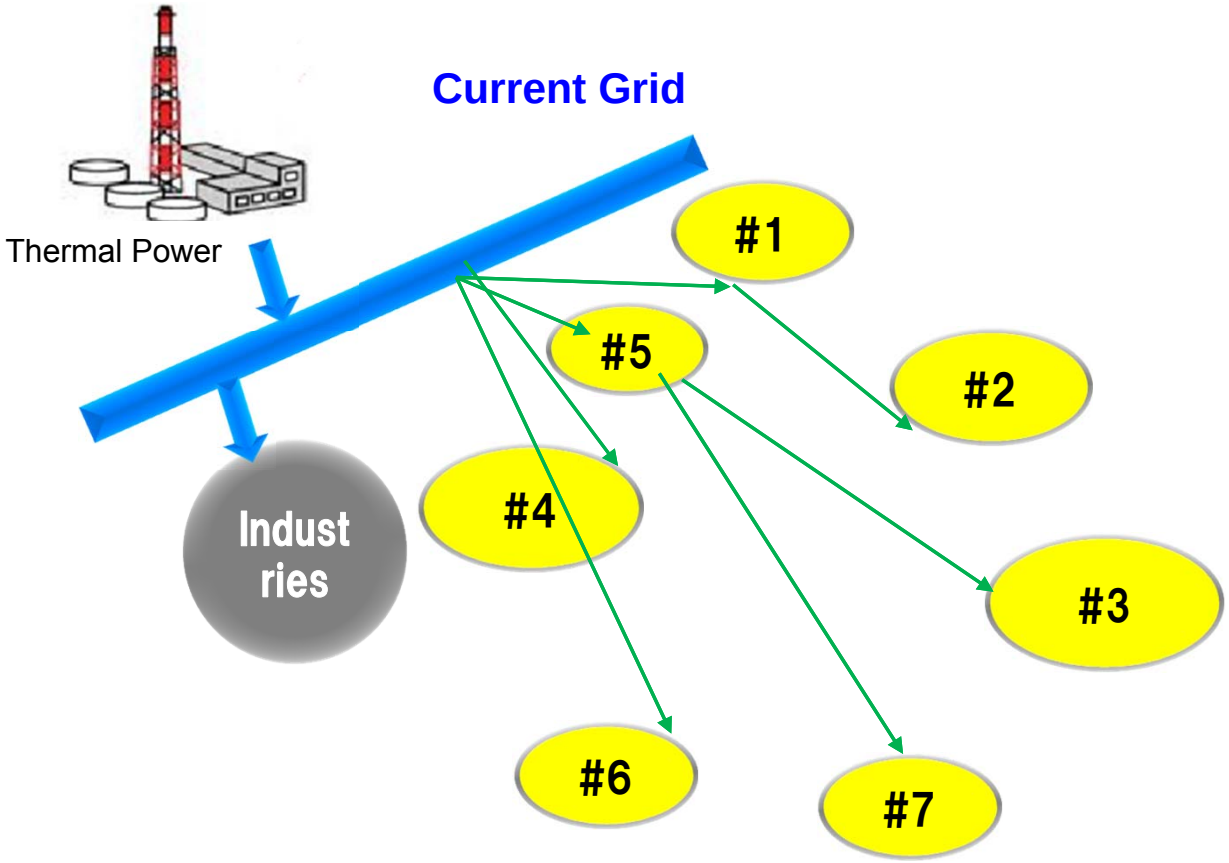
- Currently, the price of electricity is fixed. The consumer **does not know how his power is generated** and he **cannot choose his source of power.**

- 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**."

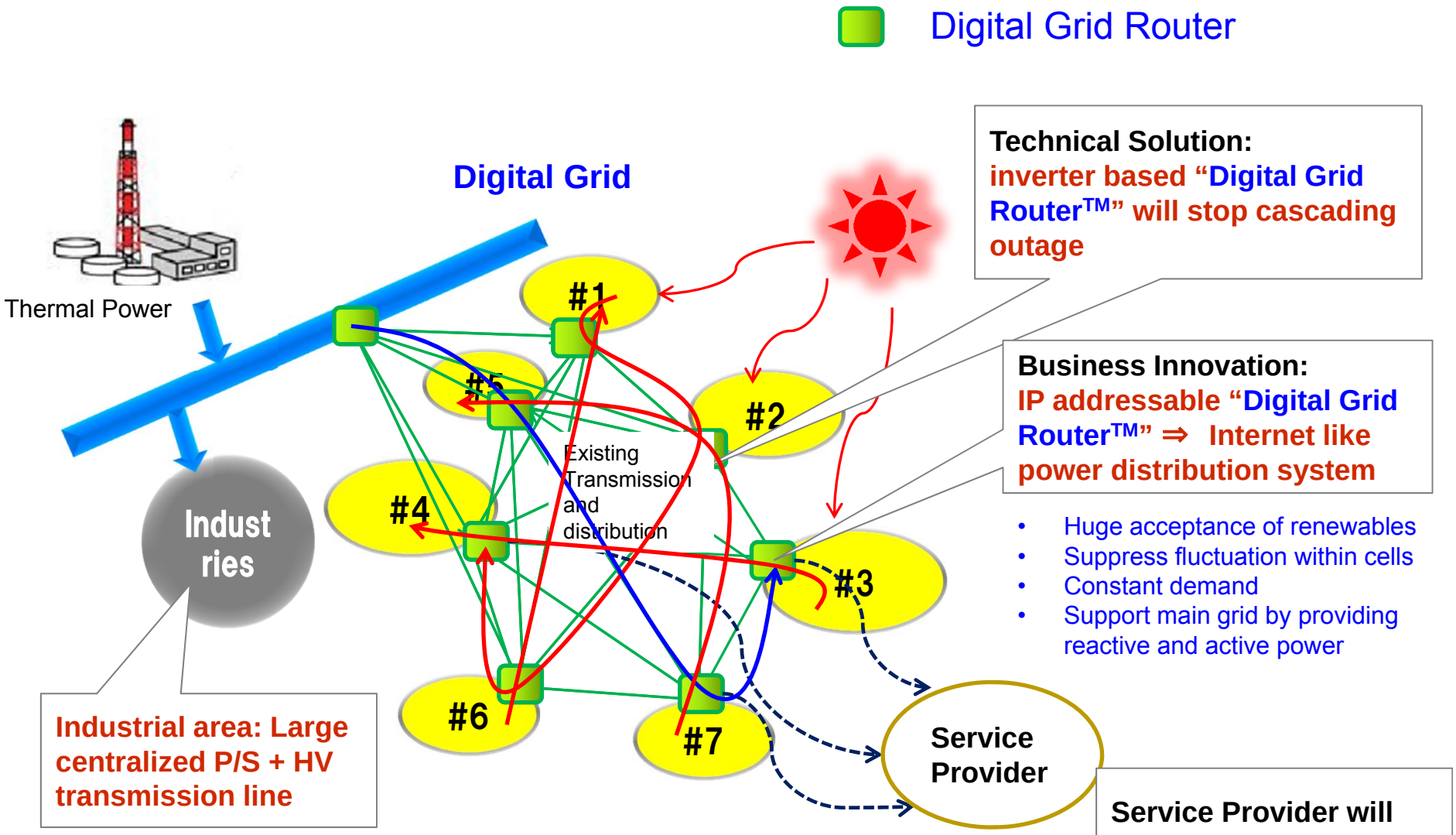
Solutions

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

Current grid



Digital Grid Solution



Potential

digital grid

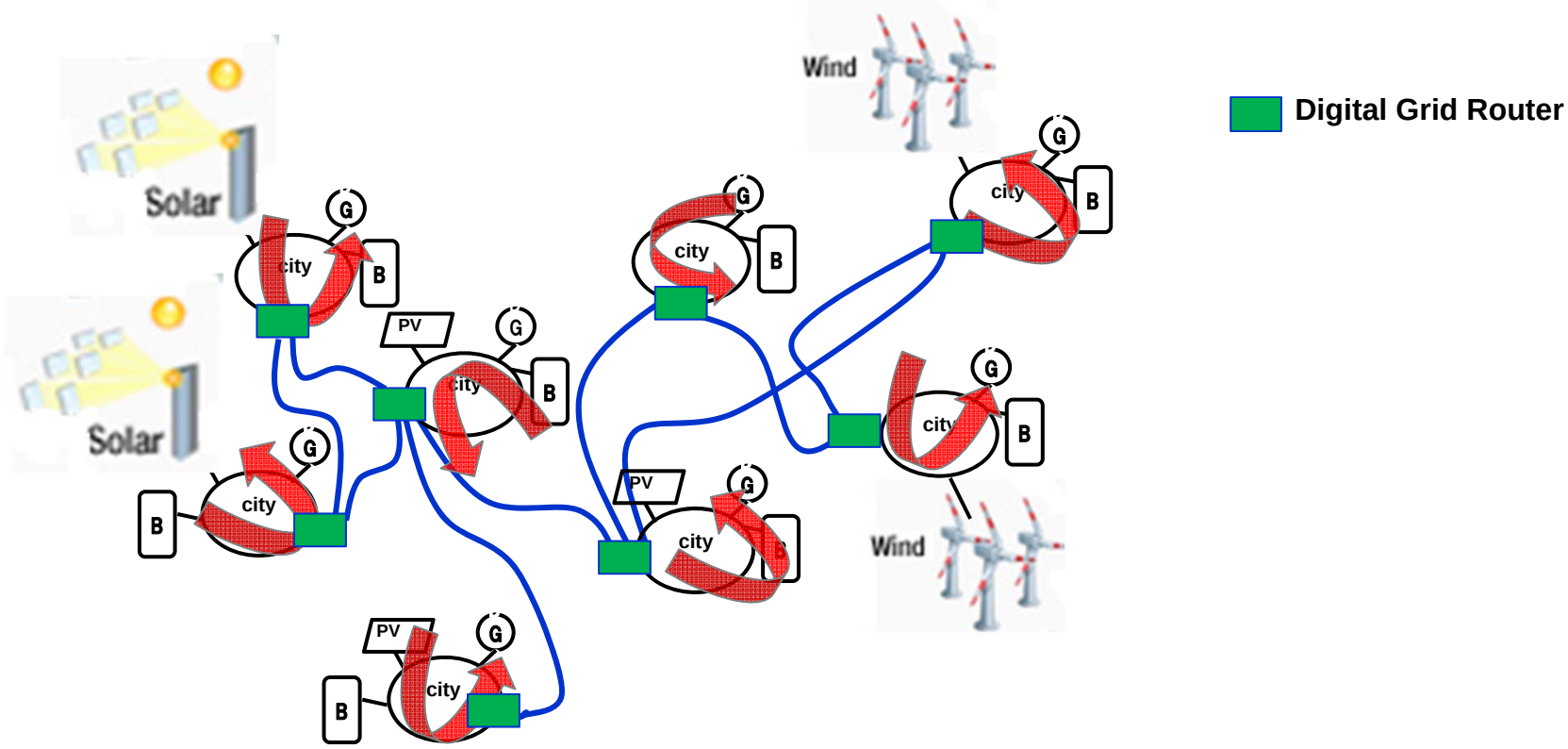
With distributed control of energy, it becomes possible to identify the source of energy and will encourage the development of new, innovative energy services.

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.

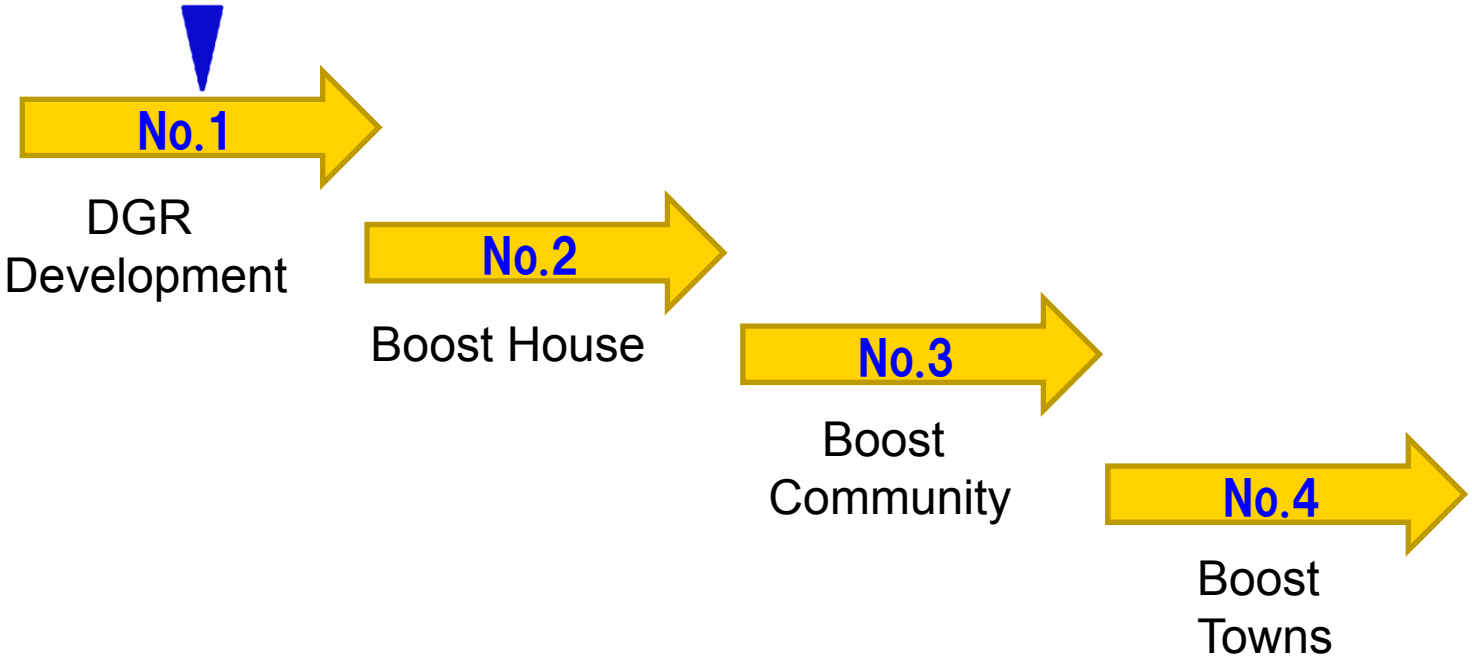
Developing countries may choose different path

- 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**.



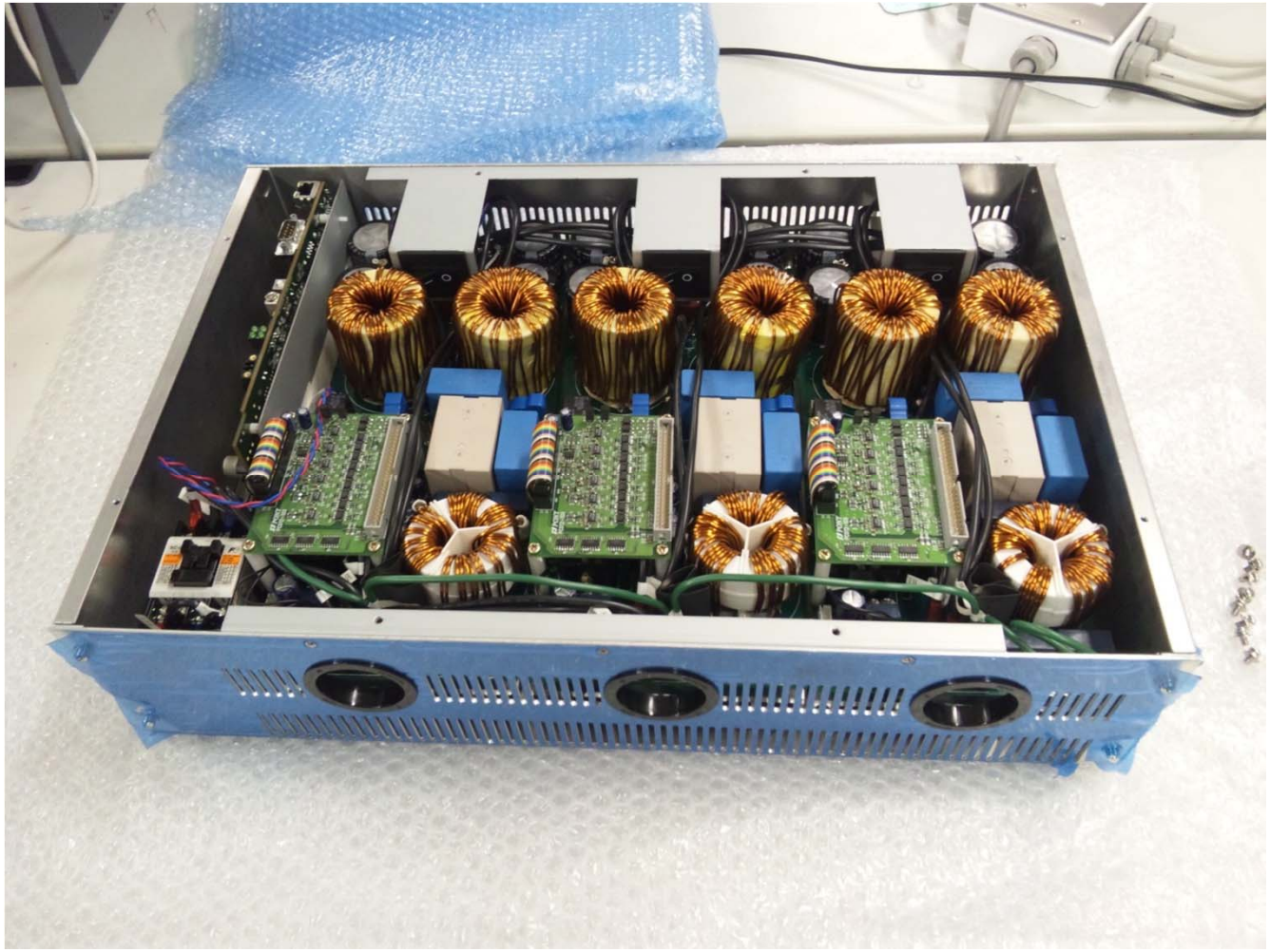
Digital Grid Roadmap

- 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..

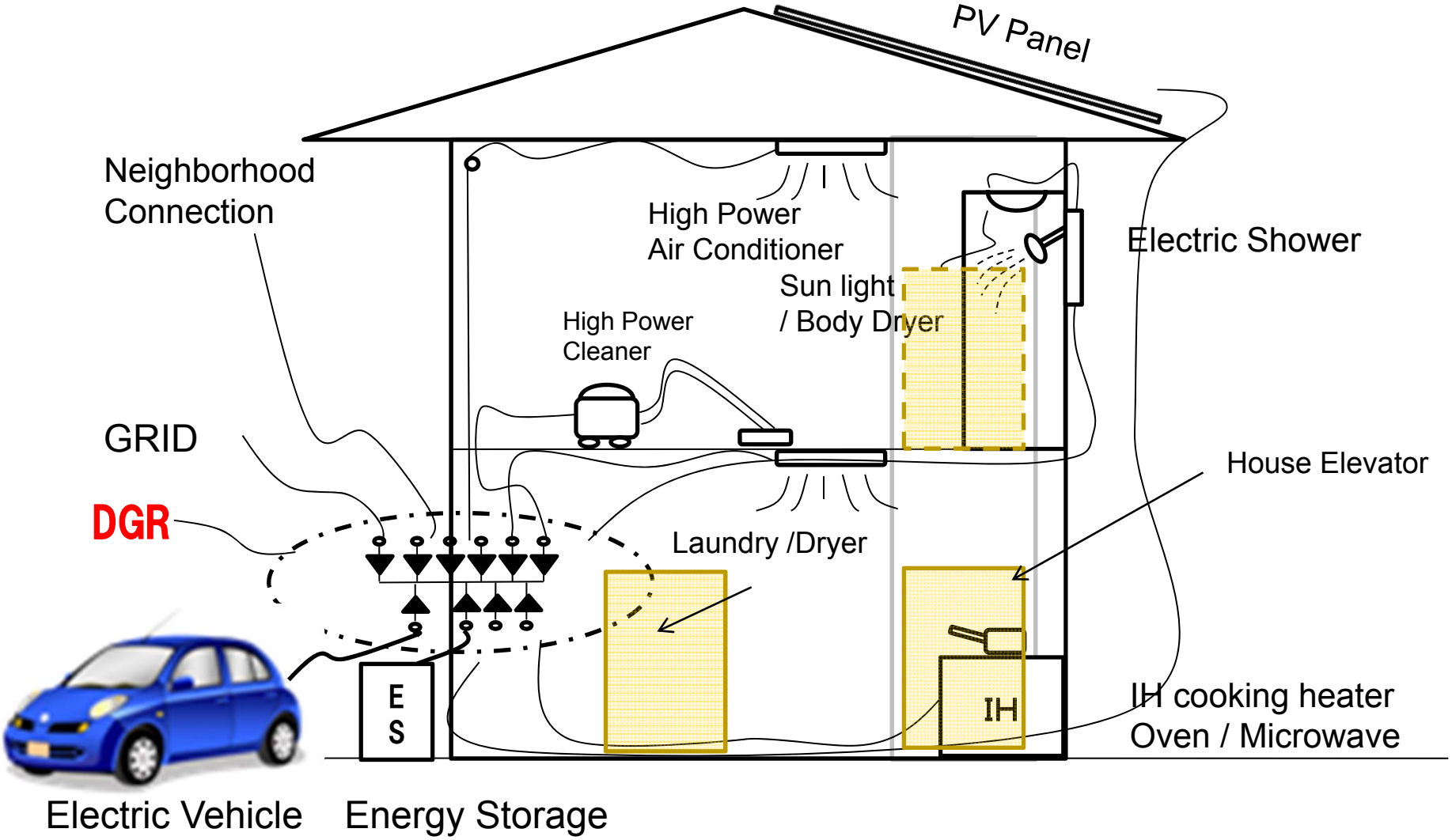
3-Leg Router (Mark I) : 2kWx3



Second Program: Boost House

- We are about to embark on the second program, which is the development of a so-called “boost house.” which, in addition to the current standard 100 volts, will supply **higher voltages** to improve energy efficiency and the use of more powerful consumer appliances such as instant electric water heaters, electric showers and elevators.
- Boost House will use a solid state, semi-conductor distribution board with power electronics. It will supply high **power on demand**. Plugs are energized when required. **Safe and secure**.
- This board is an **IP-address-built-in** power router.

Second Program: Boost House with a DGR



Summary

- Decentralized **renewable energy requires new gird system** to avoid cascading outage and the Digital Grid enables this by reconnecting smaller grids indirectly.

- 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!