The Eighth International Conference on Smart Grids, Green Communications and IT Energy-aware Technologies – ENERGY 2018

Panel: Challenges on Green Energy and Sustainability

Speakers:

- Michael Negnevitsky, University of Tasmania, Australia
- Valentinas Klevas, Lithuanian Energy Institute, Lithuania
- Liana Jacob, Technische Universität Chemnitz, Germany
- Jad Nassar, Inria – Lille, Nord Europe, France

Moderator: Anandha Gopalan, Imperial College London, UK

Communication in Smart Grids

Panel ENERGY and BIO

22-05-2018

Jad NASSAR

HEI – Yncrea HdF, France

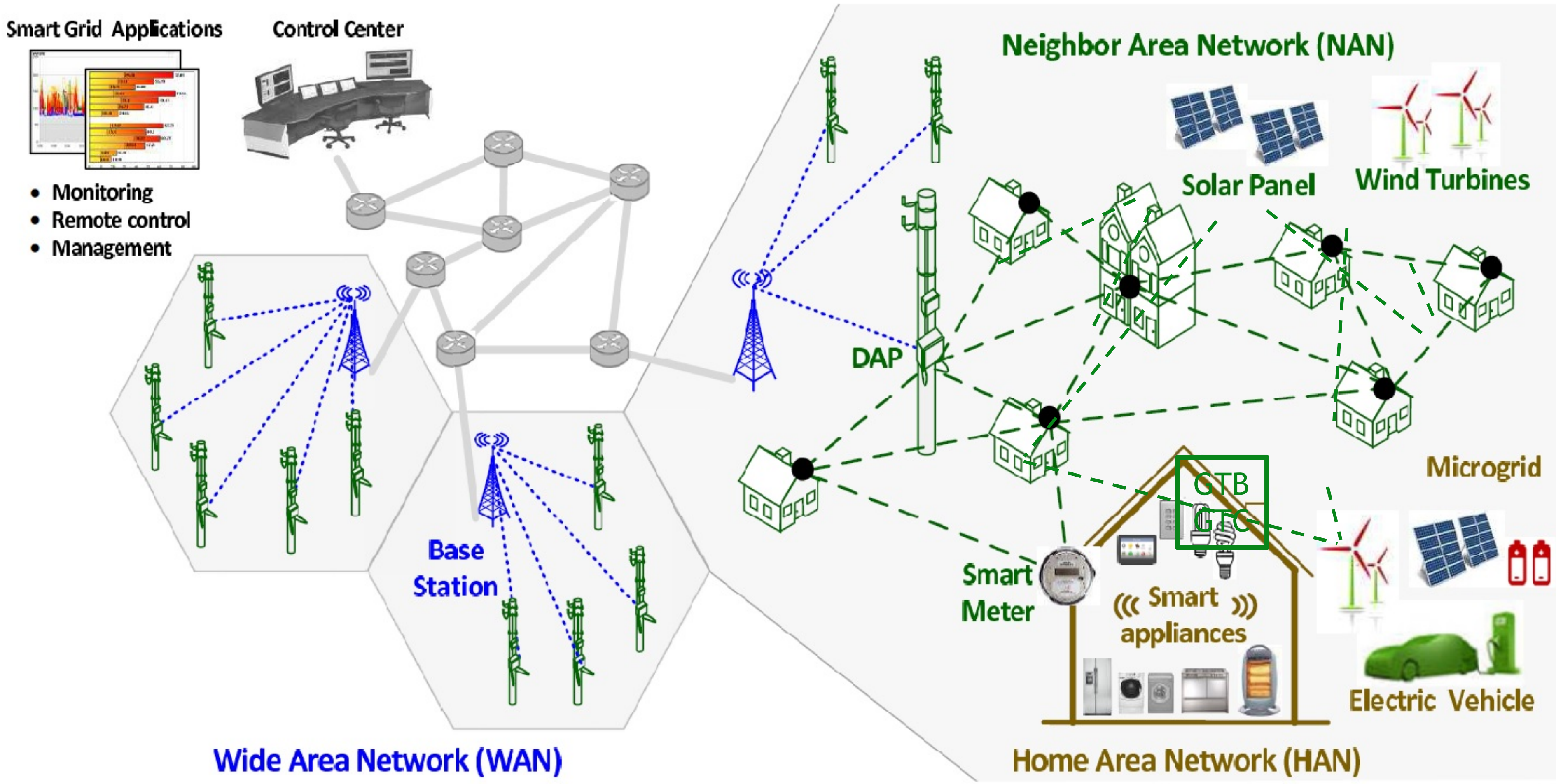
Inria, France

Why do we need a Smart Grid?

Current electric grid no longer satisfies the rapid growth of electric demands

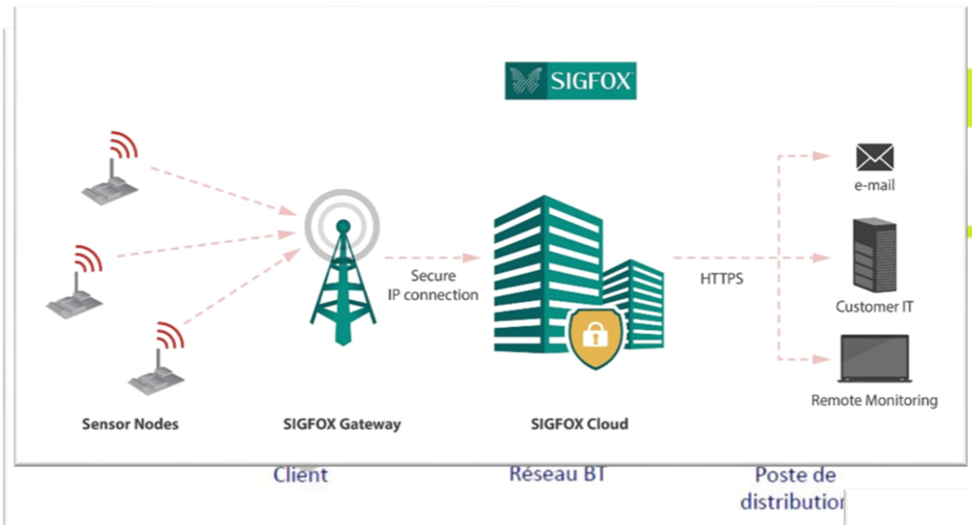
- Increasing demand on electricity per person
- Old and not adapted infrastructures
- Dependency on manual control
- Introduction of multiple renewable energy resources and storage units throughout the network

Architecture of the Smart Grid



Q.-D. Ho, Y. Gao, G. Rajalingham, and T. Le-Ngoc, Wireless Communications Networks for Smart Grid, ser. SpringerBrief in Wireless Communications. Springer, 2014.

Commercial solutions for communication in Smart Grids



SIGFOX and LORA:

- One hop communication
- Basic bidirectional support
- One hop communication alone is not enough

ERDF Solution: PLC (Power Line Commu

- Electromagnetic disturbances
- Far from being real time communica
- Power cut >>> No more data packet

http://www.libelium.com

Le CPL G3, un standard de communication au service des smart grids. Hélène Pulce, Cédric Chauvenet

Wireless sensor network across the grid

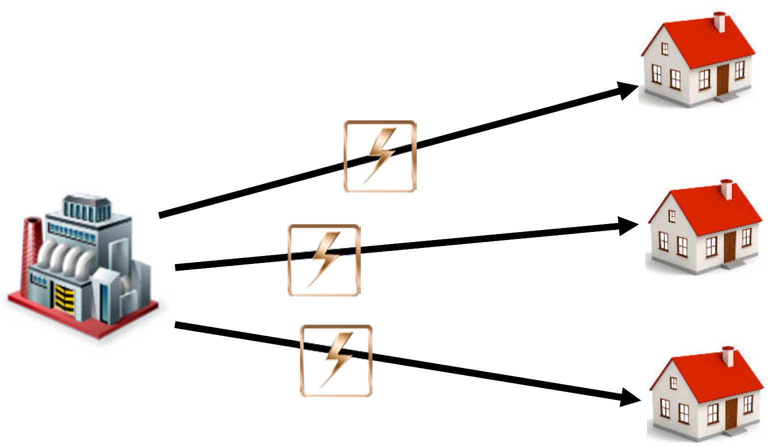
- Current electric grid

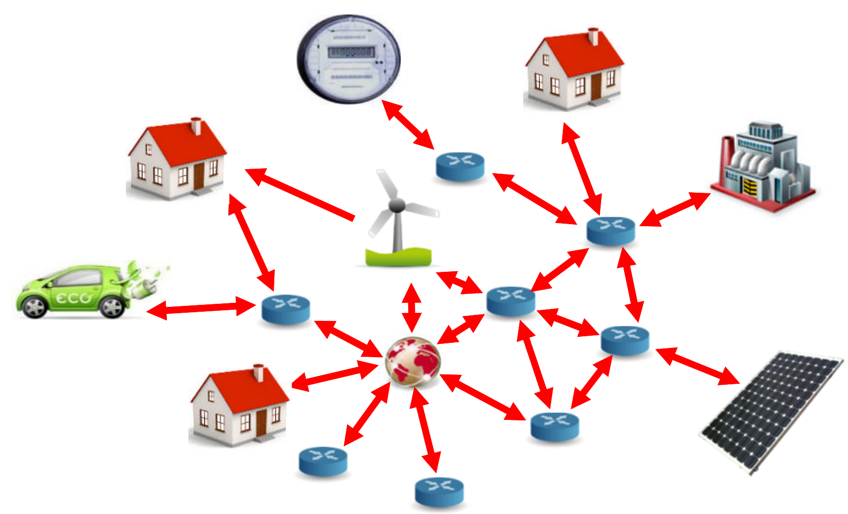
- Ubiquitous network consisting of a WSN for data collection and network control

Why WSN?

- Infrastructure free
- Extensible
- Low cost

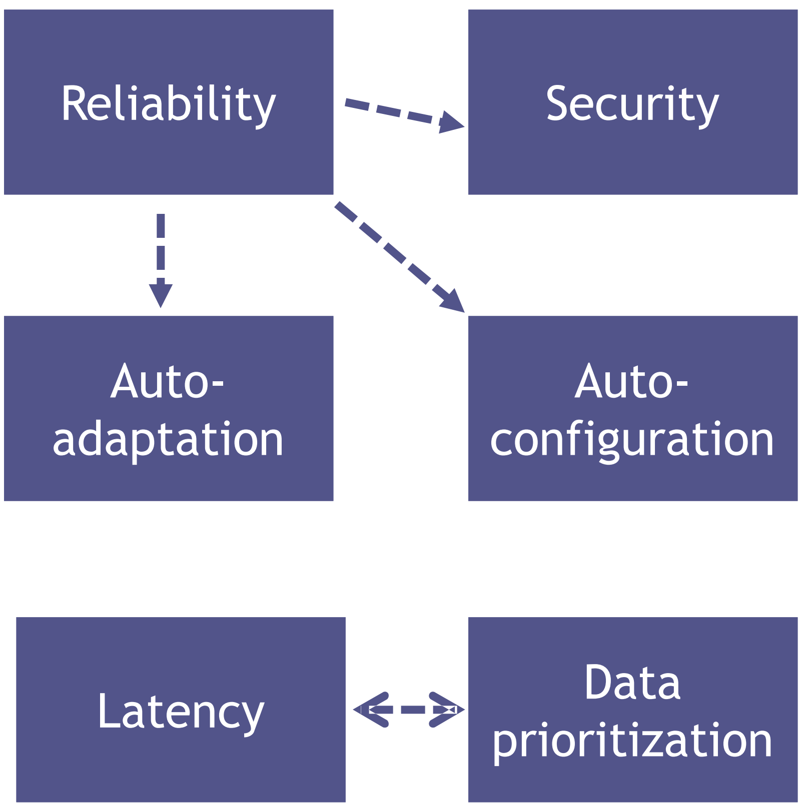
Etc…





It will be necessary to develop routing protocols to ensure the essential data routing across the network.

Ubiquitous networks requirements for Smart-Grids



"All the News That's Fit to Print"

The New York Times

Late Edition

New York: Today, mostly sunny and hot. High 91. Tonight, clear and warm. Low 75. Tomorrow, partly sunny, humid, a late storm. High 87. Yesterday, high 89, low 75. Details, Page B11.

VOL. CLII . . No. 52,576 — NEW YORK, FRIDAY, AUGUST 15, 2003 — ONE DOLLAR

POWER SURGE BLACKS OUT NORTHEAST, HITTING CITIES IN 8 STATES AND CANADA; MIDDAY SHUTDOWNS DISRUPT MILLIONS

OVERLOADED GRID

Buildings Are Evacuated and Hospitals Fill — Bush Plans Review

By JAMES BARRON

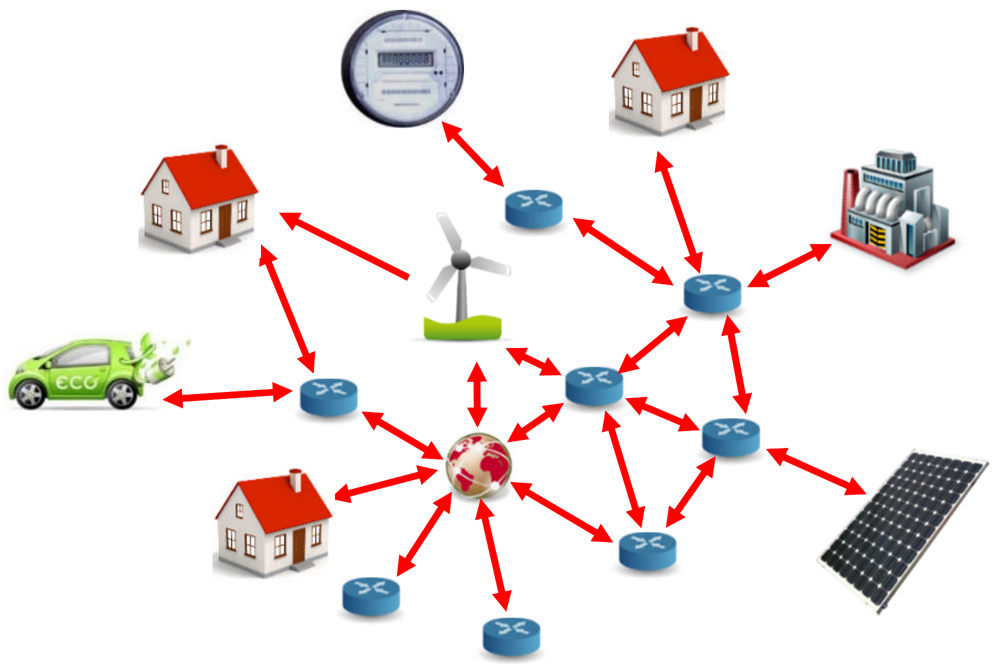
The view looking across Manhattan at sunset yesterday. New York City was left without traffic lights at rush hour, and officials struggling to head off a wider blackout shut off power.

- 50 million people left without electricity
- Between 7 et 10 billions of US dollars of losses for the economy of the 2 countries

Routing protocols requirements

Routing protocols used with WSN for Smart Grids should mainly take into consideration:

- Load Balancing
- Link Quality
- Latency
- Traffic differentiation

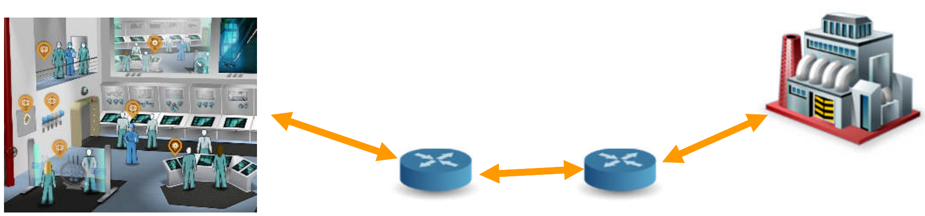


Why?

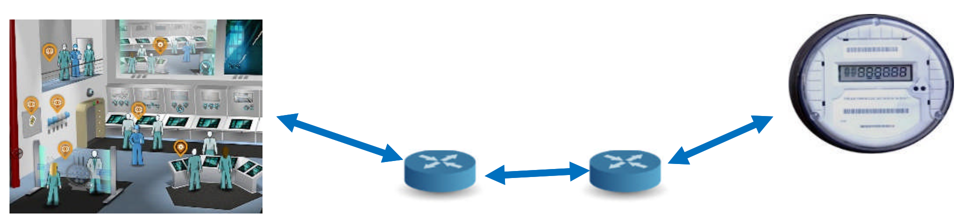
- Load Balancing
- Link Quality
- Latency
- Traffic differentiation

Let's discuss it ☺

1- Central station activation



2- Smart meter reading



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Challenges on Green Energy and Sustainability (case Lithuania)

Prof. V. Klevas and A. Kleviene

Lithuanian Energy Institute

Introduce of the prof. Klevas

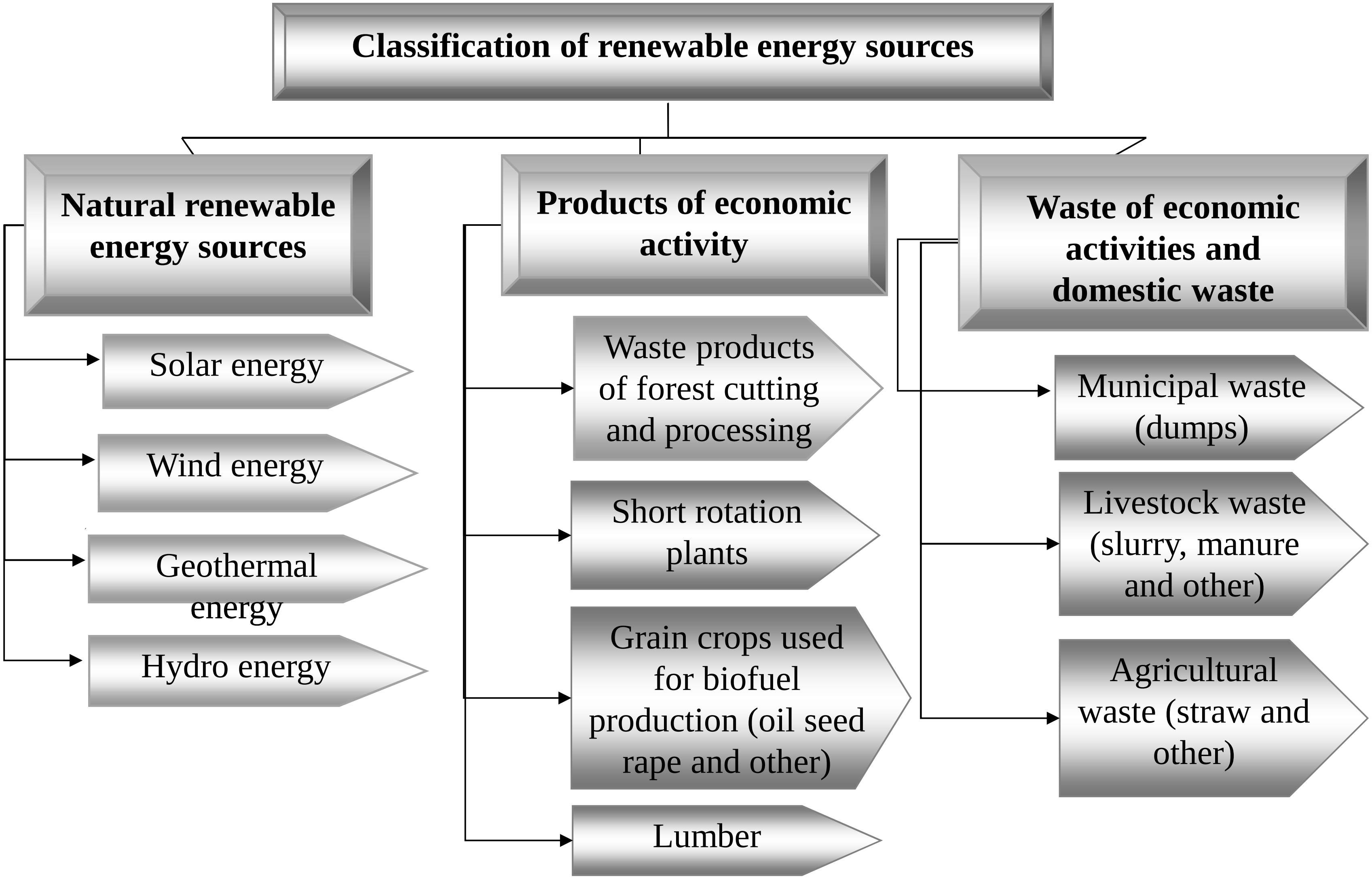
- Graduated from Vilnius university in 1973; Doctoral degree in 1990, dr. habil. degree in 2000.
- Position :Chief Research Associate at Lithuanian Energy Institute
- Professor at Kaunas University of Technology since 2005 till 2016, In 2016, the Senate of the Kaunas University of Technology gave the name of the professor
- Presentations in the conferences, seminars, meetings in international projects in 20 countries .
- IARIA BIONATURE committee member of international conferences since 2010.
- IARIA international journal “Advances in Life Sciences” editorial board member since 2011.
- Member of International Association for Energy Economics since 1992.

The reason and consequences of the unilateral use of RES: case of Lithuania

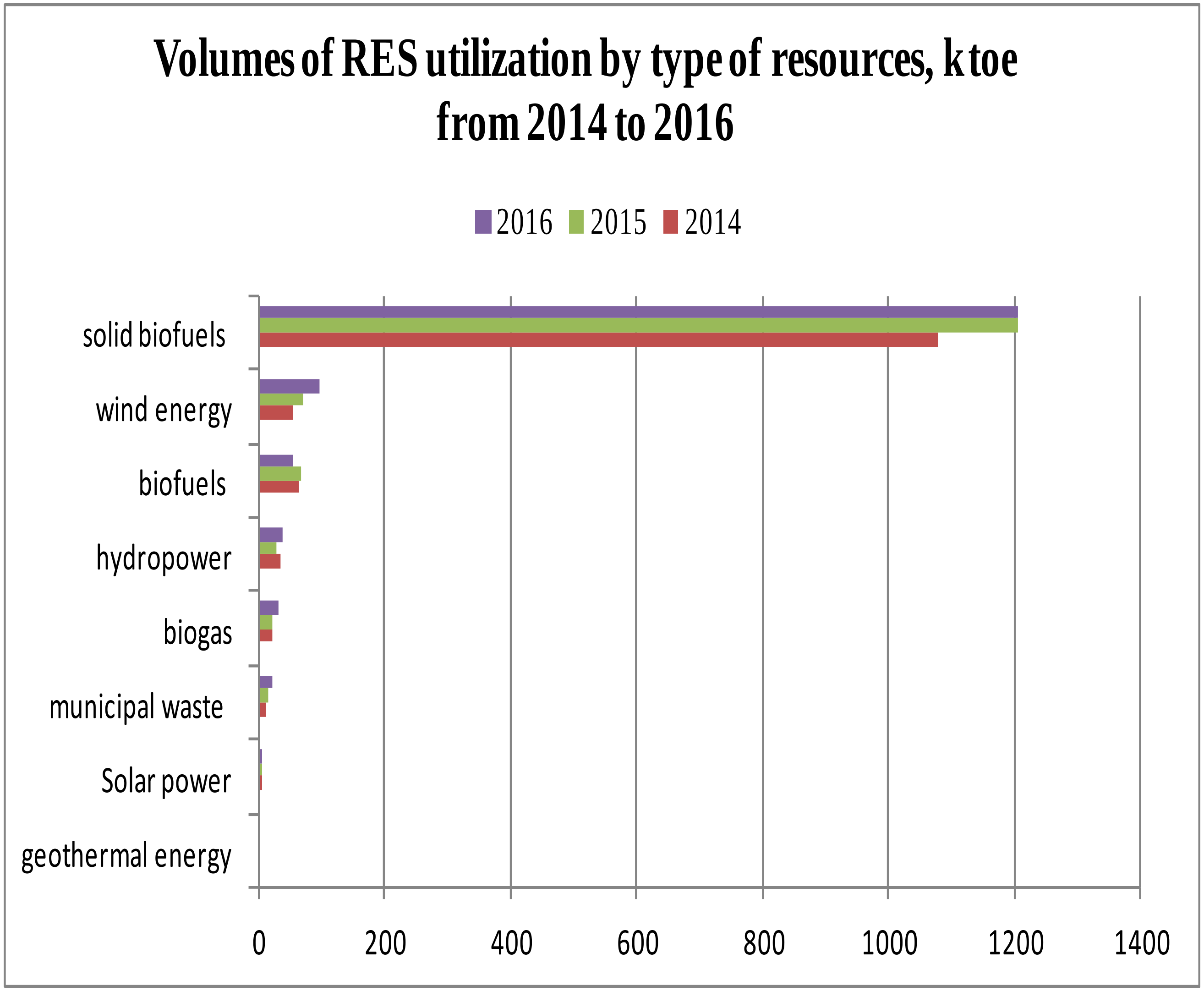
At present renewable energy sources (RES) are treated as an integrated whole, and all the advantages and disadvantages are classified as generalized, but at the same time separated from specific conditions and the infrastructure that is possible to use.

Therefore, one of the most difficult issues to be solved is that the utilization rate of RES in Lithuania (and maybe in other countries) is one-sided, focused on the use mainly of biomass for many reasons, which are not adequately investigated and identified. Meanwhile, other types of RES, such as solar, wind or geothermal energy, are scarcely used.

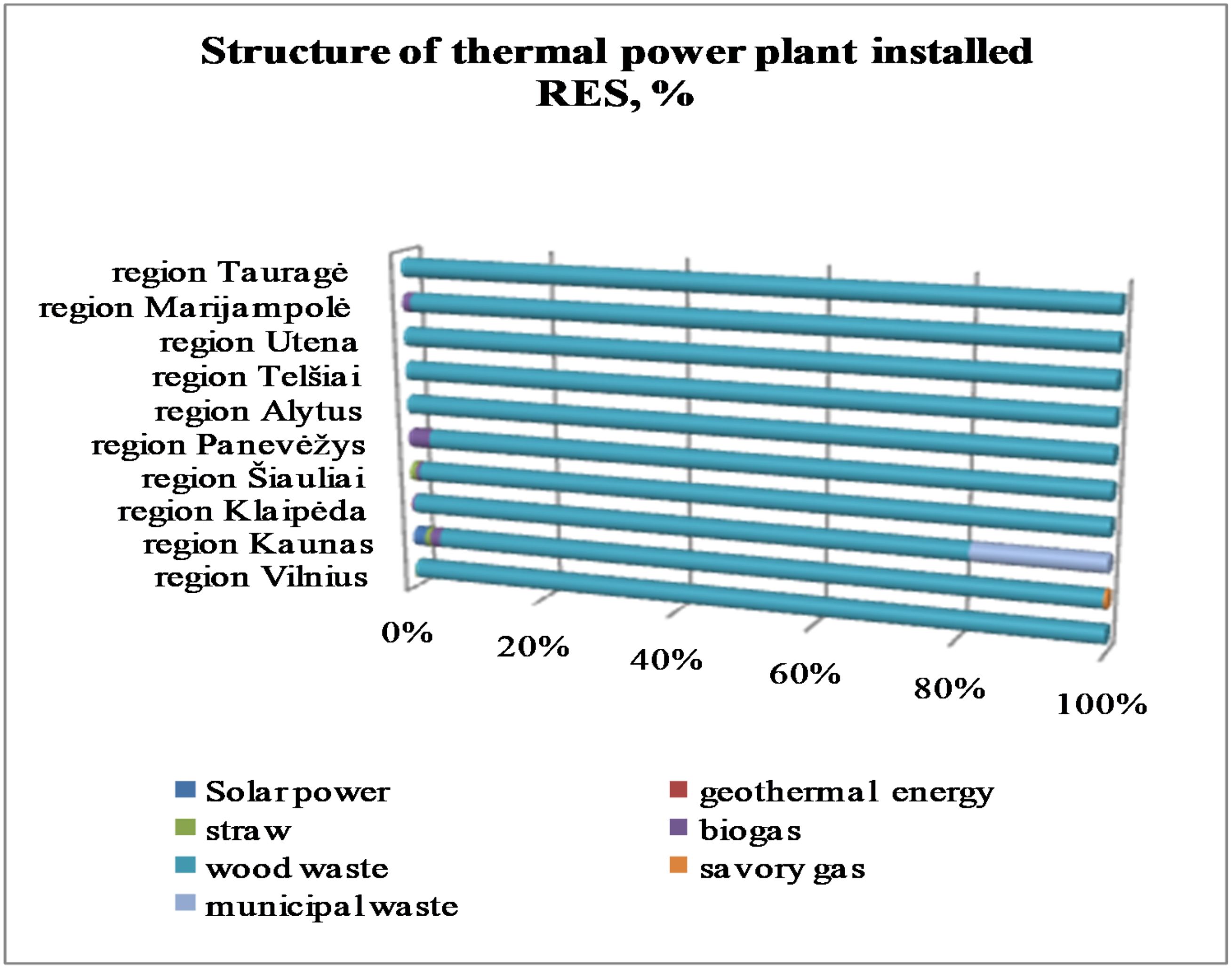
Principle scheme of RES classification



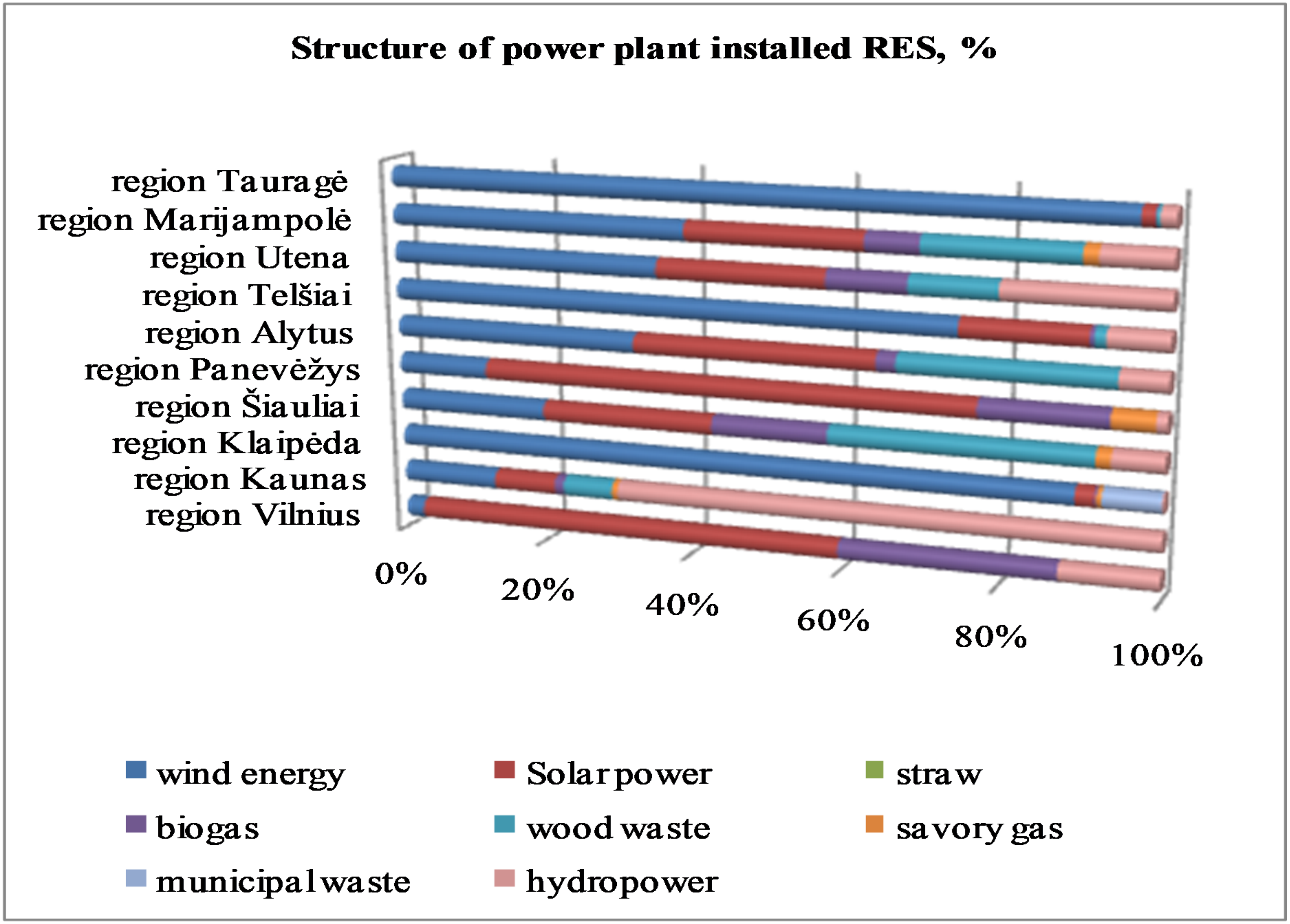
The consequences of the unilateral use of RES: case of Lithuania



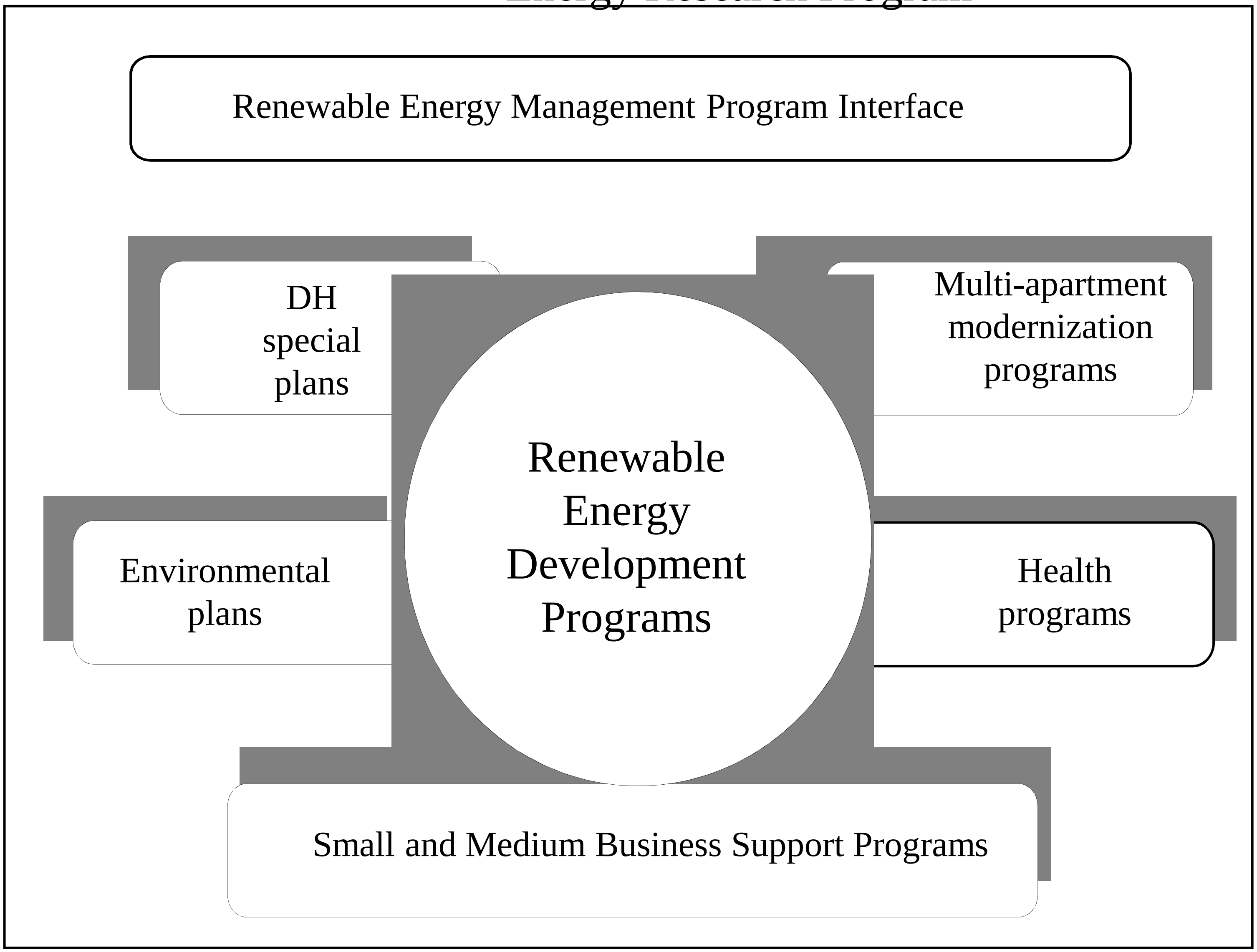
The consequences of the unilateral use of RES for thermal energy: case of Lithuania



Better situation in the electricity sector



A prerequisite for the solution of the problem is the Urban Renewable Energy Research Program



Conclusion

1. A particular obstacle to the widespread use of Renewable Energy Sources (RES) is the lack of evaluation of the benefits to society (reduction of pollution, energy supply of the future for generations, huge and never-ending potential of energy resources such as solar, wind energy) when introducing RES-technologies. Therefore, when formally calculating, RES-technologies are not sufficiently competitive compared to fossil-fuel technologies

2. Each RES has a different value in terms of external benefit, thus respective promotion schemes can and must differ significantly. This depends on the environmental situation in certain area. External conditions and current infrastructure for RES technologies differ, thus spatial planning, such as urban energy development plans, is the most appropriate tool for the benefit assessment.

3. Combination of different types of RES may create large external effect and make a significant impact not only on individual consumer of RES, but on the whole society as well. Therefore, the benefit from using RES, especially in urban areas, should be evaluated during the decision making process.

4. Urban programs should be the main form for the consolidation of investment funds and promotion on the basis of possible rational use of investment as a complex macroeconomic effect can be measured and achieved on the territorial basis.

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Thank you for the attention

Prof. Valentinas Klevas and Audrone Kleviene

E-mail

Load Shifting Algorithm Based on Extended Optimal Power Flow Calculations

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Date: 22.05.2018

Energy18
Nice, FR

University of Technology Chemnitz
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Chemnitz, Germany

Structure

- State of the Art – renewable energy – a controversional matter
- Motivation and Objectives
- Challenges – Mathematical formulation

EHT

State of the Art

Maximization of renewable electric power share → More forecast errors, deterioration of the availability profile of electric power

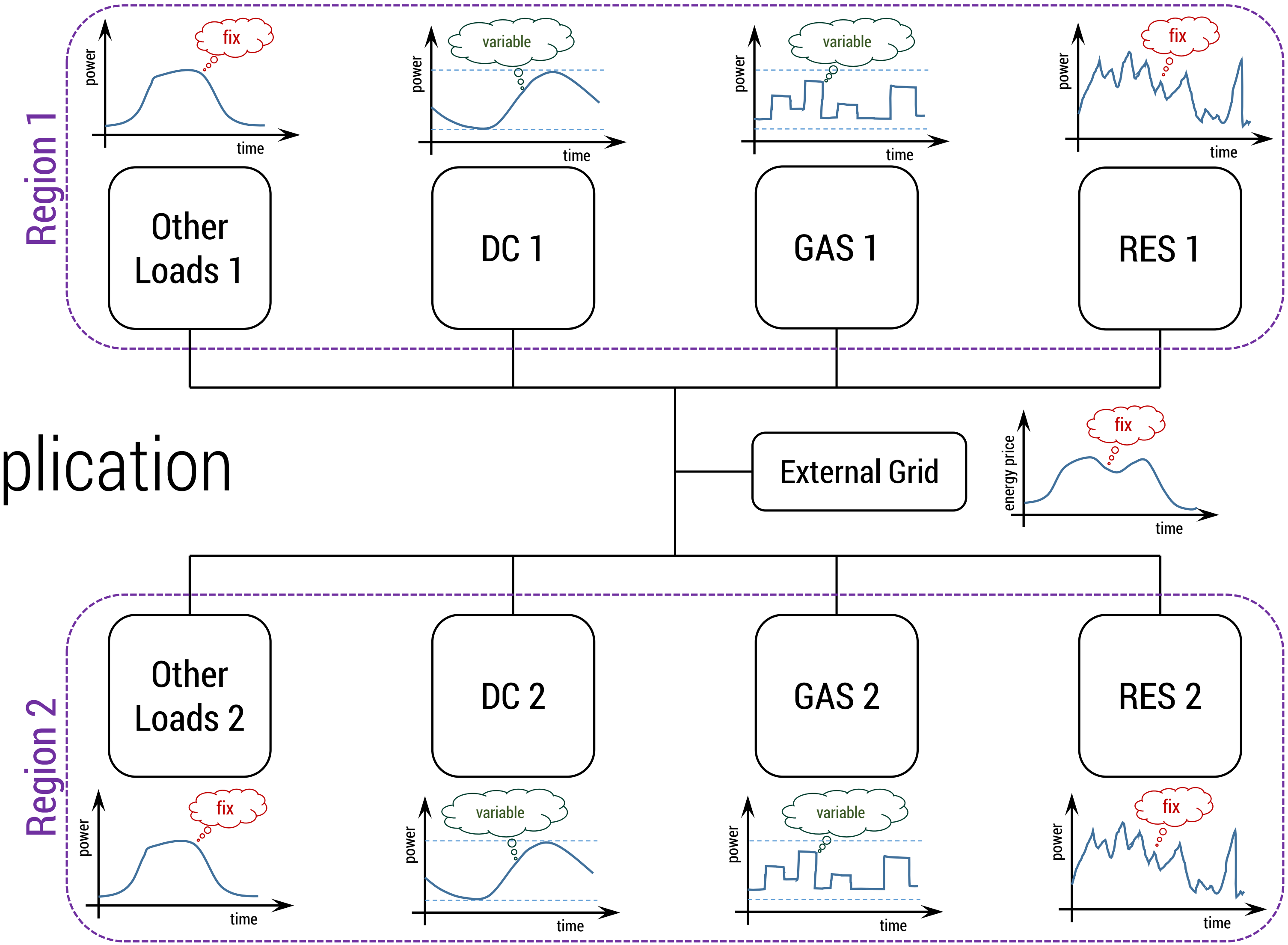
↓

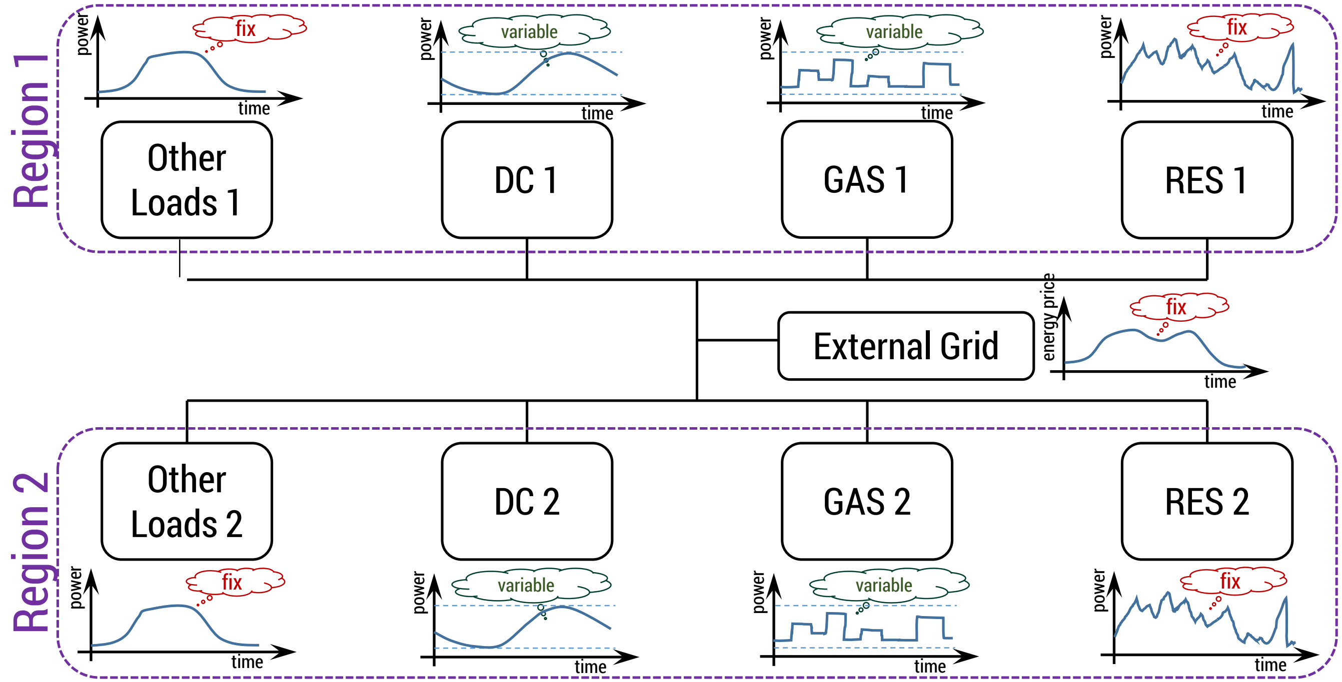
Higher Demand of Control Power in order to assure a well balanced grid operation → Control Power currently made available by conventional power plants

↑ Maximization of renewable electric power share

Principle → Controlling the consumption of big data centers

Application





Summary S1
Too much power in R2, too little in R1; *overall too much*

Shifting VMs can lower the imbalance but not entirely resolve it

Transporting power from R2 to R1 also an option

Priorities of proposed measures

- P1: VM Migration from DC 1 to DC 2
- P2: sell energy in R2; buy energy **or** increase gas power in R1
- P3: increase DC power consumption in R2 (instead of P1)
- P4: reduce gas power production in R2
- P5: reduce wind power production in R2

Motivation and Objectives

Main objective	Matching regional generation and consumption by engaging data centers in a Demand Side Management concept
Motivation	Minimizing the demand of control power in the grid
Challenge	Mathematical modelling of flexible loads for performing Power Flow Calculations

The Optimal Power Flow – Mathematical formulation

Equations:

$$\underline{P}_i(U,\vartheta) = U_i \sum_{k=1}^{n} U_k \cdot G_{ik} \cos(\vartheta_i - \vartheta_k) + B_{ik} \sin(\vartheta_i - \vartheta_k)$$

$$\underline{Q}_i(U,\vartheta) = U_i \sum_{k=1}^{n} U_k \cdot G_{ik} \sin(\vartheta_i - \vartheta_k) - B_{ik} \cos(\vartheta_i - \vartheta_k)$$

Costraints:

$$P_{min} < P_g < P_{max} \quad (1) \qquad Q_{min} < Q_g < Q_{max} \quad (2)$$

$$U_{min} < U_i < U_{max} \quad (3) \qquad \vartheta_{min} < \vartheta_i < \vartheta_{max} \quad (4)$$

$$I_i < I_{max} \quad (5)$$

The Optimal Power Flow – Need of extension

➡ Objective function: Minimization of the total generated amount of electric power

➡ equivalent to minimizing losses!

$$\underbrace{\sum P_{\text{Generation}} + P_{\text{Balance}}}_{\text{min}} = \underbrace{\sum P_{\text{Consumption}}}_{\text{constant}} + \underbrace{\sum P_{\text{Losses}}}_{\text{min}}$$

No calculation algorithm for flexible consumption

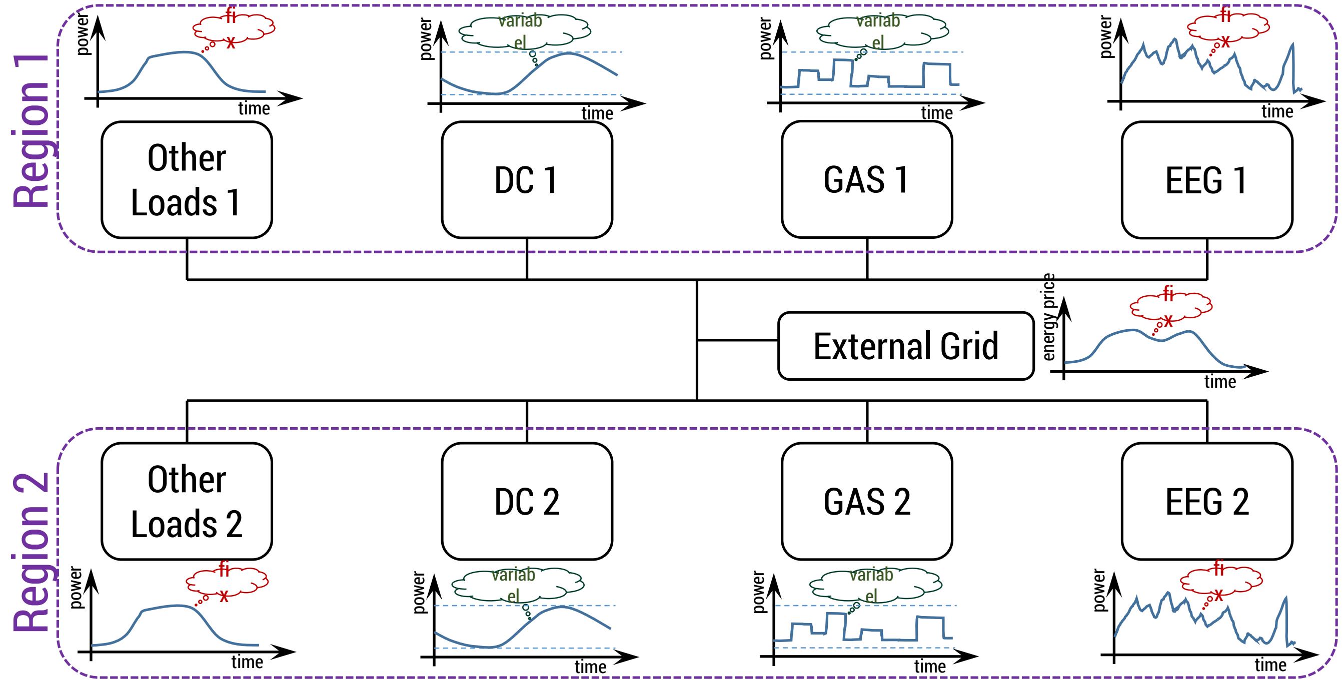
EHT

Do you have any experience with engaging data centers in a DSM concept?

What are other suitable technologies for load shifting?

What algorithm do you use in order to decide which flexible load should be activated?

Can flexible loads replace the control power provided by conventional power plants?



Summary S1
Too much power in both regions

Not enough DC capacity to compensate overproduction

Most economic measure:
Reduce gas production

Priorities of proposed measures

- P1: reduce gas power
- P2: sell energy on the market (slack)
- P3: increase DC power consumption
- P4: reduce wind power production
- P5: reduce coal power production

High Renewable Energy Penetrations in Isolated and Remote Area Power Systems

Michael Negnevitsky

ENERGY 2018
May 20 - 24, 2018
Nice, France

UTAS
Centre for Renewable Energy and Power Systems
UNIVERSITY OF TASMANIA

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Chair in Power Engineering and
Computational Intelligence
Director of the Centre for Renewable
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Tasmania, 7001 Australia

Opportunities

- Electricity in isolated power systems is traditionally generated using diesel generators.
- High cost of diesel fuel supply (the price exceeds US $1/kWh).
- Incentive for introducing renewable energy generation.

Reducing diesel dependence in isolated grids is becoming an ***accepted option***, with more interest from larger multi-lateral donor and banking organizations.

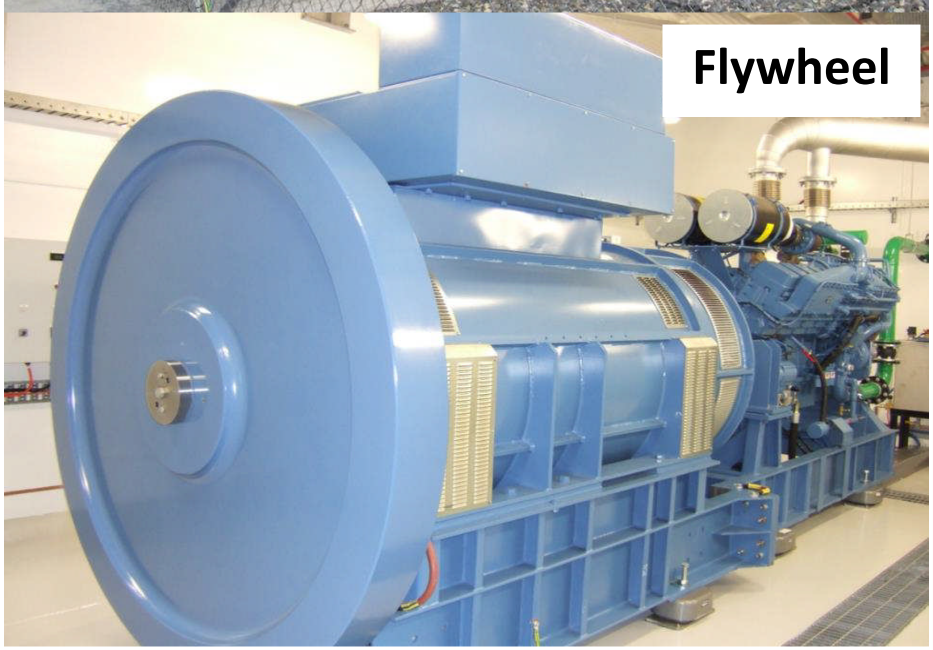
- Australian experience is typical of progress in transitioning to renewable generation. The smallest Australian states adopt the most aggressive renewable targets, 100% by 2020 and 2022 for the Australian Capital Territory (ACT), and Tasmania, respectively.
- This trend of small networks to lead renewable integration derives primarily from their ability to achieve high renewable penetrations for moderate renewable capacity addition.

Technology portfolio

- Wind and solar,
- Dual axis solar PV tracking system,
- Dynamic resistive frequency control,
- Flywheel diesel uninterrupted power supply,
- Biodiesel blending ,
- Demand side management, and
- Battery energy storage.


Dynamic resistor


Battery storage


Flywheel


Demand response
Hot Water
Commercial DSM
Data Reporting
PV control
EV Charging

Battery energy storage?

- As penetrations of renewable energy increase within a system, conventional approaches may become unable to manage system security.
- Battery energy storage is a common solution. But it is an emerging technology and currently expensive.
- Australian experience advocates approaches able to reduce both the system cost and complexity.

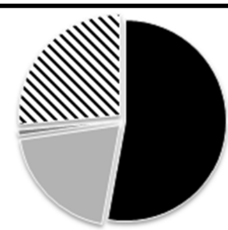
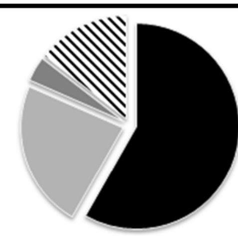
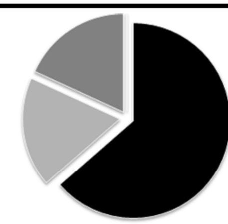
Challenges

- **Projects can be expensive.** Costs as high as $17 per Watt have been reported for small (100-kW) installations.
- **The need for energy storage**. Especially in larger grids.
- **Poor performance compared to modelled predictions.** Poor resource assessment (wind and solar); poor system modelling; few qualified people to manage projects; long contracting and deployment timelines; lack of ongoing technical assistance; use of new, untested technologies in remote communities.
- **Environmental regulations can limit potential project sites.** Especially in islanded communities with protected or endangered species.

Main challenges

- **Institutional.** Poor understanding of the technology by decision makers; lack of trained personnel; no coordinated outreach, targeted industry or users group, or expanded communications network.
- **Policy**. Subsidized fuel markets and a lack of consideration of environmental impacts; perceived risk and associated higher financial costs; complicated, costly, and multi-jurisdictional permitting processes; and risk-averse culture.

Case study metrics

	King Island renewable energy integration project	Flinders Island hybrid energy hub	Rottnest Island water and renewable energy nexus
Generation Configuration			
	■ Diesel (MW) ■ Wind (MW)	■ Solar PV (MW)	BESS Capacity (MW)
Peak Load (MW)	**2.5**	**1.3**	**1.2**
Average Load (MW)	1.4	0.8	0.6
Annual Generation (GWh p.a.)	**12**	**6.7**	**5**
Generation Capacity Total (MW)	**8.35**	**4.4**	**3.3**
Generation Capacity Renewable (MW)	2.35	1.4	1.2
Renewable Capacity (MW) WIND	**2.25**	**1.2**	**0.6**
Renewable Capacity (MW) Solar PV	0.1	0.2	0.6
Battery ESS Capacity (MW,MWh)	**3, 1.6**	**0.75, 0.3**	**n/a**
Flywheel System	Yes	Yes	No
Renewable Energy Penetration (% p.a.)	**65%**	**60%**	**50%**
Development Period	1998-2015	2014-2017	2016-2017
Utility Network Connection	No	No	No
Capital Cost ($m)	28.15	15.38	9.81
Capital Cost ($m/per MW installed)	**11.98**	**10.99**	**8.18**

Technology trends (Australian experience)

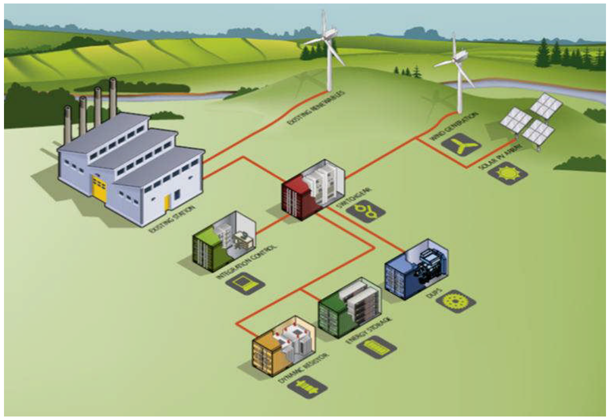
Technology Progression	King Island renewable energy integration project	Flinders Island hybrid energy hub	Rottnest Island water and renewable energy nexus
Wind	⬆	▬	▬
Solar PV		⬆	⬆
Battery		⇩	⇩
Flywheel		⇩	⇩
Low Load Diesel			⬆

▬ No Change

⬆ Increasing Relevance

⇩ Decreasing Relevance

Modular scalable enabling systems for rapid deployment



Want to see a 100% renewable energy island system operating?

www.kireip.com.au

Want to learn more about isolated power systems with high renewable energy penetration?

http://ipsconnect.org/