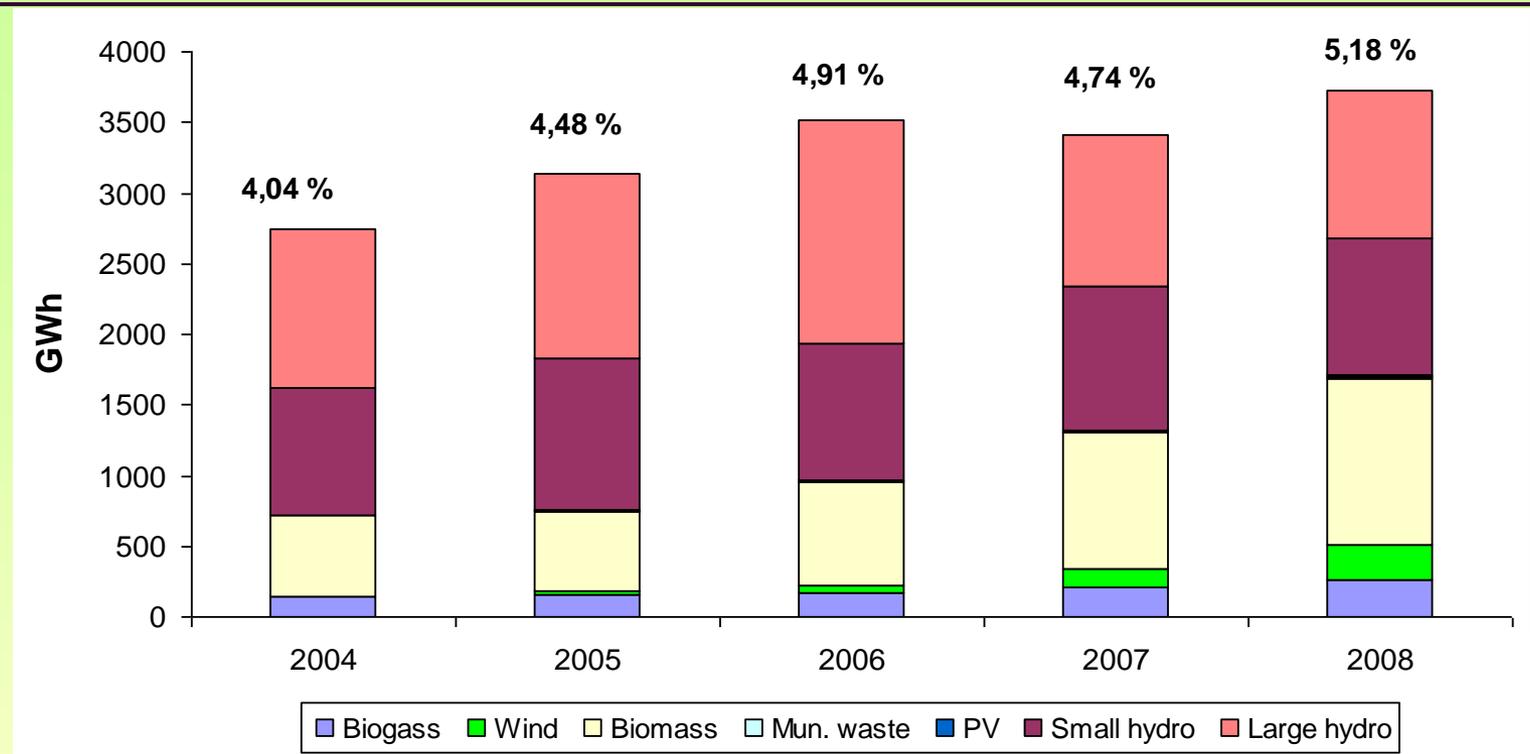

CURRENT STATUS OF RES UTILIZATION FOR POWER GENERATION IN THE CZECH REPUBLIC

doc. Ing. Jaroslav Knápek, CSc.

**Czech Technical University in Prague
Faculty of Electrical Engineering,
Czech Republic**

RES-E DEVELOPMENT IN CR



Mid. of 2009: 6,5% share of RES-E

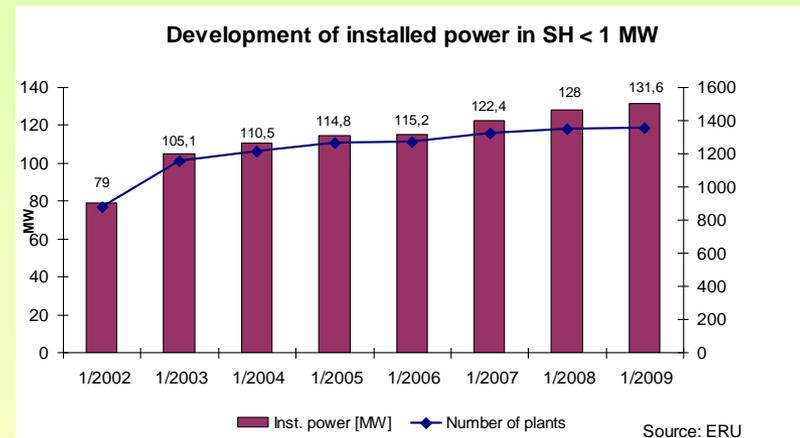
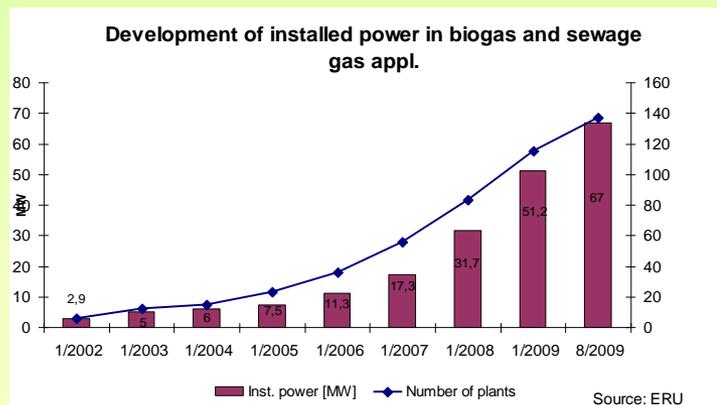
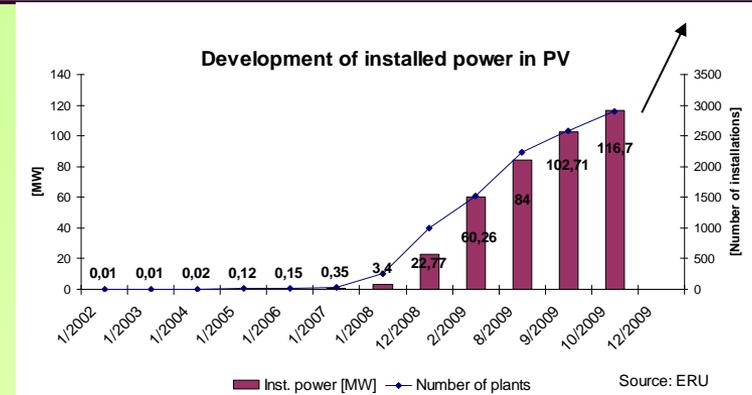
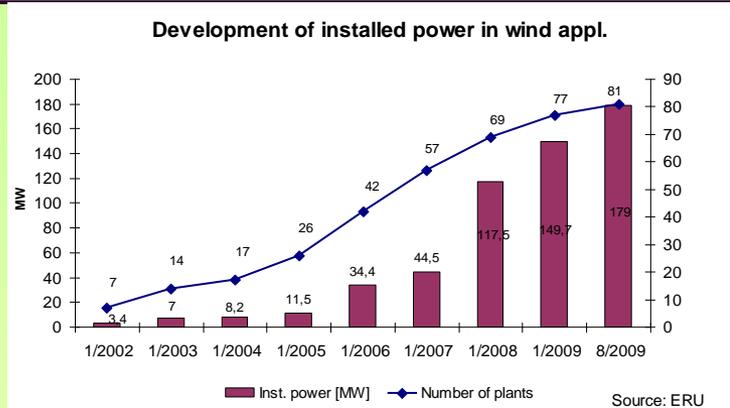
Source: MPO statistics

□ (mainly caused by power consumption decrease)

National indicative target to 2010:

□ **8 %**, meeting the target is highly uncertain

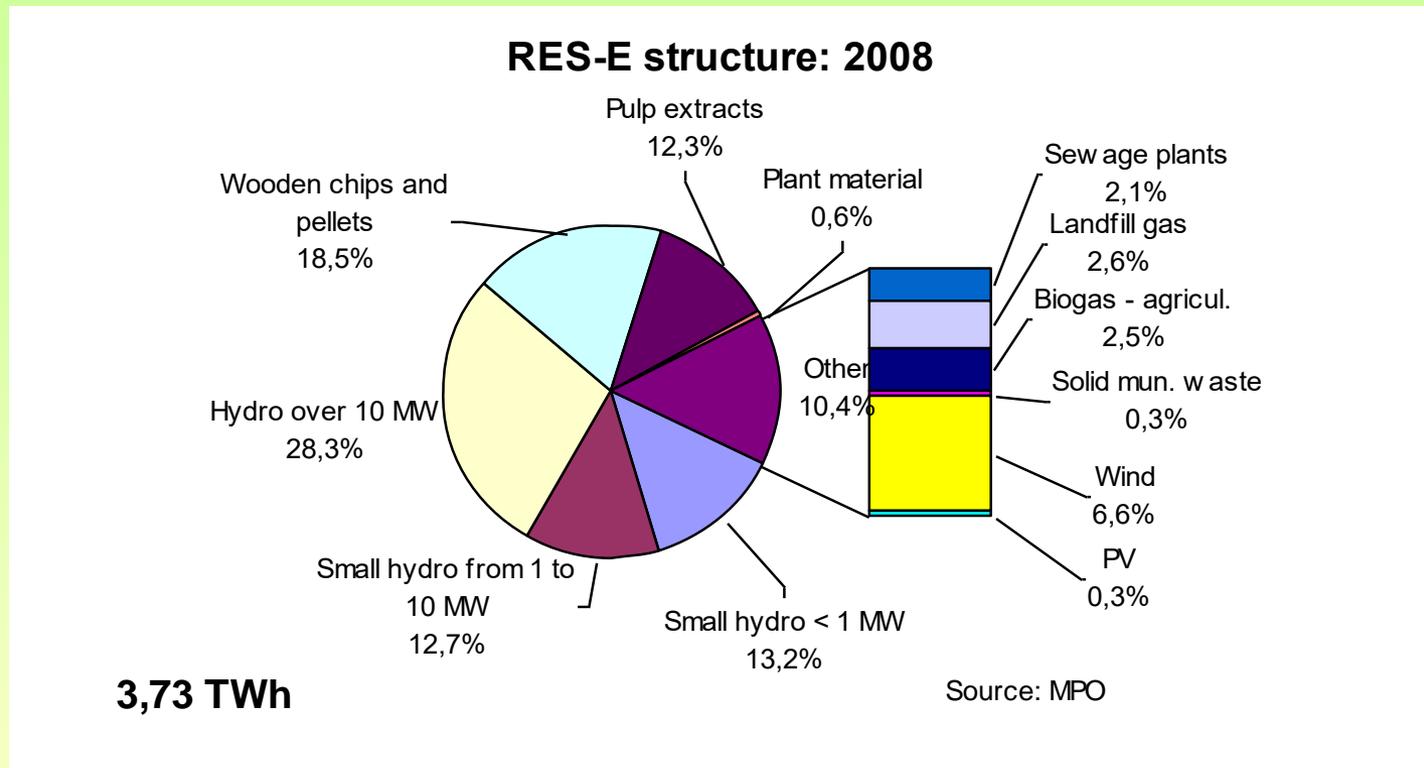
INDIVIDUAL RES-E PROJECTS DEVELOPMENT



Boom of PV: result of „gap“ in support scheme

- ❑ fall of investment cost cannot be accompanied by feed-in tariff reduction

RES-E DEVELOPMENT IN CR



Hydro (54%) and biomass burning (31%) dominates (2008)

- ❑ **Hydro stagnates**
- ❑ **year 2008/2007: Biomass: +200 GWh (+21%), Wind +120 GWh (+95%)**

INVESTORS INTEREST ON RES-E PROJECTS

PV: Highest interest of investors, enormous boom

- ❑ fall of investment cost, legislation currently let reduction of feed-in tariffs for new application only by 5%/year
- ❑ extra return for investors
- ❑ „fight“ for locations with access to grid
- ❑ no subsidy from EU structural or other funds available

Wind: High interest of investors

- ❑ but blocked by very complicated approval procedure (2-3 years or more)
- ❑ negative attitude of many regional councils and municipalities (and public too)
- ❑ limited number of good locations (good locations esp. in mountains, but conflict with environmental constraints)
- ❑ no subsidy from EU structural or other funds available

INVESTORS INTEREST ON RES-E PROJECTS 2

Biogas stations (agriculture): High interest

- Investment subsidy within Rural development plan (now app. 30%) – for companies with agricultural activities
- Development of biogas stations using planted biomass

Biomass burning: assumed as source with highest potential

- co-firing: adding of biomass into coal in coal fired power stations
- highest growth 2007 to 2008, but partly limited by lack of biomass

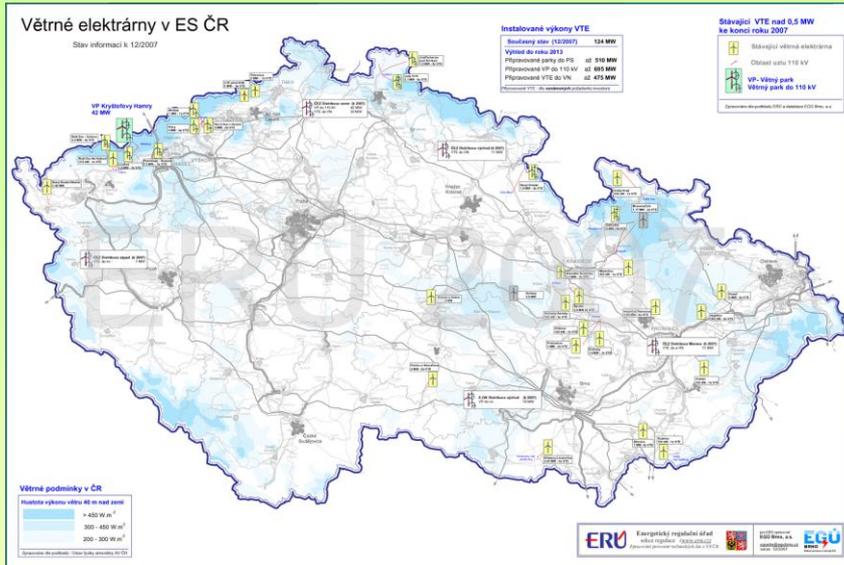
Other RES-E types stagnates

Basically effective economic support scheme

- but faster development blocked by other (non economic) barriers

WIND POWER PROJECTS

Locations of wind power projects (end of 2007)



Source: Taken from ERU Annual report on power grid operation 2007

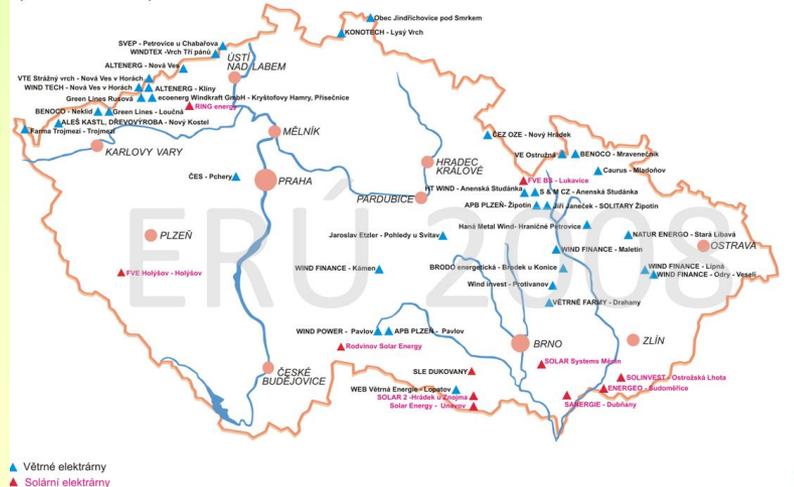
Blue: Wind
Red: PV

Outlook to 2013:

- considered projects up to 1600 MW (total)

Wind and PV at the end of 2008

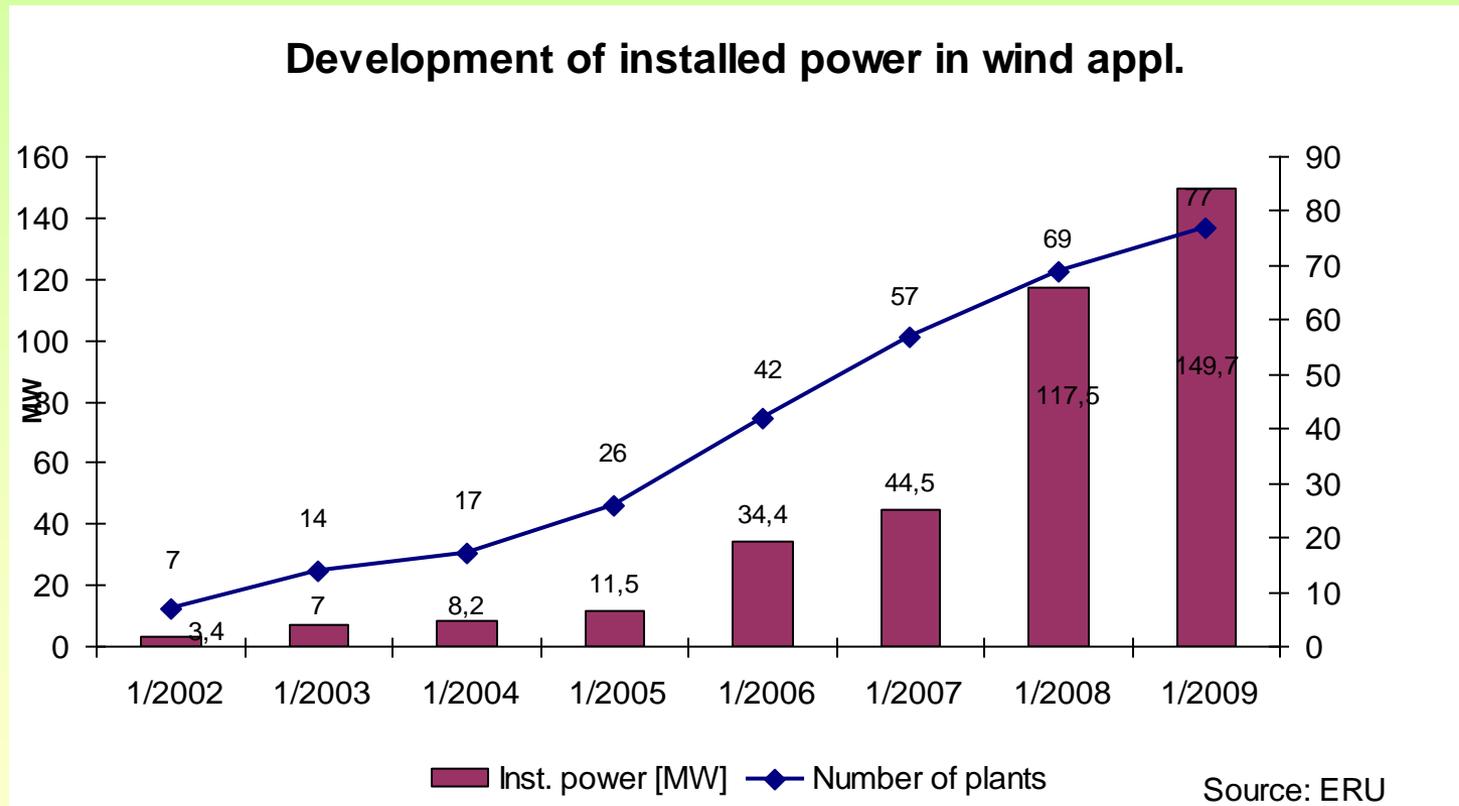
ZDROJE VTE a fotovoltaické v ES ČR - nad 1 MW_e součtového instalovaného výkonu (stav k 31. 12. 2008)



Source: Taken from ERU Annual report on power grid operation 2008

WIND POWER PROJECTS 2

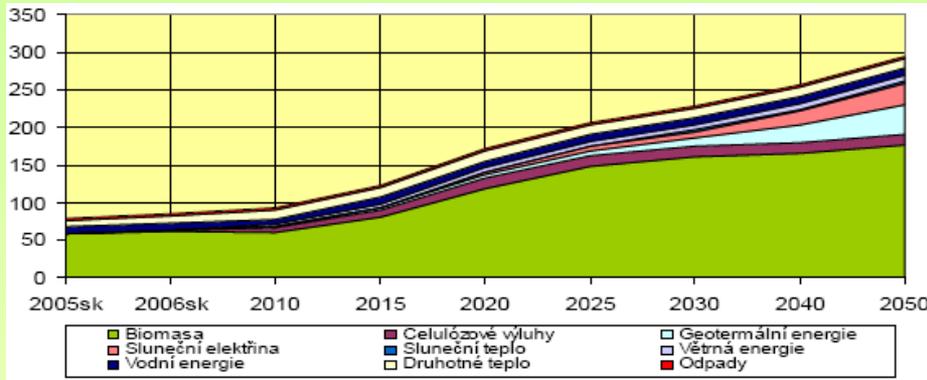
Start of F.T. system since 2006 is obvious



RES PERSPECTIVE

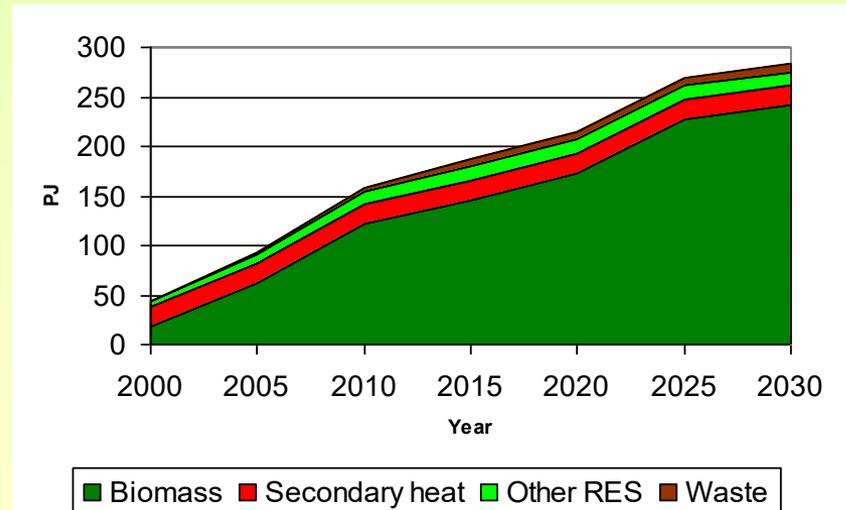
CZECH ENERGY POLICY PROPOSAL 2009

RES as primary energy sources



← SEP 2009

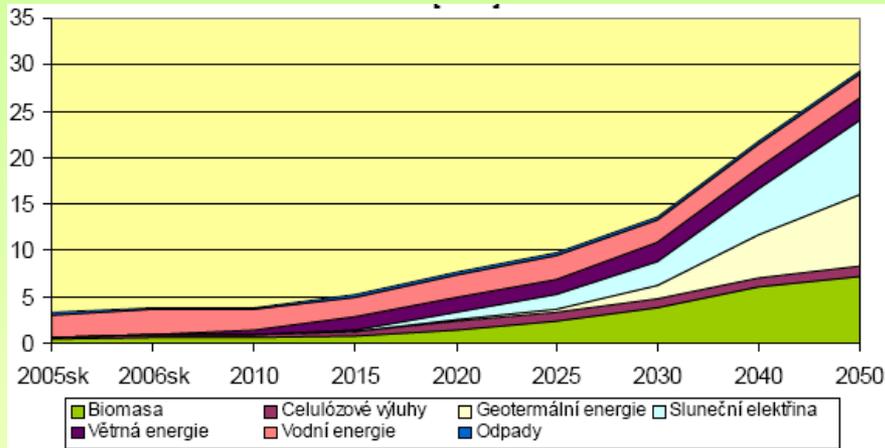
SEP 2004 →



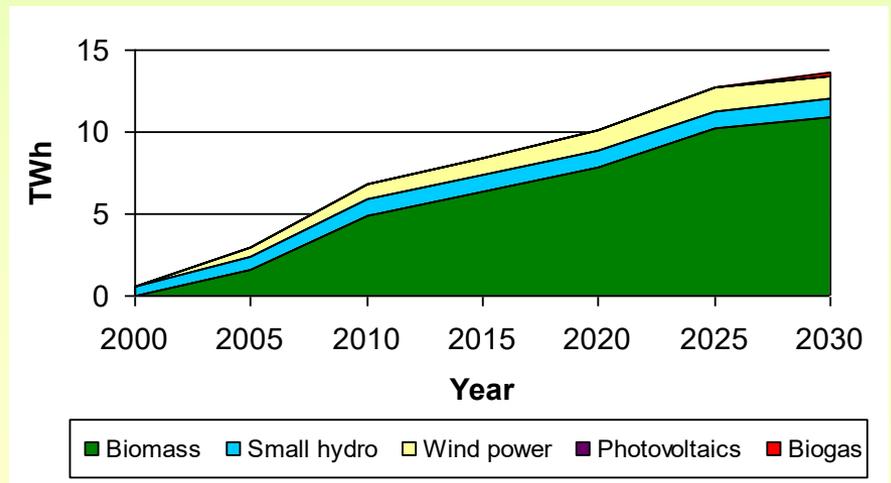
RES PERSPECTIVE

CZECH ENERGY POLICY PROPOSAL 2009

RES for power generation in TWh



SEP 2004 →

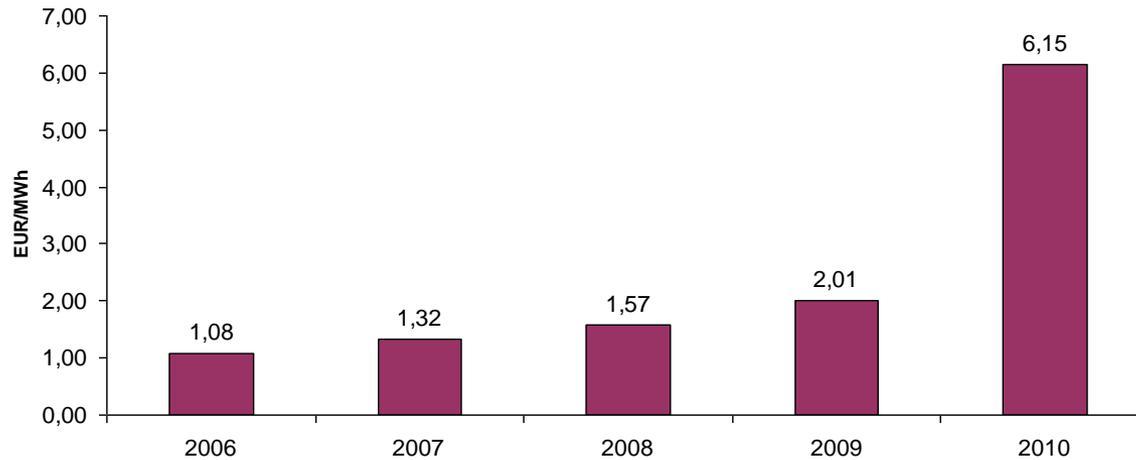


STRUCTURE OF RES-E SUPPORT SCHEME

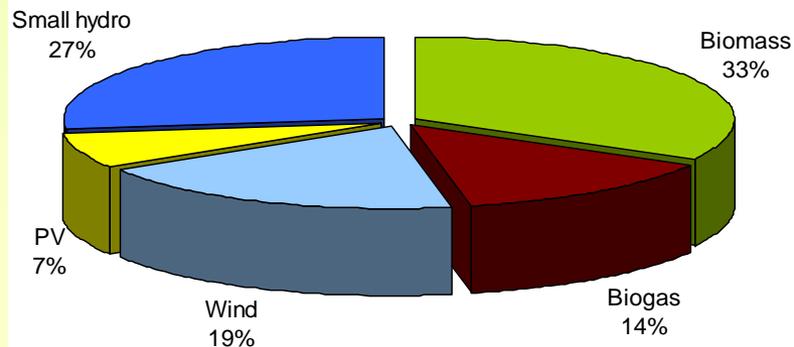
- 1) F.T. and G.B. - Act 180/2005**
- 2) Tax incentives**
- 3) Support of decentralized production**
- 4) Support from EU funds**
- 5) Other support**

DEVELOPMENT OF COST OF SUPPORT

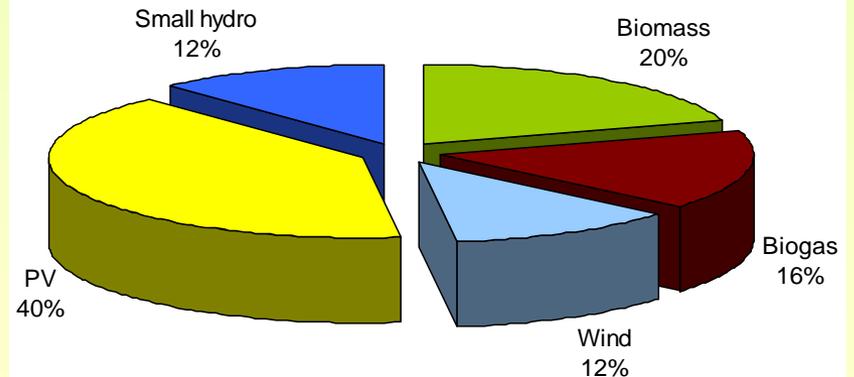
Development of fee for RES support
for final consumers



Share on RES power generation in 2010



Share on RES extra cost in 2010



RES-E SUPPORT: NEWS

Periodical update of reference projects for feed-in tariffs calculation

- update of ERU Notice 475/2005 and 364/2007

Discussion of „technical“ amendment of Act 180/2005 on RES-E support

- to reduce extra return for PV applications (payback time higher than 10 years)

Complicated calculation of green bonuses

- what will be price of electricity in 2010 ?
- what price for individual RES types will be offered ?

REFERENCE PROJECTS FOR FEED-IN TARIFFS CALCULATION

Periodical update of reference projects for feed-in tariffs calculation (2 years period)

- update of ERU Notice 475/2005 and 364/2007

Time aspects

- Data of already existing projects (2007-8)
- Data of preparing projects (2009-2011)

Data sources

- Data from RES associations
- Data from consultancy companies
- Data from applications for support from EU operational funds
- Data from ERO licensing database

REFERENCE PROJECTS UPDATE

SUMMARY

Small hydro:

- Increase of expected investment cost, increase of F.T.

PV:

- significant reduction of investment cost, slight increase of load factor, maximum possible reduction of F.T.

Biogas (agriculture)

- slight increase of load factor, slight reduction of inv. cost

Wind

- increase of inv. cost, increase of load factor

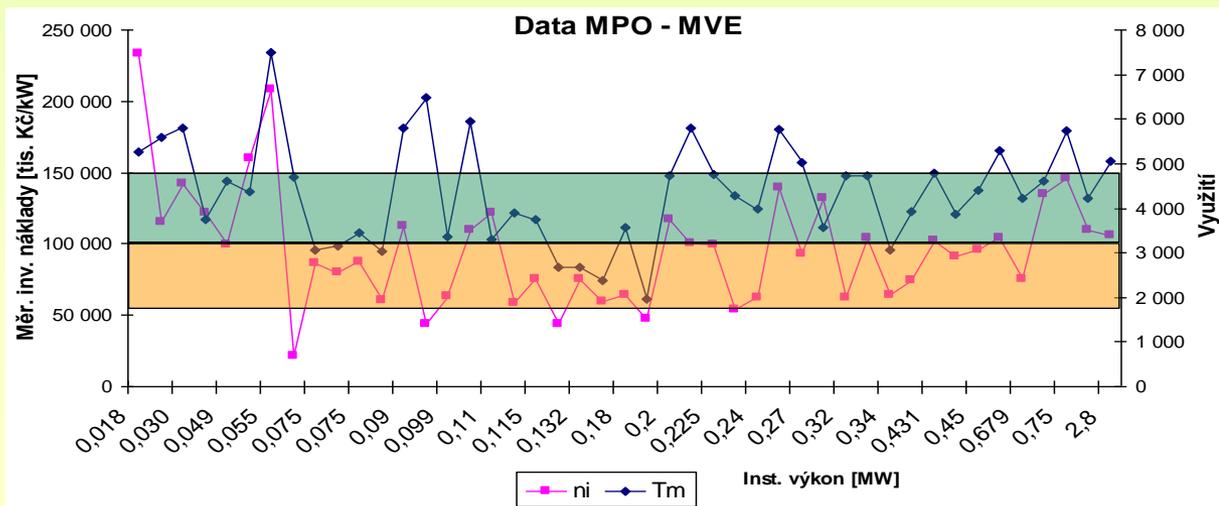
REFERENCE PROJECTS – SMALL HYDRO

ERU Notice 475/2005 and 364/2007: indicative values (technical and economic) of reference projects

Reference project defined as 3 possible combination of investment cost of load factor

- Operation cost: app. 2%
- Increase of investment cost for the same load factor for new SH since 2010
- Feed-in tariff 2009: 0,1034 EUR/kWh
- Feed-in tariff 2010: ? +11% (proposal)

	Investment [th. EUR/kW]	Load factor [hours]
	5	4000
	5,38	4300
	5,77	4600



REFERENCE PROJECTS – WIND

Existing projects:

- Load factor (average): 2150 hours
- Investment cost: 1.44 th. EUR/kW

Original indicative values:

- Investment cost: 1.48 th. EUR/kW
- Load factor: 1900 hours

New projects – indicative values:

- Load factor: 2100 hours
- Investment cost: 1.62 th. EUR/kW

Can results in app. 4% F.T. reduction

REFERENCE PROJECTS – PV

Original indicative values:

- Investment cost: 5.19 th. EUR/kW
- Load factor: 935 hours

New projects – indicative values:

- Load factor: 1000 hours
- Investment cost: 3.46 th. EUR/kW

Adequate decrease of F.T. would be app. 21% (max. 5% possible)

- F.T. 2009: 0.496 EUR/kWh
- F.T. 2010: 0.471 EUR/kWh

REFERENCE PROJECTS – BIOGAS

Existing projects:

- Investment cost: 4.5 th. EUR/kW (subsidy up to 30%)
- Load factor: 7860 hours

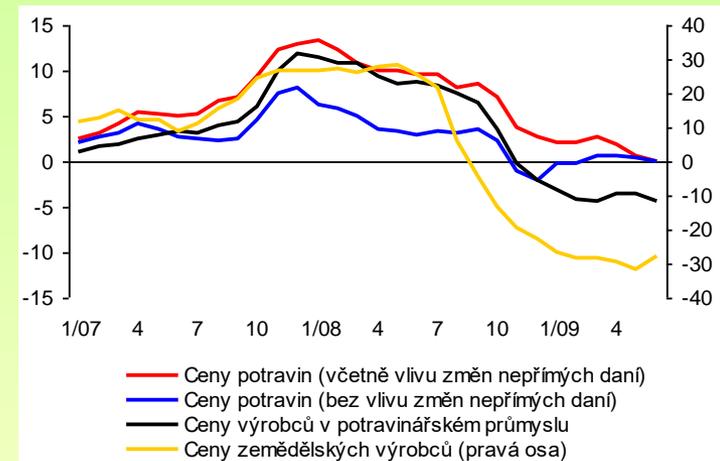
Original indicative values:

- Investment cost: 4.62 th. EUR/kW
- Load factor: 7500 hours

New projects – indicative values:

- Load factor: 7800 hours
- Investment cost: 4.23 th. EUR/kW

Fuel cost: 0.058-0.073 EUR/kWh, oper. cost 4% of inv.



REFERENCE PROJECTS – BIOMAS

Original indicative values - remains:

- Investment cost: 2.88 th. EUR/kW
- Load factor: 5000 hours

Existing projects

- Load factor: 7000-7300 hours
- Investment cost: 3.08 th. EUR/kW

3 biomass categories

- intentionally planted biomass as fuel: 6.54 EUR/GJ

Projects aimed at power generation (only), reduced care on heat

FROM HISTORY OF RES-E SUPPORT

up to 2001: no systematic support

- „market prices“ applied, only not obligatory support from the funds of Energy Agency and State Environmental Fund available (limited sources)

- **2002-2005: support based on feed-in tariff (F.T.) system**
- tariffs set up at year base by price decisions of Energy Regulatory Office
- F.T. defined based on economic analysis of reference projects, rate of return approach
- Tariffs differentiated by the type of RES
- Risk for the investors – conditions fixed only for one year
- Investors are „waiting“
- Co-firing support started from 2004 („jump“ increase of biomass price)
- 1,5 year discussions on RES-E support act, very complicated discussion in Parliament

FROM HISTORY OF RES-E SUPPORT 2

Since 2006: new legislation

- ❑ Act on RES-E support No. 180/2005
- ❑ Feed-in tariffs and green bonuses system for RES-E projects
- ❑ System solution for RES-E project
- ❑ No solution for RES project for heat generation (deleted from Act proposal)

2007-2009: continuation and improvement/corrections of system

- ❑ update of technical and economic parameters of RES-E projects for F.T. calculation
- ❑ specification of Act 180/2005 logic by Energy Regulatory Office (ERO) notices

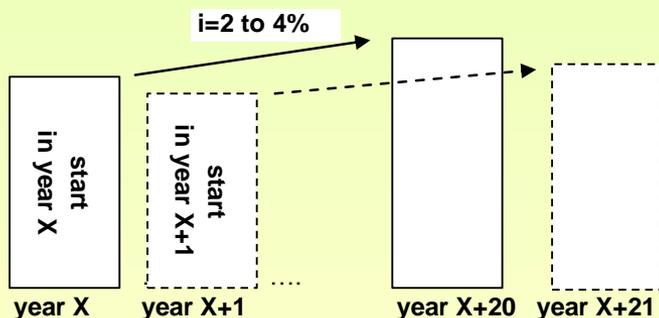
LOGIC OF CZECH RES-E SUPPORT SCHEME 1

- ❑ **Primary goal: Elimination of investor's risk**
- ❑ Application of rate of return approach - creation of economic intensiveness to invest
- ❑ Cost of support transferred to the final consumers via separate fee
- ❑ Obligation of distribution or transmission company to purchase electricity (F.T. option)
- ❑ Feed-in tariff and green bonuses (G.B.) – annual free choice (excluding co-firing)
- ❑ Feed-in tariffs guaranteed for 20 years (30 for small hydro) – originally only 15 years in Act 180/2005
- ❑ Feed-in tariffs derived from individual RES reference projects, G.B. should reflect higher risk

LOGIC OF CZECH RES-E SUPPORT SCHEME 2

- ❑ Inflation inclusion (in range 2 to 4%) based on PPI index (biomass and biogas excluded from this rule)
- ❑ Logic of time matrix is applied
- ❑ Reduction of new feed-in tariff is -5%/year at maximum
- ❑ FT and GB announced by ERO

Time matrix



F.T. and G. B. [CZK/MWh] for 2009

	F.T.	G.B.
Wind	2340	1630
S. hydro	2700	1260
Biogas AF1	4120	2580
Biogas AF2	3550	2010
Landfill gas	2420	880
Sewage gas	2420	880
Biomass 100%	4490/3460/2570	2950/1920/1030
Co-firing	-	1350/690/40
Parallel co-firing	-	1620/960/310
PV over 30 kW	12790	11810
Geothermal	4500	3140
Gas from mines	2420	880

LOGIC OF CZECH RES-E SUPPORT SCHEME 3

- ❑ F.T. and G.B. are annually announced by ERU (Price decision 8/2008 for 2009)
- ❑ Co-firing supported only by green bonuses
- ❑ Economic preference of intentionally grown biomass
- ❑ ERU is responsible for creation of economic motivation to meet 2010 indicative target
- ❑ No specific methodology for F.T. and G.B. calculation mentioned in the Act
- ❑ Differentiation of biomass types for support by Ministry of Environment notice 482/2005 (453/2008)
- ❑ G.B. also for power generated for „own“ consumption of producer

NOTICES TO ACT 180/2005 ON RES-E SUPPORT

ERU notice 150/2007

- (primarily on regulation issues), amended by Notice 140/2009
- specification of inflation rate for FT annual update – based on PPI, min 2%, max. 4% (exception: biomass and biogas applications.)
- F.T. guaranteed for the whole technical life of RES plant (etc. G.B.) – see ERU notice 475/2007

ERU notice 364/2007

- (amendment of 475/2005 ERU notice to Act 180/2005)
- defines indicative technical and economic indicators of RES-E projects (meaning of informative values - reference projects)
- defines expected technical life time
- mentions logic of F.T. calculation (in brief)
- under update just now (update of reference RES-E projects in app. two years)

PROJECTS INDICATIVE PARAMETERS

Project indicative values - selection

Wind power	Ni < 38,5 th. CZK/kW, Tm > 1900 hours
PV	Ni < 135 th. CZK/kW, Tm > 935 hours
Biogas	Ni < 120 th. CZK/kW, Tm > 7500 hours
SH	Ni < 110 th. CZK/kW, Tm > 3700 hours
SH	Ni < 130 th. CZK/kW, Tm > 4500 hours

Figures valid in 2009, Ni=investment cost, Tm=load factor

- from 2010 some significant changes expected (currently under discussion)
- possible increase investment cost for wind (but increase of load factor), can result in small decrease of F.T.
- fall of investment cost for PV down to app. 90 th. CZK/kWp (+increase of load factors) – but cannot be fully reflected in F.T. decrease
- increase of investment cost for small hydro

PRICE DECISION OF ERO (ERÚ)

F.T. and G.B. for new and existing plants announced annually by ERO price decision

- November of each year

- Further specification of rules, e.g.:
 - Small hydro: to qualify as the new plant, age of technology should be less than 5 years
 - Wind: similarly, limitation for age of technology is 2 years

- Support is paid by power consumers proportionally to their power consumption via separate distribution / transmission fee

- **2006: 28,26 / 2007: 34,13 / 2008: 40,75 / 2009: 52,18 CZK/MWh**

STRUCTURE OF RES-E SUPPORT SCHEME 2

Act 180/2005

- ❑ G.B. and F.T.: RES for power generation
- ❑ Gas from closed coal mines: 2420 CZK/MWh
- ❑ Non traditional energy sources for power generation, bonus (not G.B.) 45 CZK/MWh, or 600 CZK/MWh (gas from opened mines)

Tax incentives

- ❑ Income tax holidays (1+5 years)
- ❑ Land and property tax holidays (1+5 years)
- ❑ Level of importance: 3-4% of F.T. value

Support of decentralized production

- ❑ Differentiated by voltage level (connection point to the grid)
- ❑ 20/27/64 CZK/MWh for low/high/110 kV voltage level
- ❑ Total value: app. 60 mil. CZK (est.)

STRUCTURE OF RES-E SUPPORT SCHEME 3

EU structural funds (2007-2013)

- OPPI / part Ekoenergie: Ministry of Industry and Trade (primarily targeted to entrepen. projects)
- OPŽP: Ministry of Environment (primarily targeted to municipalities)
- Rural development plan: Ministry of agriculture (targeted to biogas stations)

RATE OF RETURN APPROACH FOR F.T.

Act 180/2005 does not define specific methodology for F.T. and G.B. calculation

- They have to create „motivation“

Basic explanation of methodology in ERU notice 364/2007

- Rate of return approach applied
- F.T. should assure the same rate of return
- Reference project for each RES type
- CF analysis during the whole lifetime

Calculation of minimum price c_{min} in first project year to assure WACC=7%

RATE OF RETURN APPROACH FOR F.T.

Feed-in tariffs as the minimum prices to get NPV=0

$$NPV = \sum_{t=1}^{T_n} CF_t \cdot (1 + r_n)^{-t} = 0 \quad \sum_{t=1}^{T_n} [MinPrice_{biomass} \cdot Q_t + Subsidy_t] \cdot (1 + r_n)^{-t} =$$

$$= \sum_{t=1}^{T_n} Expenditures_t \cdot (1 + r_n)^{-t}$$

$$C_{min,0} = \frac{\sum_{t=1}^{T_n} Expenditures_t \cdot (1 + r_n)^{-t} - \sum_{t=1}^T Subsidy_t \cdot (1 + r_n)^{-t}}{\sum_{t=1}^T (1 + Inf)^t \cdot (1 + r_n)^{-t}}$$

inf= inflation, rn=discount rate (WACC), Tn=project lifetime

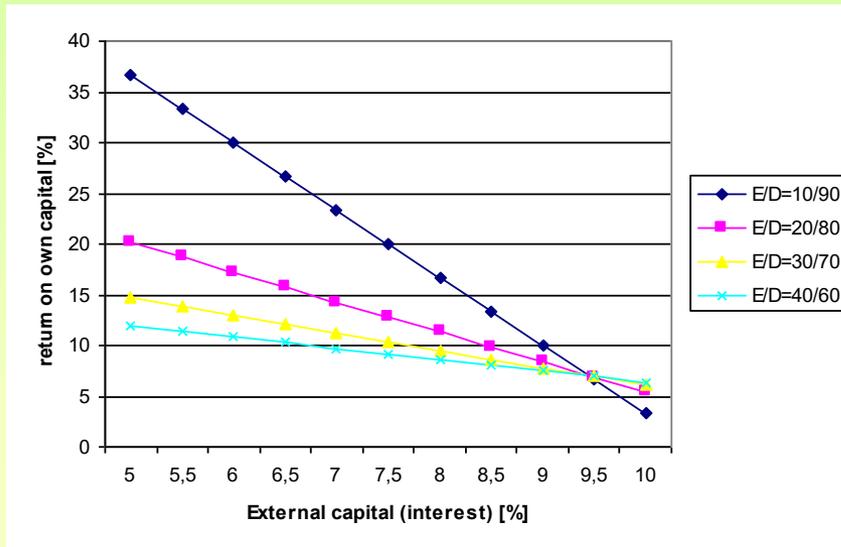
Rate of return is equal to discount rate

- **Discount taken as weighted average cost of capital - WACC (7%)**

RATE OF RETURN ON EQUITY

Discount as WACC

- Cmin calculation does not assume any specific structure of financing (E/D)



results in different rate of return to equity

based on different access to capital

GREEN BONUSES

- power is sold on free market, GB is extra revenue
- derived from minimum prices, higher risk included
- three discount rate categories based on ratio of secured and unsecured revenues
- estimation of power market price and power diagram are needed

$$GB_i \geq c_{\min^*} - MP_i$$

- **Green bonuses for co-firing have different methodology**

(Δfc increase of fuel cost, sa =saved em. allowance, k =coeff. of participation on em. allowances saving, d =depreciation of evoked investment, W =green power generated)

$$GB_{cf} > \frac{d}{W} + \Delta fc - sa \cdot k$$

POSSIBLE PROBLEMS OF SUPPORT SCHEME

- **WACC approach: different economic motivation for small and big investors (differ in access to capital)**
 - What is the main goal of the scheme ?
- **Uniform discount rate for all kinds of RES projects**
 - Leads to the assumption of the same risk
 - But projects differ in risk ! Preference of PV and wind projects.
- **Parallel support of some projects – investment support from structural funds**
 - Leads to the unequal position of different investors (no legal right for investment subsidy)
- **Heat utilization is not solved.**
- **RES utilization for heat production is not solved.**

POSSIBLE PROBLEMS OF SUPPORT SCHEME 2

- **Possible „back distortion“ of biomass market prices**
 - Expected prices of biomass can be easily derived from green bonuses values

- **Limitation of feed-in tariffs decrease can results in inadequate extra return (see PV)**

- **No „roof“ for any kind of RES**

- **Impossibility to include state strategy**

CONCLUSIONS

- **RES-E support scheme in the Czech Republic creates good and stable conditions for the investors**

- **Some imperfections still exist:**
 - different impact of rate on return approach to different investors
 - utilization of heat is not solved
 - possible parallel support
 - impossibility to include state strategy and preferences