Dr. sc. Milan Ivanović, dipl. oec.
Panon – Think tank for strategic studies, Osijek
E-mail address: panon.institut@gmail.com

Mr. sc. Franjo Ambroš, dipl. geod.
Geoprem d.o.o. - Osijek
31000 Osijek, Trg Lava Mirskog 1
E-mail address: franjo.ambros@geoprem.hr

Dalibor Mesarić, dipl. ing. el.
Faculty of Electrical Engineering - Osijek
E-mail address: dalibor2.mesaric@etfos.hr

MODELS OF INVESTMENT IN FIBER OPTIC NETWORKS AND IMPLEMENTATION OF THE "SLAVONIAN NETWORK" PROJECT

MODELI INVESTIRANJA U SVJETLOVODNU MREŽU I REALIZACIJA PROJEKTA „SLAVONSKA MREŽA“ -

ABSTRACT

The construction of fiber optic networks in telecommunications (broadband) in modern conditions is very important infrastructure project whose importance for the economy and society as a whole can be measured with the importance that had investments in the construction of railways or electrification in the nineteenth century. The Republic of Croatia in terms of coverage of its territory and population broadband access to the tail of the list of EU countries and must very rapidly overcome this lag to avoid further behind in economic and social development. Construction of optical network is financially and organizationally complex infrastructure project that is can not be financed as a private entrepreneurial investment. This paper: - discuss about the models of investment in optical network using examples of EU countries, - given a frame of structure on construction costs, - make an overview of incentives and forms of financing optical networks. Finally, proposal of model financing the construction of fiber optic network in the five counties of region within the project "Slavonia network" is given.

***Key words**: Broadband, Infrastructure, Investment, Model of financing*

SAŽETAK

Uvođenje svjetlovodne mreže u telekomunikacije (širokopojasni pristup Internetu) je u suvremenim uvjetima vrlo važan infrastrukturni projekt čija se važnost za gospodarstvo i društvo u cjelini može mjeriti sa značajem koji su imale investicije u izgradnju željeznica ili elektrifikacija u XIX. stoljeću. Republika Hrvatska u pogledu pokrivenosti svojeg teritorija i stanovništva širokopojasnim pristupom na začelju liste EU zemalja i mora vrlo ubrzano prevladati ovo zaostajanje kako ne bi još više zaostala u gospodarskom i društvenom razvoju. Izgradnja svjetlovodne mreže je financijski i organizacijski složen projekt koji se ne može financirati kao privatna poduzetnička investicija. U ovom radu se razmatraju modeli investiranja u širokopojasni pristup na primjerima EU zemalja, daje se okvirna struktura troškova izgradnje te pregled poticajnih mjera i oblika financiranja izgradnje ove mreže. Na

kraju, predlaže se model financiranja izgradnje svjetlovodn*e mreže na području pet županija istočne Hrvatske u okviru projekta „Slavonska mreža“.*

Ključne riječi: *Infrastruktura, Investicije, Modeli financiranja, Širokopojasni pristup*

1. The construction of the fibre optic network - civilisation challenge

The construction of fibre optic networks in telecommunications (broadband) in modern conditions is very important infrastructure project whose importance for the economy and society as a whole can be measured with the importance which had investments in railway construction or electri-fication in the nineteenth. century. [5] [8] [16] The Republic of Croatia concerning the broadband coverage of its territory and population at the tail of the list of EU countries and must very rapidly overcome this lag to avoid further behind in economic and social development. [2] [3] [13] In the region of Slavonia and Baranja is important to emphasize that according broadband coverage to population (third quarter 2013) on the list of Croatian counties, three counties - Brod, Požega and Virovitica – are in last place, Vukovar County is on 14 and Osijek on 7 place - as sufficient warning to needs of the seriousness action. [2] [3] [13] [14]

1.1. Categorization of availability to broadband

The availability of broadband to households certain areas are categorized with three colors:
a) The white areas include areas where broadband access is not available, or where there is no adequate broadband infrastructure.
b) The gray areas are those in which only one operator offers broadband services, or services offered multiple operators with insufficient level of competition, which has resulted in inadequate supply of broadband services to end users in terms of quality and price of services.
c) The black areas include areas where at least two operators offering broadband services, with a satisfactory level of competition, and the quality and price of services for end users.
This categorization of colors for areas of broadband services is implemented in two levels:
a) Basic (traditional) broadband access based on copper conductors that enable data transmission up to 10 Mbit/s;
b) NGA (broadband network of new generation) based on optical fibers that allow higher speeds up to 10 Gbit/s.

1.2. Developmental effects of broadband

Developmental effects of the broadband infrastructure are positive and can be classified into four main sectors: (a) education, (b) health and social care, (c) employment and economic development, and (d) energy and transport - which has already discussed in the papers [2] [3] [11] [13] [16], and here is a graphical presentation of the impact of the communications sector to economic growth.

Figure 1
The impact of the communication sector on the growth and productivity of the economy [8]

1.3. Models of the development of broadband infrastructure

The construction of broadband network is an infrastructure project that by its nature can not be financed only as a private entrepreneurial investment. EU strategic document Digital Agenda [5] committed to equal broadband access to population as a whole in the whole EU. In sparsely po-pulated (rural) areas of profitability of such investments are not motivated by telecomm companies (private companies) to invest in these areas. For these reasons, opened a series EU funds and approved giving state aid to build broadband infrastructure (under special conditions - in order not to distort the rules of free competition). Building broadband infrastructure in the EU is carried out intensively for ten years and has developed several models: (a) business, (b) market and (c) investments, which are deter-mined by: (1) competitive services, (2) public relations of local governments and private companies (operators) and (3) the investment share, responsibility for the construction and management of infrastructure, and (4) acquiring and retaining ownership of the built infrastructure. This complex problem of broadband building aggravated by a series of possible models using telecomm techno-logies; each of these has advantages and disadvantages. Therefore, it is important to be familiar with all the essential elements in the process of planning the construction of broadband.

1.4. Telecommunications network

Telecommunications network can be ground or air (on pillars). According to the type of material, guides can be copper or optical (glass fibers), for inaccessible areas using radio and satellite links.
Fiber optic networks are functionally divided into main and distribution. The main optical network consisting of fiber optic cables that connects of central office service provider (operators) to distri-bution node which can be in the street cabinet or already built in buildings. Distribution network consisting of a distribution node and optic cable to buildings, as well as vertical and horizontal fiber optic installations inside buildings to apartments or offices.

1.5. Access to the network

Access to the network is achieved by various technologies based on copper or fiber-optic con-ductors, or a combination thereof - with the use of different models of technological transfer

receipt and distribution of the signal. Here is a brief account of the basic models of access to the teleco-mmunications network that distributed network applications and services. It should be noted that for all the models shown there is no relevant practice - built networks in many regions and cities of Denmark, Finland, France, Italy, Lithuania , the Netherlands, Germany, Polish, Slovenia, Sweden , Great Britain and other European countries in the last five years. [1] [8] [17]

Fiber to the home (FTTH) involves laying a fiber-optic cable all the way from the central office/ local exchange (or suitable local access node, such as a public sector building) to the home. FTTH is the technology with the highest capacity, and therefore provides the highest degree of future proofing. However, due to the long distances involved in deploying a connection all the way to the home, the deployment costs of FTTH can be very high. To date, commercial deployments of FTTH have been limited due to this high cost. There are two main options for FTTH architecture: GPON and point to point (P2P). [1]

Fiber to the cabinet (FTTC) involves laying fiber from the central office (or local exchange) to a street cabinet or basement of an apartment block. Because the fiber is only laid for some portion of the distance to the home, significant cost savings can be realized relative to FTTH. However, as the copper network is used for the last part of the connection to the home, the speeds available on an FTTC network are also significantly lower than with FTTH (around 80% in terms of the cost to connect a home). As with FTTH technologies, the cost is strongly affected by the ability to reuse existing infrastructure.

Terrestrial wireless technologies provide a link between the home and the nearest network node without the need for a physical wireline connection. Terrestrial wireless networks are comple-mentary to fixed networks, and can be advantageous in areas where the installation of a wireline network is difficult and/or expensive (e.g. in mountainous terrain). However, because several users access the network via the same last-mile link (i.e. the wireless link), the contention32 for services can be much higher than on wireline networks, and the realized speed may be much lower than the maximum speed quoted by the service provider. In order to ensure an end user receives an assured level of service more base stations will have to be added, which will increase costs. It should also be noted that demand for high-speed rates from a large number of users on a wireless network tend to require additional investment in the fixed infrastructure that supports the wireless network.

DSL (copper-based) **broadband technologies;** basic broadband services are most often delivered over the existing copper network, using DSL technology. DSL technology has the advantage that it makes use of the existing access infrastructure and is therefore relatively cheap to deploy. However, the nature of the technology means that download speeds are heavily affected by the distance between the local exchange (central office) and the home, and in many cases are limited to below around 10Mbit/s.

The backhaul and core network are essential for the effective resolution of broadband services over large distances (e.g. between cities and surrounding villages) because of its economical way of covering a large number of end users in a large area. However, the development of backhaul/core network must rely on the existing access network. Traffic originating from a large number of end users is drawn through the pile and supporting the core network, and hence the selection of fiber optic cable common choice because of high transport capacity. [8]

1.6. Sources of financing the construction of broadband infrastructure

Building broadband infrastructure in major cities and urban agglomerations provides fast return on investment in investment (a few years) so that the telecommunications companies (private enterprise) finance this construction will continue to finance - according to market

[1] GPON = Gigabit Passive Optical Network, P2P = point-to-point; Read about it at: [1] [8] [17]

criteria. For other areas - smaller towns and rural areas - have been developed models subsidized the construction of broadband infrastructure, and their sources can be divided into three basic groups:

a) Public funds - covering all budgetary resources at the national level, the county level and local level (cities and municipalities), as well as all the funds are invested by the company in the public domain. Public funds are considered and resources from the EU Structural Funds (the European Regional Development Fund and European Social Fund) and the Cohesion Fund of the EU. EU funds can be co-financed construction projects broadband infrastructure to 85 %, while other funds from the national budget sources.

b) Private funds - include the private operators in the electronic communications and , possibly , means end users who may be involved in co-financing the construction of broadband infrastructure - usually the final segment of the access network .

c) Institutional investors - institutional investors believe the banks and investment funds, including pension funds. Since their primary interest is the realization of economic benefits, institutional investors appear as co-investors construction projects broadband infrastructure only in densely populated areas (usually black areas) where there are sustainable business models.

State aid (public funds) is justified in white and mostly gray areas, while the black areas are not jus-tified. The share of aid in the financing of projects, increasing to more sparsely populated areas (usu-ally white areas) and reaching 100 %. In contrast, the share of private funds operators increased by more densely populated areas (gray and black areas), while decreasing the share of public funds to fi-nance projects. The black areas of public funds may be invested under normal market conditions (when not state aid) together with the means of private operators and institutional investors. [11]

2. Investment models in optical network

Projects construction of broadband infrastructure can be derived through a number of investment models, which are defined by: relations of public authorities and private enterprises (operators) in the project. These relationships include investment shares responsibility for building and managing a network and acquiring and retaining ownership of the built infrastructure. [1]

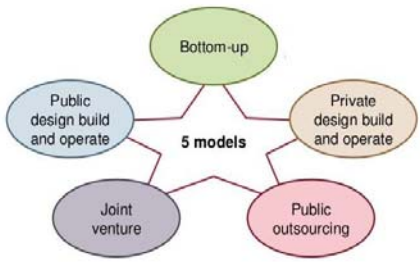

Figure 2
Models of investment in broadband network [1]

In practice, the most commonly used investment following models:

Bottom up m**odel** (a model community) includes a group of end users in the local community who are organized jointly owned and democratically controlled group that is able to monitor the contract to build a local network. Public sector here is limited to providing support - as the guarantor of the loan and/or facilitates access to publicly-owned infrastructure such as ECI.

Private DBO model includes cases in which private operators, customer support, entitles the construction and management of infrastructure, with the permanent retention of ownership of such a good infrastructure. This model does not require significant involvement of public authorities in the implementation of projects. It is protection of the public interest is limited; since the infrastructure is built with incentives remain the property of the private operators.[2]

[2] DBO is an abbreviation of the word: Design, Build and Operate that mark important stages of EKI construction.

Public outsourcing is similar to private DBO model with the difference that the infrastructure built public incentives - after the contract expires on external services - remains in the public domain. Under this model, a single contract is awarded to all aspects of the construction and operation of the network. The main feature of this model is that the network launched the private sector, but public sector retains ownership and control of a network.
Joint venture is based on a contract which is owned network is divided between public and private sectors. Construction and operational functions are likely to be undertaken by the private sector. The model implies a joint venture investment by local authorities and private operators , possibly with the financial participation of institutional investors ; in this way it is possible to balance the public interest (coverage of broadband infrastructure) and the interests of private investors (the realization of economic profit).
Public DBO model includes all cases in which the implementation of the construction of broad-band infrastructure under the control of public authorities (without any help from the private sector) where the ownership of the built infrastructure remains permanently in the public domain. Model of Public DBO requires significant involvement of administrative and technical capacity of local govern-ments, but allows long-term preservation of the public interest. The operating company in the public sector can act on the entire network, or may perform services to the wholesale and retail private operators leave the service.
Public DBO model is appropriate in cases where the application of any other models allow granting excessive benefits individual operator, such as cases of construction of basic infrastructure, and building economically unsustainable infrastructure (e.g. links to villages in sparsely populated areas). On the other hand, private DBO model is appropriate in the case of private operators already have the basic infrastructure (e.g. PAIR access network or radio network) and the application of state aid as possible to improve the infrastructure in the public interest. Model joint venture rule applies in areas where there are sustainable business models of broadband construction, whereby local authorities' parti-cipation in the project facilitate private operators investing in infrastructure (application model joint venture is generally not regarded as State aid). Also, within a single project, it is possible to combine multiple investment models (e.g. construction ECI model public DBO rights and abandonment of infrastructure management by the private operator model of external services). More recently (in late 2013) opened the possibilities of applying the model of public-private partnership (PPP).

2.1. Other elements for assessment of the possible development of network infrastructure

There are a number of other factors that are important for the governing body to consider the pro-jects of development of network infrastructure.
Technical expertise; technical experts should be involved in the process of planning the develop-ment of fiber optic infrastructure. And here there are numerous examples of good practice; the pro-ject Midtsoenderjylland municipalities in Denmark have its fiber optic master plan have formed the basis of the master plan of the Center for Network Planning at Aalborg University, which was available for free. This is the master plan for the region save about 25 % of the cost compared to what was previously planned. But there are also negative experiences - especially when expertise is not used efficiently: this is a project in France - the network operator must install more wireless transmitters from objectively necessary. [8]
Obsolescence of network technologies; technological obsolescence of network technology is a common problem in telecommunications, because in this rapidly developing technology sector - so that realized investment when the network becomes operational, is outdated and must implement system upgrades. For example, when it comes to the choice of the network between copper and fiber-optic technology implemented some projects already implemented

system upgrades. When it comes to the choice of optical technology (FTTC vs. FTTH) difficult (without research) to know what is the appropriate solution, because the operators in developed markets have adopted different stra-tegies; for example (U.S.A.) - the company Verizon is pursuing FTTH strategy and AT&T decided to FTTC. [17]
State measures to encourage the construction of broadband infrastructure may involve state aid, in accordance with the general rules on state aid at EU level. The same rules are elaborated in more detail following the current practice in EU countries and formalized within the Guidelines on state aid related to the rapid development of broadband networks, which are transmitted through the eponymous decision in the Croatian legal system. Government grants are generally justified if the positive effects of the aid, which in the context of broadband implies the availability of infra-structure across the entire national territory, dominate the negative effects related to the potential distortion of competition, or the giving of the benefits of private operators, the grant. [11]
Public broadband investment should be structured so as to reduce the barriers for end - users it and service providers - that is, to ensure that services are available and that the population uses them. For service providers, it is important to define the operational areas of adequate size, if they are too small areas it can impose a huge burden provider, on the other hand, large areas of low density may impede the operator sustainable business.
In conclusion it should be emphasized that there is no model that fits every situation, and mana-gement - the local authorities must take into account all the advantages and disadvantages of each model in order to realistically assess the situation. Therefore it is essential for local government and regional administrations cooperate with: (a) professional teams who are familiar with the issues of broadband development (b) the potential private partners at an early stage of the planning process in order to realistically determine parameters for different models of investment.

2.2. Construction of broadband infrastructure in Croatia

Company "Lator" (Zagreb) for the Ministry of Transport is made proposal study “Programs con-struction of broadband infrastructure in Croatia” [11] in accordance with the objectives of the nati-onal development strategies of the broadband. Programs that include government grants are design-nated as PDP (1-5), where the program PDP1 further divided into two subprograms (PDP1a and PDP1b, the white or gray areas). The study proposes the implementation of the program in Croatia through three phases:

a) Phase I - covered by the access and aggregation network in traditional white areas (programs PDP1a, PDP2 and PDP3);
b) Phase II - included in the aggregate network in traditional gray areas (program PDP1b);
c) Phase III - includes access network in the traditional gray and black areas (PDP4, PDP5 and P6).

Table 1 (in attachment) gives an overview of the proposed incentive construction of broadband infra-structure.
The study was performed and classification of color regions in Croatia with regard to traditional and NGA broadband. Black areas generally include settlements with more than 2,000 inhabitants, while the white areas usually settlements with fewer than 200 inhabitants. In terms of NGA broadband majority Croatian NGA is white, with the exception of the four largest cities (Zagreb, Split, Rijeka and Osijek) and municipalities Bistra (pilot project T_HT) which are categorized as NGA gray. [11]

3. Development of broadband access in Slavonia and Baranja

Faculty of Electrical Engineering is the end of 2012. launched the project "Slavonian network - development of broadband access in five counties of Slavonia and Baranja, in the framework of the Strategy for the development of broadband in the Republic of Croatia 2012th - 2015th years in the previous period realized a number of preparatory study [2] [3] [12] [13] and preliminary design "Slavonian network" (worth € 20 million) was accepted in the competition of the Ministry of transport, Croatia;[3] [14]
Results of said study - with special reference to the situation in the region of Slavonia and Baranja - are shown in Tables 2 and 3 and graphs 3 - 4;

Table 2 White, gray and black areas of basic broadband

Areas	Croatia		Slavonia and Baranja	
	N° inhabitants	%	N° inhabitants	%
White	92.115	2,2	23.685	2,94
Grey	1.842.414	43,1	452.420	56,24
Black	2.338.249	54,7	328.404	40,82
Total	4.272.778	100	804.509	100

Source: [4] [11] and authors' calculations

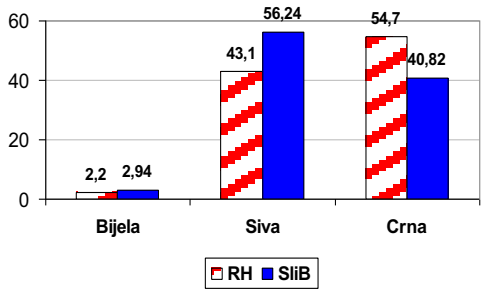

Figure 3
White, gray and black areas of basic broadband

Table 3 White, gray and black areas of the NGA broadband

Areas	Croatia		Slavonia and Baranja	
	N° inhabitants	%	N° inhabitants	%
White	3.202.702	74,96	720.112	89,61
Grey	1.070.076	25,04	83.496	10,39
Black	0	0,00	0	0,00
Total	4.272.778	100	804.509	100

Source: [4] [11] and authors' calculations

[3] The project is highly ranked (in the first third) between 50 RC projects for EU funds.

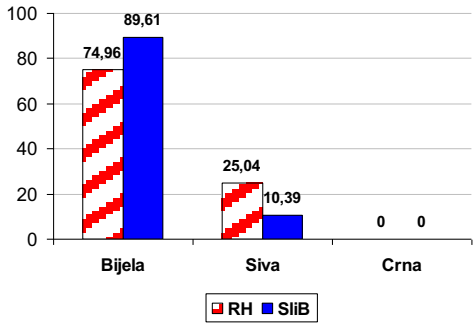

Figure 4
White, gray and black areas of the NGA broadband

4. Conclusion

The construction of fiber optic networks in telecommunications (broadband) is in modern conditions is very important infrastructure project whose importance for the economy and society as a whole can be measured with the importance which had investments in railway construction and electrification of the XIX century. The Republic of Croatia in terms of coverage of its territory and population of broadband access to the tail of the list of EU countries and has rapidly overcome this lag to avoid further behind in economic and social development.

Coverage of the territory and population in the five counties of the region Slavonia, in turn, the Croatian frames (except the city of Osijek) below average RH - which seriously warns of the need to take urgent and professional activities to develop capacity-building broadband programs in this area.

Our consideration of the essential elements of broadband development and investment models in the optical network using examples of EU countries has pointed to the complexity of the project broadband development and the importance of involving professional teams in project planning construction of broadband.

Therefore, to the governing bodies of regional and local authorities in the region Slavonia and Baranja we propose:

a) Urgent implementation of the preparatory phase of the project "Slavonian network",

b) Launch education of officials and local government bodies on the project "Slavonian network",

c) Initiation of proceedings for a complex application cadastre (infrastructure) lines,.

d) Initiation of proceedings to prepare a master plan for the project "Slavonian network".

REFERENCES

[1] Analysis Mason (2011.): ***Guide to broadband investment**, Final report*, http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=7630

[2] Ambroš, F.; Mesarić, D.; Antunović, M.; Ivanović, M. (2013.): ***Razvoj i održavanje širokopojasne mreže nove generacije u Slavoniji i Baranji*** ;22.nd Scientific Meeting „Organisation and Technology of Maintenance"- OTO '2013. Osijek, Faculty of Electrical engineering, 26. April, Proceedings, pp 77-86

[3] Ambroš, F.; Ivanović, M.; Mesarić, D. (2013.): ***Izgradnja komunalne infrastrukture i razvoj optičke mreže na području Slavonije i Baranje;*** 4th International Conference "PLIN '2013"; Osijek, 26. - 28. September; Proceedings, pp 1-10

[4] DZS (2012.): *Popis stanovništva '2011;* http://www.dzs.hr/

[5] EC (2010.): ***Digital Agenda for Europe***, http://ec.europa.eu/information_society/digital-agenda/index_en.htm

[6] EC (2011.): *Public consultation* – ***Revision of the Guidelines on public funding to broadband networks***, http://ec.europa.eu/competition/consultations/2012_broadband_guidelines/

[7] EC (2012.): ***Digital Agenda Scoreboard - Electronic Communications Market Indicators,*** http://ec.europa.eu/information_society/digital-agenda/scoreboard/2012.pdf

[8] Fornefeld, M.; Delaunay, G.; Elixmann, D. (2008): ***The Impact of Broadband on Growth and Productivity***, MICUS Consulting GmbH, Düsseldorf, Germany breitbandinitiative.de/wp/wp.../2008_micus-studie-broadbandeu_long.pdf

[9] Frontier Economics (2010): ***The impact of broadband in Eastern and Southeast Europe***, cdn1.telekomaustria.com/.../broadband-study.pdf

[10] Ivanović. M.; Širić, M. (2008.): ***The Knowledge Economy and Development of New Technologies for Knowledge Society,*** XXVII Int. Conference Science in Practice, Osijek, 5-7 May, Faculty of Electrical engineering Osijek; Proceedings, pp 31 – 36

[11] Lator, d.o.o. (2012.) ***Studija o odabiru najpovoljnijih modela financiranja i poticajnih mjera za ulaganja u infrastrukturu širokopojasnog pristupa*** (www.mppi.hr/)

[12] Medved, J.; Tumir, P.; Ivanović, M. (2014.): ***Važnost amortizacije infrastrukturnih instalacija - prilozi strukturiranju projekta „Slavonska mreža"***; 23rd Scientific Meeting „Organisation and Technology of Maintenance"- OTO '2014; Požega, 24.- 25. April; ISBN 978-953-6032-77-9, Faculty of Electrical engineering, Proceedings, pp 117-126

[13] Mesarić, D.; Ambroš, F.; Ivanović, M (2013.): ***Development of broadband network in Slavonia and Baranja***, 2nd International scientific conference „Economy of Easter Croatia", Osijek, May, 23-25, 2013; ISBN 978-953-253-106-0, Proceedings, pp 54-64

[14] Mesarić, D.; Ambroš, F.; Ivanović, M. (2013.): ***„Slavonska mreža" - razvoj mreže širokopojasnog pristupa Internetu na području pet županija regije Slavonija i Baranja -*** Idejni projekt – prijavljen Ministarstvu regionalnog razvoja i EU fondova, Elektrotehnički fakultet Osijek

[15] Ministarstvo pomorstva, prometa i infrastrukture RH (2011.): ***Provedbeni program Strategije razvoja širokopojasnog pristupa u RH razdoblje od 2012. do 2013. godine*** (NN 144/11)

[16] Sabor RH (2011.) ***Strategija razvoja širokopojasnog pristupa u Republici Hrvatskoj u razdoblju od 2012. do 2015. godine*** (NN 144/11)

[17] WIK-Consult (2008.): ***The Economics of Next Generation Access*** – *Final Report*, wik.org/uploads/media/ECTA_NGA_masterfile_2008_09_15_V1.pdf

Table 1 - Overview of incentive measures for construction of broadband infrastructure

	PDP1	PDP2	PDP3	PDP4	PDP5	P6
Target areas	**PDP1a** White - settlement > 50 inh **PDP1b** Siva pod.	White areas settlement < 50 inh.	White areas settlement > 50 inh.	Grey areas	Black areas settlement 2.000 - 50.000 inh.	Black areas cities < 50.000 inh.
Population *(% RH)*	**PDP1a** 81.000 (1.9%) **PDP1b** 1.840.000 (43.1%)	81.000 (1.9%)	11.000 (0.3%)	1.840.000 (43.1%)	1.050.000 (24.4%)	1.300.000 (30.3%)
Part of the network	Aggregation links	Access network	Access & aggregat. network	Access network	Access network	Access network
Broadband level	Fast (possible subsequent upgrade to ultrafast)	Fast (acceptable basic with obligation upgrades)	Basic	Fast	Ultrafast (friendly fast with obligation to update)	Ultrafast (friendly fast with obligation to update)
Possible Invest. models	Public DBO	Private DBO	Private DBO	Private DBO	Outsourcing Private DBO Public DBO	Joint venture
Sources of funding	Public (State and/or regional budgets, EU funds)	Public (State and/or regional budgets, EU funds) Private (Operator direct user of support to program)	Public (State and/or regional budgets, EU funds) Private (Operator direct user of support to program)	Public (State and/or regional budgets, EU funds) Private (Operator direct user of support to program)	Public (local and/or regional budgets, EU funds) Institutional (banks as creditors) Private (Operator user of support or partner)	Public (local budgets, EU funds) Institutional (invest.funds, banks) Private (operator as partner)
Business model	Wholesale	Wholesale Retail	Vertical integrated	Wholesale Retail	Wholesale (exclusively)	Wholesale Retail
Funding required (mil. kn)	**PDP1a** 441 **PDP1b** 4,167	71	252	1,067	3,647	2,361
Share of public funds	to 100%	to 70%	to 100%	to 55%	to 35%	to 30%

Izvor: [11]